ISSUES PAPER

Population status and threats to ten seabird species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*

Natural Heritage Trust

Helping Communities Helping Australia

A Commonwealth Government Initiative

Australian Government

Department of the Environment and Heritage

Prepared by the Department of the Environment and Heritage, Canberra, from a background document developed under a consultancy by the Tasmanian Department of Primary Industries, Water and Environment and funded by the Natural Heritage Trust.

The recovery plan linked to this paper is obtainable from:

http://www.deh.gov.au/biodiversity/threatened/publications/recovery/seabirds/index.html

or:

Community Information Unit
Department of the Environment and Heritage
GPO Box 787
Canberra ACT 2601
Ph: 1800 803 772

ISBN: 0642550050

CONTENTS

SUMMARY OF GENERIC ISSUES AND RECOMMENDATIONS

Introduction of predators to breeding islands

- Appropriate quarantine measures should be implemented/maintained by management authorities at important breeding sites for seabirds (sub-antarctic Heard Island, Macquarie Island, Houtman Abrolhos Group, North Keeling Island, Raine Island, Maatsuyker Island) to maintain a barrier to exotic predators and other mammal species.
- Management programs to control or preferably, eliminate feral mammal species at other sites, particularly Macquarie Island, should be supported and implemented.

Fisheries-related mortality

- Interactions with fisheries is not considered an issue for the species of petrels, terns and shags covered by this document.

Marine pollution

- The incidence and level of marine contamination in the 10 seabird species covered by this document is presently unknown.
- Marine pollution is a global phenomenon that needs to be rectified through international conservation fora.
- National responses to oil spills should accord with the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances.
- Planning for oiled wildlife response should include response strategies for remote locations, including the sub-antarctic Macquarie and Heard Islands.
- Proposals for oil and mineral exploration and exploitation should be adequately assessed and, as appropriate, conditions imposed to ensure there are no adverse effects on seabirds, particularly threatened species.

Marine debris

- There is no evidence that marine debris ingestion or entanglement is currently a significant threat to any of the 10 seabird species covered by this document.
- Nonetheless, development of a threat abatement plan for the Injury and Fatality Caused by the Ingestion and Entanglement of Marine Life in Marine Debris will benefit all seabird species.

Storms and cyclones

- Most seabirds can be significantly impacted by stochastic events such as storms and cyclones, but there is no practical or feasible way to manage this process.

Climate change

- Loss of climatic habitat, including an increase in sea surface temperature, caused by anthropogenic emissions of greenhouse gases is a potential threat to all Australian seabirds. Management of this process requires both domestic and international action, and is beyond the scope of individual species recovery plans.
- Given the poor knowledge of the oceanic distribution for the species covered by this document, it is difficult to assess the impact of climate change on the 10 threatened seabird species and thus develop appropriate management responses.

Biological and ecological information

- There is a need to improve biological and ecological knowledge for all the 10 threatened seabird species covered by this document.
- Such knowledge is essential for the planning and implementation of recovery actions.
- In some cases, consideration should be given to initially conducting studies on the larger extralimital populations, to minimise disturbance to the extremely small Australian populations.
- Low key monitoring programs for Australian populations should be established/maintained to gauge the status of the species and to guide habitat management and the control of threats.
- Identify any emerging threats that will have impact on these threatened seabird species covered by this document and develop appropriate response(s).

SUMMARY OF SPECIES ISSUES AND RECOMMENDATIONS

Tropical gadfly petrels – Round petrel and Herald Island petrel

- There is taxonomic uncertainty regarding the '*Pterodroma arminjoniana/heraldica'* type petrel that was recorded on North Keeling Island in the 1980s. Further, there have been no records since that time, despite recent attempts to locate birds. Breeding has never been confirmed on North Keeling Island.
- If a species of *Pterodroma* still occurs on North Keeling Island, collection of genetic material for analysis should be considered a priority, together with collection of a range of morphometric data, to determine its true taxonomic affinity. It should be noted that killing a live bird to achieve taxonomic resolution is unacceptable as non-lethal methods such as blood or feathers can provide appropriate genetic material. Until taxonomy and breeding are confirmed, the Round Island Petrel should be considered a vagrant or irregular visitor.
- Should Round Island Petrels still occur on North Keeling Island, establish whether or not breeding occurs and establish appropriate on-going monitoring programs.
- Appropriate quarantine measures should be implemented/maintained by management authorities at North Keeling Island and Raine Island to maintain a barrier to exotic predators.

Soft-plumaged petrel, blue petrel and fairy prions (southern)

- On Macquarie Island, the integrated eradication of feral pests – rabbits and rodents – must be given highest priority to assist effective conservation of all burrowing petrel species on the island.
- Strict quarantine procedures for access to Maatsuyker Island should be introduced to minimise the risk of introducing feral pests to the island. Quarantine procedures for Macquarie Island must be continued.
- Targeted long term monitoring for all three species should be implemented in order to track the trends in their population numbers, breeding effort and productivity, including the response to eradication of feral pests. Such monitoring must be conducted so as to minimise any researcher impact.
- The taxonomic status of fairy prions on Macquarie Island should be clarified. The subspecies are currently distinguished on the basis of bill characters and plumage. A global review of the group, incorporating molecular markers, would assist in clarification.
- The rock stacks adjacent to Macquarie Island should be surveyed to assess population size of threatened species present.
- Where possible, long radio and HF dipole aerials should be replaced by whip aerials to reduce the incidental mortality caused by bird strike. Ongoing monitoring of numbers killed by strikes to assess success of replacement aerials should be conducted.

- The taxonomic status of Soft-plumaged Petrels breeding on Maatsuyker Island (and Macquarie Island, should breeding be confirmed) should be established.
- All colonies to be protected and managed in such a way that human disturbance is minimised.

Heard shag and Macquarie shag

- On Macquarie Island, conduct annual island-wide breeding census, incorporating visits to all sites known to have been used for breeding. Surveys to be timed and recorded so that meaningful assessments of population status and inter-annual variation can be drawn.
- The presence/status of the Macquarie shag population breeding on Bishop and Clerk Is should be assessed.
- Complete surveys of Heard Shag populations to be undertaken when possible in order to assess population status.
- Progress feral pest eradication program on Macquarie Island to mitigate possibility of rat predation on eggs and chicks.
- Ensure effective quarantine programs at all sites to minimise introduction of pests.
- Where possible, long radio and HF dipole aerials should be replaced by whip aerials to reduce the incidental morality caused by bird strike.
- All colonies to be protected and managed in such a way that human disturbance is minimised.
- Maintain current prohibitions of fishing in waters immediately adjacent to the breeding islands. .

Antarctic tern (New Zealand) and Antarctic tern (Indian Ocean)

- Continue monitoring of breeding population size and breeding success on Macquarie Island.
- When possible, monitor breeding population size and breeding success on Heard Island.
- Progress feral pest eradication program on Macquarie Island to mitigate possibility of rat predation on eggs and chicks.
- Continue rabbit control on Macquarie Island
- Ensure effective quarantine programs at all sites are maintained to minimise the introduction of pests.
- All colonies to be managed in such a way that human disturbance is minimised.

Australian lesser noddy

- The existence of Australian lesser noddies at Ashmore reef requires confirmation.
- Should Australian lesser noddies still occur at Ashmore Reef, establish their taxonomic affinity, and whether or not the population is a breeding population. All colonies should be managed in such a way that human disturbance is minimised.
- Maintain monitoring and management of breeding islands at Houtman Abrolhos.
- Implement the recommendations of the Fisheries Management Paper No.117 (Department of Fisheries 2002) in relation to exotic plant and feral animal control and quarantine procedures to prevent introduction of exotic plants and animals.

PART A: Introduction and Generic Threats and Issues

1. Purpose

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a comprehensive legislative framework to protect Australia's marine environment. A list of threatened species has been established under Part 13 of the EPBC Act. Species on this list are considered extinct in the wild; critically endangered; endangered; vulnerable; or conservation dependent. Listed threatened species are protected to help ensure their long-term survival.

The EPBC Act provides for recovery plans to be made for the purposes of the protection, conservation and management of listed threatened species. Recovery plans must set out the recovery objectives and actions required to achieve those objectives, performance indicators, in addition to identifying who is responsible for implementing the actions and the timeframes involved.

The seabird species listed in Table 1 all appear on the EPBC Act list of threatened species and therefore require the development of recovery plans.

Table 1: Seabird species requiring recovery plans under the EPBC Act.

Species scientific name	Species common name	EPBC Status	Date of listing
Pterodroma arminjoniana	Round Island petrel	Critically endangered	2/7/2002
Pterodroma heraldica	Herald petrel	Critically endangered	2/7/2002
Sterna vittata bethunei	Antarctic Tern (New Zealand)	Endangered	16/7/2000
Sterna vittata vittata	Antarctic Tern (Indian Ocean)	Vulnerable	16/7/2000
Halobaena caerulea	Blue Petrel	Vulnerable	16/7/2000
Pachyptila subantarctica	Fairy Prion (southern)	Vulnerable	16/7/2000
Phalacrocorax nivalis	Heard Shag	Vulnerable	16/7/2000
Phalacrocorax purpurascens	Macquarie Shag	Vulnerable	16/7/2000
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable	16/7/2000
Anous tenuirostris melanops	Australian lesser Noddy	Vulnerable	16/7/2000

2. Scope and limitations

This document covers all the seabird species and taxa listed in Table 1. It aims to provide a contemporary picture of the biology of these taxa, and to identify the threats to their long-term persistence in the wild. This document is not a recovery plan and hence does not prescribe management actions necessary to address population decreases. A separate recovery plan for the species is being prepared by the Australian Government Department of the Environment and Heritage. However, where appropriate management strategies are evident they have been identified.

The format of this document closely follows that developed by Taylor (2000) who prepared a national seabird conservation strategy for New Zealand seabirds. There are two parts to this report. Part A provides an introduction to the taxa covered by the report and covers issues and threats that are applicable to all seabird species and taxa. Part B assesses the biology and conservation issues specific to each species or taxon. Because some of the taxa addressed share similar biology, they have been arranged into five groupings. The evaluations for each taxon/group have focussed on global populations in general and Australian populations in particular, addressing key information on the population status, distribution and threats for all the listed taxa. The document format has been structured to permit an extension to include other seabird taxa should they become listed under the EPBC Act.

3. Sources of information

This review has been prepared following a review of the literature and subsequent consultation with relevant agencies, individuals, researchers and interested organisations to ensure that the most current information on each species is collected. The main source of information on Australian seabirds is the *Handbook of Australian, New Zealand and Antarctic Birds* Volume 1 (Marchant and Higgins 1990) and Volume 3 (Higgins and Davies 1996). These were used extensively to collect information about taxonomy, distribution, abundance, biology and ecology.

The *Action Plan for Australian Birds 2000* (Garnett and Crowley 2000), *Threatened Birds of the World* (Birdlife International 2004) and Baker *et al.* (2002) were used as the main source of information on the conservation status and threats to Australian populations. Other important references included Warham's two volumes on the petrels (Warham 1990; Warham 1996) and the recently published *Albatrosses and petrels across the world* (Brooke 2004).

Information was also sought from other researchers with experience of some or all of the taxa covered by this document. The assistance of the following experts is gratefully acknowledged Barry Baker (Australian Antarctic Division), Geoff Copson (DPIWE), Wendy Murray (Parks Australia North, DEH) and Martin Schulz.

4. Threats to seabirds

The threats identified below comprise the major threats that currently endanger seabird populations in Australia. Although some of these (e.g. fisheries-related mortality) are not currently thought to threaten the 10 listed seabirds considered in this document, they are included here for completeness.

4.1 Introduction of predators to breeding islands

Although native species can be serious predators of seabirds e.g. pied currawongs *Strepera graculina* and Australian ravens *Corvus coronoides* (Priddel and Carlile, 1997), Lord Howe Island woodhen *Gallirallus sylvestris* (A. Bester unpublished), the major threat of predation to seabirds comes from alien species.

Alien pest species may reduce seabird population sizes by predation of adults and or nest contents (eggs and chicks), nest destruction and habitat modification. Introduced mammals are the foremost land-based threat to seabirds on sub-Antarctic islands (Jouventin and Weimerskirch 1991). Seabirds are especially vulnerable to alien mammalian predation specifically due to their lack of effective anti-predator behaviour; the habit of most species of nesting at ground level and leaving chicks unattended during long-range foraging; and their low annual productivity. Smaller species are particularly at risk from predation since breeding age adults in addition to chicks are killed (Baker *et al*. 2002).

Three mammal species have posed the most significant conservation problems for Australian seabirds in recent years: – cats, rats and rabbits. Cats and rats directly impact seabirds through predation of eggs, chicks and adults, and rabbits damage vegetation leading to loss of breeding habitat (Baker *et al*. 2002). Two of these species have been listed as Key Threatening Processes under the EPBC Act and Threat Abatement Plans prepared to manage their impact (Environment Australia 1999a; 1999b).

Many islands that are important breeding sites for seabirds are currently free of predators, and at these sites feral predators would not be considered an immediate threat. However, the risk of alien introductions is always present, particularly where islands are visited regularly by humans. Small populations of seabirds, in particular, could be immediately threatened if the predator-free status of important breeding sites was lost. Appropriate quarantine measures should be put in place at these breeding sites to minimise this threat.

Issues and Recommendations

- Appropriate quarantine measures should be implemented/maintained by management authorities at important breeding sites for seabirds (sub-antarctic Heard Island, Macquarie Island, Houtman Abrolhos Group, North Keeling Island, Raine Island, Maatsuyker Island) to maintain a barrier to exotic predators and other mammal species.
- Management programs to control or preferably, eliminate feral mammal species at other sites, particularly Macquarie Island, should be supported and implemented.

4.2 Fisheries-related mortality

Each year tens of thousands of seabirds are accidentally killed on longline hooks when birds, attracted to fishing vessels by discards and baits, ingest baited hooks during the setting or, less commonly, hauling of the longline. The hooked birds are subsequently pulled under the water by the weight of the line and drown. The extent of this mortality is such that longline fishing now represents a major threat to many seabirds, causing widespread decreases in breeding populations (Baker *et al*. 2002).

While this threat is known to impact many seabirds, there is no evidence to suggest that any of the 10 species covered by this issue paper are likely to be caught incidentally in longline fisheries. These birds either do not follow boats (e.g. Soft-Plumaged Petrel, Herald Petrel), do not feed in areas where fisheries operations are undertaken (e.g. shags) or have not been recorded as bycatch in any fishery for which data exists (Environment Australia 1998; Rosemary Gales and Barry Baker unpublished). It is the larger petrel species (body mass >400g) that are able to swallow baited hooks and that habitually follow ships that are recorded as bycatch in longline fisheries (Baker *et al*. 2002). Longline fishing is unlikely to threaten any of the gadfly petrels or other seabird species addressed in this document.

There is considerable trawl fishing within Australian waters and many sea birds have learnt to scavenge prey caught within the trawl net during the net haul process. Considerable mortality can occur as birds become entangled in the net or trawl gear, or collide with trawl apparatus and monitor cables (Baker *et al*. 2002). As described for longline fishing, the 10 seabird species covered by this document do not typically overlap with fishery operations in their daily foraging routines, or do not follow boats, and hence are unlikely to be impacted directly by trawl fisheries (Baker *et al*. 2002). Some species of seabird are potentially affected by competition with commercial fisheries, although this is not currently an issue for any of the species covered by this plan.

Issues and Recommendations

- Interactions with fisheries is not considered an issue for the species of petrels, terns or shags covered by this document.

4.3 Marine pollution

Chemical contamination has been clearly implicated in the decline of a number of seabirds. Its relevance to the conservation of albatrosses and petrels has been reviewed recently by Baker *et al*. (2002), and includes deleterious effects through diminished reproductive success caused by eggshell thinning, embryo inviability and offspring deformities. Elevated levels of chemicals and heavy metals can be found in the plasma of adults, chicks and eggs of seabirds from every continent and virtually all islands across the globe. Organochlorines and heavy metals degrade very slowly in the environment, are retained by organisms and passed along the food chain, becoming increasingly concentrated. Consequently, top order predators, such as seabirds, may accumulate high levels of chemicals in tissues, a problem which is exacerbated because these birds are long-lived and highly mobile species.

Bulk fuel and oil spills also have the potential to affect high numbers of seabirds. Birds coming into contact with oil can become physically smothered, or suffer oiled plumage, which leads to reduced insulation and increased heat loss, loss of waterproofing, reduced ability to forage efficiently, usually resulting in emaciation and death. Birds may also ingest oil, leading to potential toxicity. Since seabirds spend much of their time on the sea surface, they are particularly vulnerable to the hazards of oil or fuel spills and are difficult to rehabilitate.

Shipping discharge of oil and other pollutants is regulated by the International Convention for the Prevention of Pollution from Ships (1973) and its Protocol (1978) - MARPOL 73/78. The Australian Maritime Safety Authority (AMSA) administers MARPOL in Australian waters under the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*.

Response to marine oil spills are managed by AMSA, with the States and the Northern Territory, through the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances (AMSA 1996). The Plan sets out the role and responsibilities for government and industry in the event of an oil spill. The Plan identifies the potential effects on wildlife and the operations and procedures that should be put into place in the event of an oil spill. However, with current resources, when the incident occurs in remote areas, there may be little that can be done when large numbers of birds are affected.

Marine pollution is becoming increasingly apparent in the southern hemisphere and impact on Australian seabirds is likely to increase in the future. Internationally, only a few studies of any seabird species have been undertaken to identify whether marine contaminants (e.g. organochlorines and dichloro-diphenyl-trichloroethane (DDT) affect seabird survival, in particular aspects of their breeding biology (Croxall 1998; Ludwig *et al.* 1998).

Issues and Recommendations

- The incidence and level of marine contamination in the 10 seabird species covered by this document are unknown.
- Marine pollution is a global phenomenon that needs to be addressed through international conservation fora.
- National responses to oil spills should accord with the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances.
- Planning for oiled wildlife response should include response strategies for remote locations, including the sub-antarctic Macquarie and Heard Islands.
- Proposals for oil and mineral exploration and exploitation should be adequately assessed and, as appropriate, conditions imposed to ensure there are no adverse effects on seabirds, particularly threatened species.

4.4 Marine debris

Marine debris can affect seabirds either through ingestion or entanglement. Most of the marine debris affecting seabirds are derived from material jettisoned by vessels at sea (Huin and Croxall 1996).

Many species ingest considerable quantities of plastic and other marine debris, which has a wide range of lethal or sub-lethal effects. The debris can cause physical damage, or perforation, mechanical blockage or impairment of the digestive system, resulting in starvation. Chicks appear to be at greater risk than adults because of their high rates of ingestion and low frequency of regurgitative casting of indigestible material. When the plastics are regurgitated to chicks, the physical impaction and internal ulceration are likely to lower survival. In addition, the chick receives less food, lowering its nutrient intake and increasing its chances of starvation (Fry *et al*. 1987; Sileo *et al*. 1990).

Some seabirds are also killed after becoming entangled in marine debris (Nel and Nel 1999). Such entanglement can constrict growth and circulation, leading to asphyxiation. Entanglement may also increase the bird's drag coefficient through the water, causing the animal to die due to reduced ability to catch prey or avoid predators. The rate of this source of mortality remains completely unknown for Australian species.

Injury and Fatality Caused by the Ingestion and Entanglement of Marine Life in Marine Debris has been listed a Key Threatening Process under the EPBC Act. It was considered that 20 listed species are adversely affected by marine debris. Of the species covered by this issues paper, the Blue Petrel is among those listed as being adversely affected by marine debris, through the ingestion of floating particles of plastic perceived as food by the birds.

The problems of plastic ingestion and entanglement may affect many Australian breeding petrels, and has been reviewed in Baker *et al.* (2002). While it is likely that most seabirds ingest plastic debris without it being observed or documented, and birds of any species may become entangled in marine debris from time to time, there is currently no evidence that these are a significant threat to any Australian seabird species, with the possible exception of the flesh-footed shearwater *Puffinus carneipes* (D.Priddel unpublished). There are recent records of plastic ingestion in 2 of 18 Antarctic prions at Heard Island (Auman et al. in press), although there is no suggestion that the plastic killed the birds.

Issues

- There is no evidence that marine debris ingestion or entanglement is currently a significant threat to any of the 10 seabird species.
- Nonetheless, development of a threat abatement plan for the Injury and Fatality Caused by the Ingestion and Entanglement of Marine Life in Marine Debris will benefit all seabird species.

4.5 Storms and cyclones

Small populations such as those of Herald petrel and Round Island petrel, Heard Is shag, Macquarie Island shag, and Antarctic terns will always be adversely affected by stochastic events such as storms and cyclones. Storms and cyclones have the potential to have serious effects on the nesting substrate, vegetation and wildlife on remote seabird breeding islands, in addition to impacting seabirds at sea. Such natural factors can place additional pressures on seabird populations adversely affected by anthropogenic influences. However, stochastic events such as storms

and cyclones are beyond the control of management authorities and cannot be addressed in species recovery plans.

Issues and Recommendations

- Most seabirds are adversely affected by stochastic events such as storms and cyclones, but there is no practical or feasible way to manage this process.

4.6 Climate change

Climate change is a threat that impacts many marine organisms including seabirds. This threat was recently assessed for a tropical seabird, Abbott's booby *Papasula abbotti* (Olsen 2002). The text below has been largely taken from that document — it is entirely relevant to all Australian seabird species.

The "Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases" has been declared a Key Threatening Process under the EPBC Act. The threat is described as reductions in the bioclimatic range within which a species or ecological community exists due to emissions induced by human activities of greenhouse gases (DEH website). The listing of this threat recognises that the distribution of the process is continental. Non-biological components of the process include: temperature rise; changes in rainfall patterns; changes to the El Niño Southern Oscillation; and sea level rise. The potential consequences to seabirds could include deleterious effects of an increase in extreme weather events, changes in prey abundance and distribution, and alteration to nesting habitat.

A reduction in the emissions of greenhouse gases requires an internationally coordinated effort. Australia is a signatory to the relevant international agreements, and has made a commitment to limit greenhouse gas emissions. In addition, the States and Territories are pursuing additional opportunities to abate greenhouse gas emissions in a cost-effective and environmentally sensitive manner.

Australia has developed a National Greenhouse Strategy (NGS) with the goals: "to limit net greenhouse gas emissions, in particular to meet international commitments; to foster knowledge and understanding of greenhouse issues; and to lay the foundation for adaptation to climate change". The Strategy (DEH website) provides: a broad range of actions some of which will be implemented by governments acting individually, some by joint inter-governmental initiatives and some through partnerships between government, various stakeholders and the community. To date, the emphasis of the NGS has been on emission reduction, but the long-term strategy will also address adaptation actions, including the development of a "framework for progressing adaptation planning for biodiversity conservation, … providing for more detailed plans targeted towards components of biodiversity of conservation significance", including: endangered and vulnerable species and communities; assessment of the capacity of protected areas to sustain their biodiversity in the event of climate change; identification of altitudinal and latitudinal buffers; and adaptation requirements of species and communities that are likely to be subject to a change in conservation status as a result of climate change.

There is very little data on breeding ecology, feeding requirements and distribution at sea for the 10 threatened seabird species. It is therefore difficult to determine the effects of climate change/sea temperature change on these species.

Issues and Recommendations

- Loss of climatic habitat, including an increase in sea surface temperatures, caused by anthropogenic emissions of greenhouse gases is a potential threat to all Australian seabirds. Management of this process requires both domestic and international action, and is beyond the scope of individual species recovery plans.
- Given the poor knowledge of the oceanic distribution for most species it is difficult to assess the impact of climate change on the 10 threatened seabird species and thus develop appropriate management responses.

4.7 Biological and ecological information

Management of small populations of any organism requires adequate biological and ecological knowledge to ensure appropriate conservation action. Unfortunately for most threatened Australian seabirds, there is little relevant biological and ecological data available for both Australian and extra-limital (i.e. outside Australia) populations. The summary tables prepared for each of the 10 threatened seabirds highlights these deficiencies. Future research should focus on addressing the following deficiencies:

— basic breeding biology, particularly frequency of breeding and breeding success, where this is unknown;

— demographic parameters, particularly juvenile and adult survival, and age at first breeding;

— distribution at sea, to identify key foraging areas for both breeding and non-breeding birds. Note: the state of current technology precludes the use of satellite telemetry for this purpose on all but the largest species; and

— low key, non-intrusive monitoring of Australian breeding populations.

Collection of biological and demographic information often involves levels of research intensity that can potentially disturb breeding birds. While there may be colony-specific differences in these parameters, it may be preferable that studies to address these deficiencies are initially carried out on the larger extralimital populations, where applicable. This would minimise disturbance to the extremely small Australian populations (Antarctic terns, tropical gadfly petrels), and provide an indication of the sensitivity of each species to research and monitoring protocols. Such an approach will rely either on the fortuitous research activities of the jurisdictions that contain breeding populations of these species, or require a proactive collaborative approach by Australian conservation biologists.

Issues and Recommendations

- There is a need to improve biological and ecological knowledge for all the 10 threatened seabird species covered by this document.
- Such knowledge is essential for the planning and implementation of recovery actions.
- In some cases, consideration should be given to initially conducting studies on the larger extralimital populations, to minimise disturbance to the extremely small Australian populations.

- Low key, non-intrusive monitoring programs for Australian populations should be established/maintained to gauge the status of the species and to guide habitat management and the control of threats.

References

AMSA (1996). *National Contingency Plan, National Plan to Combat Pollution of the Sea by Oil*. Australian Maritime Safety Authority: Canberra.

Auman HJ, Woehler EJ, Riddle MJ & Burton HR (in press) Plastic debris ingestion by seabirds at subantarctic Heard Island. Marine Ornithology.

Baker, G.B., Gales, R., Hamilton, S. & Wilkinson, V. (2002). Albatrosses and petrels in Australia: a review of their conservation status and management. Emu 102: 71-97

BirdLife International. (2004). Threatened birds of the world 2004. CD-ROM. Cambridge, U.K: BirdLife International.

Brooke, M. de L. (2004). Albatrosses and petrels across the world. Oxford University Press, Oxford.

Croxall, J.P. (1998). Research and Conservation: a future for albatrosses? In *Albatross Biology and Conservation*. (Eds G. Robertson, and R. Gales.) pp 269-290. Surrey Beatty and Sons: Chipping Norton.

DEH Website. www.deh.gov.au/biodiversity/threatened/ktp/greenhouse.html

Environment Australia (1998). *Threat Abatement Plan for the Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations*. (Environment Australia Biodiversity Group: Canberra.)

Environment Australia. (1999a). *Threat Abatement Plan for Predation by Feral Cats*. (Environment Australia: Canberra.)

Environment Australia. (1999b). *Threat Abatement Plan for Competition and Land Degradation by Feral Rabbits*. (Environment Australia: Canberra.)

Fry, D.M., Fefer, S.I., and Sileo, L. (1987). Ingestion of plastic debris by Laysan Albatrosses and Wedge-tailed Shearwaters in the Hawaiian Islands. Marine Pollution Bulletin 18, 339-343.

Garnett, S.T. & Crowley, G.M. (2000). The Action Plan for Australian Birds 2000. (Environment Australia: Canberra.)

Higgins, P.J. & Davies, S.J.J.F. (eds). (1996). *The Handbook of Australian, New Zealand and Antarctic Birds. Volume 3.* Oxford University Press, Melbourne.

Huin, N. and Croxall, J.P. (1996). Fishing gear, oil and marine debris associated with seabirds at Bird Island South Georgia, during 1993/94. Marine Ornithology 24, 190-194.

Jouventin, P., and Weimerskirch, H. (1991). Changes in the population size and demography of southern seabirds: management implications. Pp. 297-316 In 'Bird Population Studies: Their Relevance to Conservation and Management.' (Eds. C.M. Perrins, J.D. Lebreton and G.M.Hirons.) pp 297-316). Oxford University Press: Oxford.

Ludwig, J.P., Summer, C.L., Auman, H.J., Gauguer, G., Bromley, D., Giesy, J.P., Rolland, R., and Colborn, T. (1998). The roles of organochlorine contaminants and fisheries bycatch in recent population changes of Black-

footed and Laysan Albatrosses in the North Pacific Ocean. In *Albatross Biology and Conservation*. (Eds G. Robertson, and R. Gales.) pp 225-238. Surrey Beatty and Sons: Chipping Norton.

Marchant, S. and Higgins, P.J. (eds). (1990). *The Handbook of Australian, New Zealand and Antarctic Birds. Volume 1.* Oxford University Press: Melbourne.

Nel, D.C., and Nel, J.L. (1999). Marine debris and fishing gear associated with seabirds at sub-Antarctic Marion Island, 1996/97 and 1997/98, in relation to longline fishing activity. CCAMLR Science 6, 85-96.

Olsen, P. (2002). Abbott's booby recovery plan *Papasula abbotti* 2003-2007. Environment Australia: Canberra.

Priddel, D. and Carlile, N. (1997). Conservation of the endangered Gould's Petrel *Pterodroma leucoptera leucoptera*. Pacific Conservation Biology 3, 322-329.

Sileo, L., Sievert, P.R. and Samuel, M.D. (1990). Causes of mortality of albatross chicks at Midway Atoll. Journal of Wildlife Diseases 26, 329-338.

Taylor, G.A. (2000). The action plan for seabird conservation in New Zealand. Part A: Threatened seabirds. Department of Conservation: Wellington, New Zealand.

Warham J. (1990). *The petrels: Their ecology and breeding systems*. Academic Press: London.

Warham J. (1996). *The behaviour, population biology and physiology of the petrels*. Academic Press: London.

PART B: Conservation Issues For Specific Species/Groups

1. TROPICAL GADFLY PETRELS — CONSERVATION ISSUES

Herald Petrel	*Pterodroma heraldica*
Conservation Status	Native Species
BirdLife International Status	Least Concern
EPBC Status	Critically Endangered

Round Island Petrel	*Pterodroma arminjoniana*
Conservation Status	Native Species
BirdLife International Status	Vulnerable
EPBC Status	Critically Endangered

1.1 General Introduction

The gadfly petrels (Procellariidae: *Pterodroma* spp.) are a group of highly oceanic seabirds, comprising some 30 species, that are complex in plumage and taxonomy (Nelson 1980). Found throughout the ocean basins of the world, they are widely distributed in the tropics and sub-tropics, but with some species breeding in the subantarctic zone (Warham 1990). They are adapted to a highly aerial and oceanic life, and possess short sturdy bills adapted for seizing soft prey at the surface, and unusual helicoidally twisted intestines. The function of the twisted intestines is obscure but believed to assist in digesting marine animals that have an unusual biochemistry (Imber 1985, Kuroda 1986). They also show complex markings on the face and wings that are thought to serve as interspecific recognition characters (Murphy and Pennoyer 1952).

As a group gadfly petrels vary considerably in size (160—525 g, Warham 1990). The Herald petrel (*Pterodroma heraldica*) and Round Island or Trindade petrel (*P. arminjoniana*) are medium to large-sized gadfly petrels, (280—450 g; Gardner *et al*. 1985), and are 34-39 cm long with a wingspan of 80-100cm (Marchant and Higgins 1990). Their plumages are well described in the literature (Marchant and Higgins 1990), and both species are polymorphic, possessing both light and dark morphs. For both species the genders and young birds are similar in appearance.

The Herald Petrel and Round Island Petrel are both tropical/sub-tropical species and are considered to be closely related (Imber 1985; Brooke *et al.* 1996; Brooke *et al*. 2000). Historically they have been considered by some authors to be conspecific e.g. Warham (1990).

1.2 Taxonomy

P.arminjoniana and *P.heraldica* are extremely similar in appearance and have been the subject of considerable taxonomic debate. Taxonomic resolution has been hampered by the considerable plumage variation in both species/forms — both are polymorphic with dark and white-bellied morphs, as well as intermediate forms occurring. Much of the taxonomic history for these birds has been summarised by Brooke and Rowe (1996).

P.arminjoniana was described by Giglioli and Salvidori (1869) on the basis of a type specimen (white-bellied morph) collected in 1868 near Trindade Island in the South Atlantic Ocean. In 1948 another population was discovered breeding on Round Island off Mauritius in the Indian Ocean (Vinson in Gardner *et al*. 1985). Murphy and Pennoyer (1952) considered the Indian Ocean specimens to be quite indistinguishable from the South Atlantic examples but definitely larger than birds from the South Pacific (see below). No scientific names have been ascribed exclusively to the Round Island Petrels which occur in dark, light and intermediate forms.

From the Pacific, *Aestrelata (Pterodroma) heraldica* was described in 1888 from two (white-bellied) specimens obtained at Chesterfield Island, northwest of New Caledonia. *P. heraldica* was subsequently found to have an extensive South Pacific breeding range, and also to occur in both light and dark forms (Warham 1990).

Despite the size differences between *arminjoniana* and *heraldica* (the former is larger) Murphy and Pennoyer (1952) treated *heraldica* as the Pacific representative of Atlantic *arminjoniana*.

In the next major review of the genus *Pterodroma*, Imber (1985) gave specific status to both *arminjoniana* and *heraldica* because of their geographic separation and because they host different *Halipeurus* feather lice. Warham (1990) subsequently restored *heraldica* to subspecific status, believing Imber's (1985) classification to be radical because it was based on gut morphology and parasite-host associations which were not proven as reliable taxonomic characters.

Brooke and Rowe (1996) and Brooke *et al*. (2000) used molecular data from the Pitcairn Islands and Round Island, together with other biological evidence, to assess the taxonomic relationships of *P. arminjoniana*, *P. heraldica* and the Kermadec Petrel *P. neglecta*. They believed the molecular data confirmed that *heraldica* and *arminjoniana* were closely related, but were reluctant to assert that Round Island Petrels should be assigned to *heraldica* rather than, as had been traditional, to *arminjoniana*. It should be noted that in conducting their molecular analyses, neither Brooke and Rowe (1996) or Brooke *et al*. (2000) had genetic samples from true *P. arminjoniana* from Trindade Island in the Atlantic for analysis, throwing into question if, in fact, the birds from Round Island and Trindade Island are conspecific.

More recently, BirdLife International (2004), quoting Brooke (2004) as the source of their taxonomic advice, believed that *P.arminjoniana*, although normally regarded as conspecific with *P. heraldica*, was closer to the Kermadec Petrel *P. neglecta* in many respects. Further, they believed that the *Pterodroma* population on Round Island could be assigned to either *P. arminjoniana* or *P. heraldica*.

Specimens of Herald Petrels from Raine Island have been collected and are available for re-appraisal if necessary (King 1984). However, their specific identity is not in question. In contrast, Stokes and Goh (1987) captured and photographed a

Pterodroma on North Keeling Island, but did not collect a specimen. They identified this bird as an intermediate morph of the Herald Petrel *P.arminjoniana*, and believed this bird 'probably belonged to the nominate subspecies known to breed … in the south Atlantic ocean and on Round Island'. In view of the taxonomic uncertainty regarding the '*P. arminjoniana*/*heraldica*' type petrel that occurs on Round Island, and in the absence of a specimen from North Keeling Island, it is therefore impossible to determine the true taxonomic affinity of the *Pterodroma* species recorded there by Stokes and Goh (1987). Resolution of this matter, assuming the petrel can still be found on North Keeling Island, therefore remains a conservation priority. Until this is confirmed the Round Island Petrel should be considered a vagrant or irregular visitor

1.3 Distribution

Because they are polymorphic and possess a range of plumages, identification of individuals to specific populations at sea is very difficult. As a result the distribution of both species is not properly understood and movement patterns are poorly known (Marchant and Higgins 1990).

Herald Petrel

The Herald Petrel breeds on Raine Island and possibly other small cays in the Coral Sea, (Garnett and Crowley 2000). However, despite regular surveys of the Herald, Coringa and Magdelaine Cays of the Coral Sea over the last 15 years, Herald Petrels have not been recorded breeding (B.Baker unpublished). The Australian population has been estimated at 25 breeding birds (Garnett and Crowley 2000). There are no estimates of former abundance for the Australian population. Extralimitally, it breeds on a number of other islands in the Pacific Ocean including Easter Island, French Polynesia, the Cook Islands, the Pitcairn group; and the Tonga group (BirdLife 2004; Murphy and Pennoyer 1952). It forages in surrounding waters, mostly south of the equator (Marchant and Higgins 1990).

Round Island Petrel

In Australian territory, the Round Island Petrel possibly breeds on North Keeling Island (Stokes and Goh 1987). Garnett and Crowley (2000) estimated the Australian population to comprise 25 breeding individuals. Extralimitally, this petrel also breeds on Round Island, near Mauritius in the western Indian Ocean, and Trindade Island and Martin Vaz Rocks in the southern Atlantic Ocean. It forages in surrounding waters, mostly south of the equator (Brooke and Rowe 1996; Marchant and Higgins 1990).

There is, however, no data to suggest that that the Round Island Petrel is anything other than either a vagrant to the region or that it has attempted, and failed, to colonise North Keeling Island. It is now nearly 20 years since Stokes and Goh (1987) recorded a small petrel on North Keeling Island and, despite regular visits to the island by Parks Australia North (Commonwealth Dept of Environment and Heritage) staff, it has not been seen since. Breeding has still not been confirmed and intensive searches between May—August in 2002, and June—July in 2003 failed to detect the species (W. Murray and D. Hopton unpublished). Further, the amount of breeding habitat on North Keeling Island suitable for petrels appears extremely restricted and

the occurrence of land crabs may be an added deterrent to smaller surface-breeding species (Barry Baker unpublished).

1.4 Population Size and Trend

Garnett and Crowley (2000) assessed Australian populations of the Round Island petrel and Herald petrel as critically endangered. Both species were estimated to have Australian populations of only 25 individuals, and while these populations were considered to be stable, the very restricted geographic distribution of both species was considered precarious for their survival in Australia (Garnett and Crowley 2000). In Australia, the area of occupancy was estimated to be 1km^2 for the Round Island Petrel, and 2km^2 for the Herald Petrel.

BirdLife International (2004) recently assessed the global conservation status of the Round Island Petrel as Vulnerable and the Herald Petrel as Least Concern. The global population for Round Island Petrel was estimated to be 2,500—10,000 individuals and for the Herald Petrel, >10,000 individuals.

1.5 Breeding Biology, Ecology and Diet

There are few studies on the breeding biology or ecology of the Herald Petrel and the Round Island Petrel. Table 1.9 provides a summary of known biological information for the two species.

Biological and ecological knowledge has been well summarised by Marchant and Higgins (1990). Perhaps the most valuable breeding studies are those of Gardner *et al.* (1985) for *P. arminjoniana* on Round Island, and Brooke (1995) for *P. heraldica* on the Pitcairn Islands. There is little data available for Australian populations of both species. King (1984) described the nesting site of Herald Petrel on Raine Island. Stokes and Goh (1987) identified the occurrence of Round Island Petrels on North Keeling Island but were unable to confirm breeding was occurring. Both these reports indicate a winter breeding season, accompanied by vocal, diurnal aerial display flights, particularly during the late afternoon. John Cornelius, Environment Protection Agency Queensland, is currently preparing a report updating knowledge for Herald Petrels on Raine Island (Stephen Garnett pers.comm.).

The diet is thought to consist of cephalopods (Marchant and Higgins 1990). Most gadfly petrels are solitary when feeding at sea, capturing prey by swooping down to snatch food by from the sea surface by ‘dipping’, often pausing on rapidly beating wings to grab items of food (Warham 1990).

1.6 Threats specific to the Herald Petrel and Round Island Petrel

Management of small populations of any organism requires adequate biological and ecological knowledge to ensure appropriate conservation action. As is the case with other species discussed in this paper, there is little relevant biological and ecological data available for both Australian and extralimital populations of the Herald and Round Island Petrels. Table 1.9 highlights these deficiencies. The need to improve biological and ecological knowledge for these species is discussed in Part A where generic recommendations are given to address this deficiency.

Information supporting the listing of Round Island Petrel (DEH website) noted that although North Keeling Island is a National Park, the population was so small that the birds are at risk from the accidental introduction of predators. Herald Petrels breeding on Raine Island would also be similarly threatened by the introduction of alien predators. At this stage, feral predators are not considered an immediate threat to either species as none occur on Raine Island or on North Keeling Island. However, the smaller breeding species of petrels are susceptible to predation by introduced predators (Baker *et al*. 2002) and appropriate quarantine measures should be put in place at all breeding sites to minimise this threat.

Small populations such as those of the Herald Petrel and Round Island Petrel will always be susceptible to stochastic events such as storms and cyclones. Cyclones have the potential to have serious effects on the vegetation and wildlife of North Keeling Island. A cyclone database maintained by the Bureau of Meteorology shows that a number of cyclones have regularly but unpredictably affected both the Cocos (Keeling) Islands and Raine Island. Such stochastic events are beyond the control of management authorities and cannot be addressed in species recovery plans.

1.7 Issues and Recommendations

- There is taxonomic uncertainty regarding the *Pterodroma arminjoniana/heraldica'* type petrel that was recorded on North Keeling Island in the 1980s. Further, there have been no records since that time, despite recent attempts to locate birds. Breeding has never been confirmed on North Keeling Island.
- If a species of *Pterodroma* still occurs on North Keeling Island, collection of genetic material for analysis should be considered a priority, together with collection of a range of morphometric data, to determine its true taxonomic affinity. It should be noted that killing a live bird to achieve taxonomic resolution is not appropriate as non-lethal techniques are available. Until this is confirmed the Round Island Petrel should be considered a vagrant or irregular visitor.
- Should the Round Island Petrel still occur on North Keeling Island, establish whether or not the population is a breeding population and establish appropriate on-going monitoring programs.
- Appropriate quarantine measures should be implemented/maintained by management authorities at North Keeling Island and Raine Island to maintain a barrier to exotic predators.

1.8 References

Baker, G.B., Gales, R., Hamilton, S. & Wilkinson, V. (2002). Albatrosses and petrels in Australia: a review of their conservation status and management. Emu 102: 71-97

BirdLife International. (2004). Threatened birds of the world 2004. CD-ROM. Cambridge, U.K: BirdLife International.

Brooke, M. de L. and Rowe, G. (1996). Behavioural and molecular evidence for specific status of dark and light morphs of the Herald Petrel *Pterodroma heraldica.* Ibis 138: 420-432. 1996

Brooke, M. de L. (1995). The breeding biology of the gadfly petrels *Pterodroma* spp. of the Pitcairn Islands: characteristics, population sizes and controls. Biol.Journal Linn. Soc.

Brooke, M. de L. (2004). Albatrosses and petrels across the world. Oxford University Press, Oxford.

Brooke, M. de L., Imber, M.J. and Rowe, G. (2000). The occurrence of two surface-breeding species of *Pterodroma* on Round Island, Indian Ocean. Ibis 142: 154-158.

Burger, J. and Gochfeld, M. (1991). Nest-site selection by the Herald Petrel and White-tailed tropicbird on Round Island, Indian Ocean, Wilson Bull. 103: 126-130.

Da Silva, G.L. (1995). Aspectos da biologia reprodutiva de *Pterodroma arminjoniana* (Giglioli & Salvadori, 1869) (Aves, Procellariidae) na Ilha de Trindade, Atlantico Sul. Unpublished MSc thesis, Museu Nacional – UFRJ, Rio de Janeiro.

DEH Website. www.deh.gov.au/biodiversity/threatened/information/factsheets /round-island-petrel.html

Gardner, A.S., Duck, C.D. & Greig, S. (1985). Breeding of the Trindade Petrel, *Pterodroma arminjoniana* on Round Island, Mauritius**.** Ibis 127: 517-522.

Garnett, S.T. & Crowley, G.M. (2000). The Action Plan for Australian Birds 2000. (Environment Australia: Canberra.)

Gill, F.B., Jouanin, C. & Storer, R.W. (1970). Notes on the seabirds of Round Island, Mauritius. Auk 87: 514-521

Harrison, P. (1983). Seabirds: An identification guide. Sydney: Reed

Imber, M.J. (1985). Origins, phylogeny and taxonomy of the glad-fly petrels, *Pterodroma* spp. Ibis 127: 197-229

Imber, M.J., Jolly, J.N., Brooke, M. de L. (1995). Food of three sympatric gad-fly petrels (*Pterodroma* species) breeding on the Pitcairn Islands. Biological Journal of Linnean Society 56:233-240.

King, B.R. (1984). The Herald Petrel *Pterodroma armonjoniana* breeding on Raine Island. Emu 84:246-247.

Kuroda, N. (1986). On the intestinal twistings in gadfly-petrels and comparative notes on the digestive tract in Procellariiformes. Japanese Journal of Ornithology 35: 1-14.

Marchant, S. and Higgins, P.J. (eds). (1990). *The Handbook of Australian, New Zealand and Antarctic Birds. Volume 1.* Oxford University Press, Melbourne.

Murphy, P.C and Pennoyer, J.M. (1952). Larger petrels of the genus *Pterodroma*. American Museum Novitates 1580: 1-43.

Nelson, B. (1980). Seabirds their biology and ecology. Hamlyn: London.

Stokes, T. and Goh, P. (1987). Records of Herald Petrels and the Christmas Island Frigatebird from North Keeling Island, Indian Ocean. Australian Bird Watcher 12:132-133.

Vinson, J.M. (1976). Notes sur les procellariens de l'Ile Ronde. Oiseau Rev.Fr.Ornithol. 46: 1-24.

Warham J. (1990). *The petrels: Their ecology and breeding systems*. Academic Press: London.

Warham J. (1996). *The behaviour, population biology and physiology of the petrels*. Academic Press: London.

Table 1.9: Summary of biological information for Herald Petrel and Round Island Petrel

	Herald Petrel	Refs	Round Island Petrel	Refs
Common name	Herald Petrel		Round Island Petrel; Trindade Petrel	
Scientific name	*Pterodroma heraldica*		*Pterodroma arminjoniana*	
Conservation status **— Australia EPBC** **—BirdLife Int.**	 Critically Endangered Least Concern		 Critically Endangered Vulnerable	
Australian breeding localities	Raine Island. Possibly other small cays in the Coral Sea	C, D	Possibly North Keeling Island	C, F
Extra-limital breeding localities	Other islands in the Pacific Ocean	C	Trindade Island, Martin Vaz Rocks, Atlantic Ocean; Round Island, Indian Ocean	C
Foraging localities	Poorly known. Waters surrounding breeding localities, mostly south of the equator.	C, E	Poorly known. Waters surrounding breeding localities, mostly south of the equator.	B, C, E
Annual breeding pairs **— Aust populations** **— Global**	 10 not quantified, >10,000 individuals	 A G	 Breeding unconfirmed — 10? 2,500 — 10,000 individuals	 A G
Australian % of global population	<1%	C	<1%	C
Breeding frequency (annual/biennial)	possibly annual	A	possibly annual	A
Clutch size	1	E	1	E
Breeding success — % chicks fledged from eggs laid	No data		No data	
Age at first breeding	No data	E	No data	E
Juvenile survival	No data		No data	
Adult survival	No data		No data	
Nest site	Surface nesting. Among shrubs on sand cays, rainforest on high Pacific Islands.	C,& D	Surface nesting. Nests on rocky ground under ledges or under piles of boulders on Round Island; among shrubs on sand cays	C, H
Nesting behaviour (colonial / dispersed pairs)	Possibly colonial	A	Possibly colonial	A
Breeding season	Winter in Australia	A	Winter in Australia? all year, peak July—October on Round Island	A H
Food / Foraging	Forages at sea, probably for cephalopods, though diet is otherwise unknown	E	Forages at sea, probably for cephalopods, though diet is virtually unknown	E

Refs: A — Baker 2002; B — Brooke and Rowe 1996; C — Garnett and Crowley 2000; D — King 1984; E — Marchant and Higgins 1990; F — Stokes and Goh 1987; G — BirdLife International 2004; H — Vinson 1976.

2. SOFT-PLUMAGED PETREL, BLUE PETRELS AND FAIRY PRION (SOUTHERN) — CONSERVATION ISSUES

Soft-plumaged Petrel	*Pterodroma mollis*
Conservation Status	Native Species
BirdLife International Status	Least Concern
EPBC Status	Vulnerable

Blue Petrel	*Halobaena caerulea*
Conservation Status	Native Species
BirdLife International Status	Least Concern
EPBC Status	Vulnerable

Fairy Prion (southern)	*Pachyptila turtur subantarctica*
Conservation Status	Native Subspecies
BirdLife International Status	Least Concern
EPBC Status	Vulnerable

2.1 General Introduction

The Procellariidae are a cosmopolitan family of seabirds, the taxonomy of which is complicated and subject to frequent revisions. At present the family comprises about 70 species, all characterised by a compact build, long narrow wings and "tubenoses".

The Soft-plumaged Petrel is a medium sized petrel (32-37 cm, 279-312 g) (del Hoyo *et al*. 1992) that nests colonially over a wide range. The Blue Petrels is a single species within the genus *Halobaena.* It is a smaller petrel (26-32 cm, 170-230 g), that nests colonially on offshore islands. It superficially resembles prions in body colouration. Fairy prions, are a smaller species among the genus *Pachyptila*, (23-28 cm, 90-175g). This genus is the subject of diverse opinion regarding the number of full species (Marchant and Higgins 1990).

2.2 Taxonomy

The taxonomy of Soft-plumaged Petrels is complicated and the subspecific status of the Australian breeding birds has not yet been confirmed. Clancey *et al*. (1981) recognised two subspecies: *P.m mollis* from the Tristan da Cunha and P. dubia from the Prince Edward, Iles Crozet, Iles Kerguelen and the Antipodes Islands. Confusion persists as some distinguishing features used by Clancey *et al*. (1981) alter with wear (Marchant and Higgins 1990).

More recently Bretagnolle (1995) suggested three subspecies of P. mollis, with P.m.mollis on Marion Island, Iles Crozet and Iles Kerguelen; *P. m. dubia* on Gough and Antipodes Islands, and a third subspecies, *P. m. deceptornis*, on Amsterdam Island (Garnett and Crowley 2000). In the absence of a full suite of morphological and molecular data, Bretagnolle (1995) suggested that the Tasmanian birds are probably closest to the Amsterdam Island birds, *P. m. deceptornis*.

There is much debate as to the number of full species within the genus *Pachyptila*, with three to six species, and up to 14 forms recognised. All are externally similar and found in the Southern Ocean. The taxonomic treatment of Fairy prions varies, Marchant and Higgins (1990) recognising two subspecies: *turtur* (nominate) and *subantarctica*. Others treat Fairy prions as monotypic, forming a superspecies with Fulmar prions (*P. crassirostris*). Cox (1980) treated Fairy prions as having a number of subspecies, normally attributed to *P. crassirostris*, the subspecific differences based mainly on bill morphology. Brothers (1984) attributed Fairy prions residing on Macquarie Island on the basis of measurements of adults, concluding that measurements separated them from the similar Fulmar prion.

Marchant and Higgins (1990) report that the breeding populations of Fairy prions fall into two discrete groups: a northern large-billed form, and a southern stout-billed form. The difficulty has arisen in differentiating the southern stout-billed form from Fulmar prions. The validity of the southern stout-billed form (*subantarctica*) has been questioned because of the initial descriptions being based on a young bird. For the purposes of this review, the Macquarie Island birds are referred to as Fairy prions (southern form: *P. t. subantarctica*). However, further work is required to confidently distinguish them from Fulmar prions (see also Woehler 1991).

Although distinctive, the Blue Petrel has a plumage pattern broadly similar to the *Pachyptila* prions, but diverges in some ecological traits (del Hoyo 1992). It is clearly identifiable at sea with the diagnostic white tip to tail.

2.3 Distribution

Soft-plumaged Petrels

A small colony of Soft-plumaged Petrels in Australian territory has been confirmed breeding on Maatsuyker Island (43° 39'S, 146° 16'E), a 186 ha island situated 13 km south of the Tasmanian mainland (Wiltshire and Hamilton in press). On sub Antarctic Macquarie Island (54 30'S, 158 57'E), a 12 800 ha island lying 1 500 km south of Tasmania, birds have yet to be confirmed as breeding although their presence on the island suggests that breeding may occur.

Elsewhere Soft-plumaged Petrels breed on islands over a range of 80° latitude in three oceans: South Atlantic (Gough Island, Tristan da Cunha, Inaccessible Island, Nightingale Island); Indian Ocean (Iles Crozet, Prince Edward Islands, Marion Island, Amsterdam Island, Iles Kerguelen), and the New Zealand region of the Southern Ocean on Antipodes Island (Bretagnolle 1995). Birds disperse widely at sea, occurring over Antarctic, Subantarctic and subtropical waters (Marchant and Higgins 1990; Woehler *et al*. 1991).

Blue Petrels

Blue Petrels are circumpolar in the Southern Ocean, occurring particularly close to and south of the Antarctic Convergence. Breeding colonies occur on South Georgia, Prince Edward Island, Marion Island, Iles Crozet, Iles Kerguelen and islands in Southern Chile. In the Australian region breeding has been confirmed on Macquarie Island. Suggestions of a small breeding population on Heard Island (Downes *et al.* 1959) have yet to be substantiated.

At sea Blue Petrels range north to reach the southern coasts of Australia, New Zealand, South America and South Africa (Marchant and Higgins 1990; Woehler *et al.* 1991). Some birds remain in the vicinity of their breeding island throughout the year, as indicated by almost continuous visitation of burrows on Macquarie Island (Brothers 1984).

Fairy prions

Fairy prions are numerous and circumpolar in their distribution, ranging north to subtropical waters during non-breeding periods. Garnett and Crowley (2000) report that the nominate subspecies of Fairy prions occurs through most of their range, with *subantarctica* restricted to Antipodes, Big South Cape and Snares Is., and Macquarie Islands (Woehler *et al*. 1991).

2.4 Population Size and Trend

Soft-plumaged Petrels

On Maatsuyker Island, breeding by Soft-plumaged Petrels was suspected after a bird was spotlighted and caught during the 1990s (D. Pemberton pers. comm.). Subsequently, targeted searches resulted in the discovery of six nests in the 2001-2002 season, with a further five eggs confirmed the following season (Wiltshire and Hamilton in press). It is unknown whether these few birds represent a recent colonisiation, or the persistence of a small colony that has been difficult to detect due to the coexistence of large numbers of other burrowing petrel species.

On Macquarie Island, three Soft-plumaged Petrel carcasses were found in 1989, and a pair of courting birds observed at night (N. Brothers pers. comm. in Garnett and Crowley 2000). Since then additional carcasses have been retrieved (N. Brothers unpublished data), and targeted searches during 2002 and 2003 have identified extensive aerial activity (S. Robinson and M. Schulz pers. comm.). One bird was discovered in a burrow in 2002, and a further bird the following year. However, the presence of an egg has yet to be confirmed. The Australian breeding population cannot be confirmed as exceeding 50 mature adults.

Elsewhere, *P. m. deceptornis* also occurs on Amsterdam Island, although there is no estimate of population size. These birds are frequently taken by feral cats *Felis catus* (Roux and Martinez 1987), and are considered to be almost extinct (V. Bretagnolle in Garnett and Crowley 2000).

Globally, the populations of the other subspecies are considerably larger, the species numbering in the order of 60 000 individuals. Global population trends have not been quantified, although some authors have reported population decreases (del

Hoyo *et al*. 1992; BirdLife International 2004). On Antipodes Island, the population has expanded, increasing in numbers from about 100 pairs in 1978 to several thousand pairs in 1995 (Taylor 2000). Globally the species is evaluated as Least Concern.

Blue Petrels

The persistence of Blue Petrels at their colonies on Macquarie Island year round results in their extreme vulnerability to predation by feral predators. Historically, Blue Petrels were reported to occupy lower coastal habitat, within the hunting range of rats (*Rattus spp*.) and wekas (*Gallirallus australis scotti*). These traits likely resulted in the extirpation of Blue Petrels from the mainland of Macquarie Island, but low numbers persisted on offshore stacks, coexisting with rats, but isolated from cats and wekas.

Surveys of Macquarie Island in the late 1970s confirmed six Blue Petrel colonies all located on discrete sea stacks (Brothers 1984). Estimating the number of breeding pairs of Blue Petrels is extremely problematic, due to the extent of breeding failures and the maze of interconnected burrows. Based upon burrow density, and likely traits of occupancy, Brothers (1984) estimated a total population of ca 500-600 pairs of Blue Petrels for Macquarie Island between 1975 and 1982.

In 1999, for the first time in 100 years, Blue Petrels were found to have re-established on the mainland of Macquarie Island, adjacent to a colony on an offshore stack. The new colony contained about 30 burrows, but examination revealed egg shell fragments, and partially eaten adult birds, evidence of rat predation (N. Brothers unpublished data). In 2000, the first fledgling was discovered. From 2000 to 2003, Blue Petrel breeding efforts appear to have increased on the island, as indicated by extensive vocalisation and burrow excavating but there are no accurate estimates of numbers (M. Schulz and S. Robinson pers. comm.). At this stage, the total Macquarie Island population of Blue Petrels in Macquarie Island is estimated to be 500-1000 breeding pairs.

Fairy prions

Fairy prions were first reported as a breeding species on Macquarie Island in 1979 with the discovery of birds on two rock stacks, with population estimates of 22 pairs, and 16-18 pairs on another (Brothers 1984). Although colonies were visited during winter, the inclusion of Fairy prions as a breeding species for Macquarie Island, is based on the discovery on a single egg in a crevice occupied solely by this species. A further colony was reported in 1993 by N. Brothers (unpublished data) on Bishop and Clerk Island, 37 km from Macquarie Island. More recently, Brothers (unpublished data) reported a record for Fairy prions breeding on Macquarie Island, with small numbers being observed in a cave at the islands northern most tip. However, breeding was not confirmed at that site until 2001 when a large chick was observed (G. Hedley unpublished data). Another likely breeding site was discovered in the same year, in a cave on the west coast. Twenty abandoned eggs were discovered, and attributed to Fairy/Fulmar prions (G. Hedey pers. comm.). The species identity of the birds recently reported as breeding on Macquarie Island remains to be confirmed.

Given the lack of confirmed numbers of prions breeding on Macquarie Island, it is impossible to determine either the trend or the status of the breeding population. The

size of the entire population has been cited by Garnett and Crowley (2000) as 50-250 mature individuals, presumably based on the estimate of ca 40 pairs by Brothers (1984).

2.5 Breeding Biology, Ecology and Diet

Soft-plumaged Petrels

There have been no detailed studies of the biology and ecology of the Soft-plumaged Petrel across its range. Observations have been summarised by Marchant and Higgins (1990) and are supplemented here with observations from Maatsuyker Island (Wiltshire and Hamilton in press). The species breeds colonially on offshore islands, loosely associated with other petrels in some locations, including Maatsuyker Island. Birds are thought to return to their colonies in August-September, although birds have been observed at Macquarie Island in July (M. Schulz pers comm). On Maatsuyker Island, determination of their presence is simplified by searching prior to the arrival of the more numerous conspecific Short tailed shearwaters (*Puffinus tenuirostris*) return. Eggs are reported to be laid from November to December, with most eggs laid on Maatsuyker Island after mid-December. Fledging occurs during April and May.

Breeding success for the species is poorly known. For two seasons on Maatsuyker Island, four of six nests (67%) contained late stage chicks in 2002, and three of five nests (60%) in 2003.

Soft-plumaged Petrels are typically present in southern-eastern Australian waters between September and April, but appear absent during the winter months (Reid *et al*. 2002). This species obtains their food via surface-seizing, their prey comprising mainly cephalopods, with some fish and crustaceans.

Blue Petrels

The breeding ecology of Blue Petrels is not well known. General information from extralimital sites has been summarised by Marchant and Higgins (1990). A single egg is laid is in rock crevices, or burrows dug out among rocks or vegetation. On the sea stacks off Macquarie Island most burrows were situated between 10 and 14 m above sea level (Brothers 1984). Laying occurs in late October, and eggs are incubated for ca. 6-7 weeks. The nestling period also extends for 6-7 weeks, chicks fledging in late January-early February. At Iles Kerguelen and South Georgia, after the chicks fledge the adults depart, returning to their burrows between late April and late June, after which they are absent again until September.

Observations from Macquarie Island indicate that birds are present and attend burrows almost all year (Brothers 1984). Breeding success data are limited, but the available information suggests that productivity is typically low as a result of predation. At Macquarie Island, probably very few chicks fledge, being heavily predated by both rats and skuas (Rounsevell and Brothers 1984).

Blue Petrels obtain the prey by surface seizing and diving. Their diet comprises a range of species of pelagic crustaceans, fish and cephalopods, the relative importance of each group varying with locality (Marchant and Higgins 1990).

Fairy Prions

The ecology of Fairy prions has been well summarised by Marchant and Higgins (1990). The breeding season broadly extends from September to March. Laying occurs from October through to December, depending on locality, the season being earlier in the northern colonies. The single egg is laid in a crevice, or burrow, and incubated for 44-55 days. The fledgling period is similar (43-56 days) and both parents share in feeding the chick.

Breeding success of Fairy Prions in New Zealand has been reported as between 74 and 79% (Harper 1976). There are no published breeding success data from Australian colonies. On Macquarie Island, only one single chick has been observed in December 2001, although the survival of this chick to fledgling, as well as the specific identity (Fulmar or Fairy prion) was not resolved (G. Hedley pers. comm.). Marchant and Higgins (1990) summarised the timing of the presence of Fairy prions at the colonies, with young fledging and adults departing in February/March and adults returning to colonies in August/September. In Tasmania however, the birds attend the colonies in Bass Strait throughout the winter months (R. Gales pers. comm.), and on Macquarie Island, Brothers (1984) records adults as being present in May, with birds also observed in June and July (M. Schulz pers. comm.).

The diet of the prions on Macquarie Island is unknown. It is likely be similar to the diet reported elsewhere: small crustaceans (especially euphausiids), with smaller amounts of fish (Marchant and Higgins 1992). Prey is typically obtained by surface seizing and dipping.

2.6 Threats specific to the Soft-plumaged Petrel, Blue Petrel and Fairy prion (southern)

The breeding populations of Soft-plumaged petrels, Blue petrels and Fairy prions (southern) in Australia are all considered threatened because their populations are both small and restricted in distribution. As a result, the birds could be adversely affected by effects of climate changes on sea temperature and food supply (Garnett and Crowley 2000) in addition to other holistic threats that affect small and vulnerable species of seabirds (see Part A).

The most significant and immediate threat to these birds is that posed by predation from introduced pests, especially cats. On Marion Island, Williams (1978) estimated that cats killed 38 000 Soft-plumaged Petrels out of a population of ca 400 000 birds. Cats have also been implicated in the demise of petrels and prions on Iles Kerguelen, Iles Crozet and Macquarie Island (Pascal 1980, Jouventin *et al*. 1984, Brothers 1984). In New Zealand, Fairy prions currently are restricted in distribution to those islands free of introduced predators (Taylor 2000). The northern subspecies of Soft-plumaged Petrels (*P.m. deceptornis*) also occurs on Amsterdam Island, where it is frequently taken by cats, and is now almost extirpated there (V. Bretagnolle in Garnett and Crowley 2000).

Feral cats were recorded on Macquarie Island in 1820 after being introduced by sealers. Jones (1977) and Brothers *et al.* (1985) estimated that about 60,000 birds were killed each year by feral cats, with the winter breeding species being most seriously impacted. Fairy prions and Blue Petrels are year round residents on Macquarie Island (Brothers 1984), and elsewhere Soft-plumaged Petrels are known to be absent from the colony for only two months of the year (Serventy *et al*. 1971). In New Zealand high numbers of Fairy prions were killed by cats on Mangere Island,

but quickly recovered once cats were removed from the island (Taylor 2000). On Macquarie Island, feral cats, weka and black rats extirpated populations of Fairy prions from the mainland, relegating, until recently, the birds to offshore island stacks (Brothers 1984).

Wekas (were also introduced to Macquarie Island in the mid 1800s, and significantly impacted on burrow-nesting petrels (Blackburn 1968). In the 1980s wekas were largely confined to tussock slopes coinciding with the former habitat of Blue Petrels and fairy prions (Brothers 1984). As the number of wekas and cats increased, the small burrow-nesting petrels were presumably eliminated, with the winter residents being most vulnerable to destruction.

A targeted eradication of wekas from Macquarie Island was successful, with the last recorded individual being observed in 1988 (Copson 1995). A cat eradication program was implemented in 1985, with the last cat being observed on the island in 2000. Since the eradication of wekas and cats, the recovery of burrowing petrels on Macquarie Island has been remarkable. Since 2000, Grey Petrels (*Procellaria cinerea*) and Blue Petrels have re-established in several colonies.

Black rats and rabbits have replaced cats and wekas as being significant in impacting the survival of small and medium sized petrels on Macquarie Island. Even on the rock stacks predation of Blue Petrels by subantarctic skuas *Catharacta lonnbergi* and rats to the extent that few pairs, if any, are thought to breed successfully (Rounsevell and Brothers 1984). In 2002-2003 rats continue to be implicated in the deaths of Fairy prions and Blue Petrels on Macquarie Island (M.Schulz and J. Lynn unpublished data).

Skuas are significant predators of Blue Petrels on Macquarie Island, with Blue Petrels comprising 70% of all petrel remains located at skua breeding sites in 2003 (G. Copson unpublished data; M. Schulz and J. Lynn unpublished data). The population of skuas on Macquarie Island are thought to be artificially inflated due to high rabbit numbers (Skira 1984), recent observations indicating that numbers of both rabbits and skuas continuing to rise (Bradshaw 2004), with the latter having a small wintering population present (M. Schulz pers. comm.).

As a result of increasing rabbit numbers, partly linked to the eradication of cats from the island, the vegetation on Macquarie Island has undergone extensive changes, following the impact of grazing. This habitat alteration has likely increased the exposure of the petrels to predation by skuas, in addition to impacting on the stability and thermal properties of burrow structure. The consequences of these impacts have serious implications for the long-term survival of burrowing petrel species on Macquarie Island.

Reduction in rabbit numbers must be combined with parallel efforts to eradicate rats from Macquarie Island in order to effectively secure the survival of burrow nesting species. Reducing rabbit numbers alone would allow the recovery of native Tall Tussock (*Poa foliosa*) grassland, and with it the spread of rats (Copson and Whinam 2001). The inadvertent increase in rat numbers, a species whose habitat is associated with Tall Tussock, would take an increasing toll on the susceptible burrowing petrels, particularly those present on the island in winter.

Feral House mice (*Mus musculus*) were first recorded on Macquarie Island in the 1890s (Cumpston 1968). Mice are distributed across the island from sea level to the higher peaks in all vegetation communities, with a preference for tall tussock

grassland associations (Copson and Whinham 2001). The impact of this feral species on the breeding success of burrowing petrels, particularly of smaller species, is not known on Macquarie Island (Brothers 1984) and poorly documented elsewhere (Taylor 2000). There are records of House mice taking the eggs of smaller burrowing petrels (Johnstone 1985, Taylor 2000). This feral species may also be a vector for disease (Taylor 2000), in addition to impact the invertebrate fauna and effect the nutrient cycles of the island (G. Copson pers comm.)

Remarkably, Maatsuyker Island has remained free of feral pests, despite being inhabited as a lighthouse station since 1891. Should predators ever become established on the island, the survival of the small and vulnerable Soft-plumaged Petrel colony may well be irrevocably threatened.

Bird strikes are also occasionally reported on Macquarie Island. There are confirmed reports of Blue Petrels found dead under radio and high-frequency (HF) dipole aerials of some field huts (DPIWE unpublished data). Low numbers of other threatened species, including Fairy prions, have also been found dead under these wires. In 2003, some aerials were replaced by whip aerials, and the incidence of bird strike has been greatly reduced (M. Schulz pers. comm.).

2.7 Issues and Recommendations

- On Macquarie Island, the integrated eradication of feral pests – rabbits and rodents – must be given highest priority to assist effective conservation of all burrowing petrel species on the island.
- Strict quarantine procedures for access to Maatsuyker Island should be introduced to minimise the risk of introducing feral pests to the island. Quarantine procedures for Macquarie Island must be continued
- Targeted long term monitoring for all three species should be implemented in order to track the trends in their population numbers, breeding effort and productivity, including the response to eradication of feral pests. Such monitoring must be conducted so as to minimise any researcher impact.
- The taxonomic status of the Fairy prions on Macquarie Island should be clarified. The subspecies are currently distinguished on the basis of bill characters and plumage. A global review of the group, incorporating molecular markers, would assist in clarification.
- The rock stacks adjacent to Macquarie Island should be surveyed to assess population size of the species present.
- Where possible long radio and HF dipole aerials should be replaced by whip aerials to reduce the incidental mortality caused by bird strike.
- The taxonomic status of the Soft-plumaged Petrels breeding on Maatsuyker Island (and Macquarie Island, should breeding be confirmed) should be established,
- All colonies to be protected and managed in such a way that human disturbance is minimised.
- Identify any emerging threats that will have impact on either species and develop an appropriate response.

2.8 References

Baker, G.B., Gales, R., Hamilton, S. and Wilkinson, V. (2002) Albatrosses and petrels in Australia: a review of their conservation and management. Emu 102: 71-97.

BirdLife International. (2004) Threatened birds of the world 2004. CD-ROM. Cambridge, U.K: BirdLife International.

Blackburn, A. (1968) The birdlife of Codfish Island. Notornis 15: 51-65.

Bradshaw, C. (2004) Rabbit Scourge Strips Macquarie Island Bare. Australian Science May 2004: 23-26.

Bretagnolle, V. (1995) Systematics of the Soft-plumaged Petrel *Pterodroma mollis* (Procellariidae): new insight from the study of vocalizations. Ibis 137, 207-218.

Brothers, N.P. (1984) Breeding, Distribution and Status of Burrow-Nesting Petrels at Macquarie Island. Australia Wildlife Research 11: 113-131.

Brothers, N.P., Skira, I.J., and Copson, G.R. (1985) Biology of the feral cat, *Felis catus* (L.) on Macquarie Island. Australian Wildlife Research 12: 425-436.

Clancey, P.A., Brooke, R.K. and Sinclair, J-C. (1981) Variation in the current nominate subspecies of *Pterodroma mollis* (Gould) (Aves, Procellariiformes). Durban Mus. Novitates 12, 203-213.

Copson, G. R. (1995. An integrated vertebrate pest strategy for subantarctic Macquarie Island. In: Proceedings of the 10th Vertebrate Control Pest Conference, Hobart May 1995.

Copson, G.R. and J. Whinam (2001) Review of ecological restoration programme on subantarctic Macquarie Island: Pest management progress and future directions. Ecological Management and Restoration 2: 129-138.

Cox, J. B. (1980) Some remarks on the breeding distribution and taxonomy of the prions (Procellariidea: *Pachyptila*). Rec. S. Aust. Mus. 18: 91-121.

Cumpston, J. S. (1968) *Macquarie Island*. Publication No. 93, Australian National Antarctic Research Expedition Reports, Series A (1), Antarctic Division, Department of External Affairs, Melbourne.

Downes, M.C., Ealey, E.H.M., Gwynn, A.M., and P. S. Young (1959) The birds of Heard Island. Australian National Antarctic Research Expeditions Scientific Reports – Series B. Zoology 1, 124-128.

Garnett, S.T. & Crowley, G.M. (2000) *The Action Plan for Australian Birds 2000.* Environment Australia: Canberra.

Harper, P C. (1976) Breeding biology of the fairy prion (*Pachyptile turtor*) at the Poor Knights Islands, New Zealand**.** New Zealand Journal of Zoology 3: 351-371.

Del Hoyo, J., Elliot, A. and Sargatel, J. (1992) Handbook of Birds of the World Vol 1. Lynx Edicions, Barcelona.

Johnstone, G. W. (1985) Threats to birds on sub-antarctic islands*. International Council for Bird Preservation Technical Publication* 33, 101-121.

Jones , E. (1977) Ecology of the feral cat, *Felis catus* (L.)(Carnivora, Felidae) on Macquarie Island. Australian Wildlife Research. 4: 249-62.

Jouventin, P., Mougin, J.–L., Stahl, J.–C., and Weimerskirch, H. (1985) Comparative biology of the burrowing petrels of the Crozet Islands. Notornis 32: 157-220.

Marchant, S. and Higgins, P.J. (eds). (1990) The Handbook of Australian, New Zealand and Antarctic Birds. Volume 1. Oxford University Press, Melbourne.

Pascal, M. (1980) Structure et dynamique de la population de chats harets de l'archipel des Kerguelen. Mammalia 44: 161-182.

Reid, T.A., Hindell, M. A., Eades, D. W., and Newman, M. (2002) Seabird Atlas of South-eastern Australian waters. Birds Australia, Melbourne

Rounsevell, D.E. and Brothers, N. P. (1984) The status of seabirds on Macquarie Island. In: *Status and conservation of the world's seabirds*. Vol. 2 (Eds J.P. Croxall, P.G.H. Evans and R. W. Schreiber). Pp. 587-592. International Council for Bird Preservation Technical Publication 2, Cambridge.

Roux, J. –P. and Martinez, J. (1987) Birds of Amsterdam and St. Paul Islands. Cormorant 14: 3-19.

Serventy, D.L., Serventy, V., and Warham, J. (1971) *The Handbook of Australian Seabirds*. A.H. and A. W. Reed: Sydney.

Skira, I. (1984) Breeding distribution of the Brown Skua on Macquarie Island. Emu 84: 248-249.

Taylor, G.A. (2000) Action Plan for Seabird Conservation in New Zealand. Part B: Non-threatened Seabirds. Department of Conservation, Wellington, New Zealand.

Wiltshire, A. and Hamilton, S. (In press) First record of Soft-plumaged Petrels, *Pterodroma mollis*, breeding in Australia. Emu.

Woehler, E.J. 1991. Morphology of prions *Pachyptila* and diving petrels *Pelecanoides* at Heard Island. Marine Ornithology 19, 19-30

Woehler, E.J., Hodges, C.L. & Watts, D.J. 1990. An atlas of the pelagic distribution and abundance of seabirds in the southern Indian Ocean 1981 to 1990. ANARE Research Notes 77, 406pp.

Table 2.9a: Summary of biological information for Soft-plumaged Petrel and Blue Petrel

	Soft-plumaged Petrel	Refs	Blue Petrel	Refs
Common name	**Soft-plumaged Petrel**		**Blue Petrel**	
Scientific name	*Pterodroma mollis*		*Halobaena caerulea*	
Conservation status				
—Australia EPBC	Vulnerable		Vulnerable	
—BirdLife Int.	Least Concern (see text)	F	Least Concern (see text)	F
Australian breeding localities	Maatsuyker Island (confirmed) Macquarie Island (unconfirmed)	E	Macquarie Island	B
Extra-limital breeding localities	Islands in S. Pacific and S. Indian Oceans, depending on subspecies.	C	Numerous islands in Indian and Atlantic Oceans	A
Foraging localities	Poorly known	A	Southern Oceans	A
Annual breeding pairs				
— Aust populations	ca 55 pairs	F. E	500-1000 pairs,	
— Global	unknown		Hundreds of thousands of pairs, ca 2 000 000 individuals	A, F
Australian % of global population	unknown		<0.1%	
Breeding frequency (annual/biennial)	Unknown		Probably annual	
Clutch size	1		1	A
Breeding success — % chicks fledged from eggs laid	60-67% for two seasons on Maatsuyker	D	Minimal	A, B
Age at first breeding	No data		No data	B
Juvenile survival	No data		No data	
Adult survival	No data		No data	B
Nest site	Burrow	A	Burrows, crevices	A, B
Nesting behaviour	Loosely colonial	A	Colonial	A
Breeding season	September - May	D	Typically October-Feb	A, B
Food / Foraging	Cephalopods, with some fish and crustacea (based on other populations)	A	Pelagic crustaceans, fish and cephalopods	A

Refs: A — Marchant and Higgins 1990; B — Brothers 1994; C – Garnett and Crowley 2000; D – Wiltshire and Hamilton in press; E – Robinson and Schulz pers. comm. F — BirdLife International 2004;

Table 2.9b: Summary of biological information for Fairy Prion (southern)

	Fairy Prion	Refs
Common name	**Fairy prion (southern)**	
Scientific name	*Pachyptila turtor subantarctica*	
Conservation status		
—Australia EPBC	Vulnerable	
—BirdLife Int.	Least Concern (see text)	
Australian breeding localities	Macquarie Is., Bishop & Clerk Islets.	B
Extra-limital breeding localities	Antipodes, Big South Cape and Snares Is. .	C
Foraging localities	Poorly known	
Annual breeding pairs		
— Aust populations	ca 55 pairs	D
— Global	unknown	E
Australian % of global population	<1%	
Breeding frequency (annual/biennial)	Annual	A
Clutch size	1	A
Breeding success — % chicks fledged from eggs laid	Unknown for Macquarie Island	
Age at first breeding	Unknown	
Juvenile survival	Unknown	
Adult survival	Unknown	
Nest site	Burrow, crevices, caves	
Nesting behaviour	Colonial	A, B
Breeding season	August-March	A
Food / Foraging	Pelagic, mostly crustacea	A

Refs: A — Marchant and Higgins 1990; B — Brothers 1994; C – Garnett and Crowley 2000; D – Baker *et al.* 2002; E — BirdLife International 2004

3. HEARD SHAG AND MACQUARIE SHAG — CONSERVATION ISSUES

Heard Shag	*Phalacrocorax nivalis*
Conservation Status	Endemic Species
BirdLife International Status	Least Concern
EPBC Status	Vulnerable

Macquarie Shag	*Phalacrocorax purpurascens*
Conservation Status	Endemic Species
BirdLife International Status	Least concern
EPBC Status	Vulnerable

3.1 General Introduction

Cormorants and shags are distinctive aquatic birds typically breeding on both mainland and island sites. Those that are restricted to remote islands are typically sedentary. Recent reviews of the taxonomy have resulted in the recognition at the specific level of several forms restricted to particular islands (Shirihai 2002). The Heard and Macquarie Shags represent such forms and both have been the subject of several studies (eg Brothers 1985, Green 1997a,b; Green and Williams 1997)

3.2 Taxonomy

Both endemic species.

The taxonomy of the blue-eyed (imperial) shag complex remains confused. Some authors recognised eight subspecies of *Phalacrocorax atriceps* (e.g. Harrison 1983) whilst others (eg Marchant and Higgins 1990) recognise eight distinct species, with *P. nivalis* and *P. purpurascens* restricted to Heard and Macquarie Islands, respectively. Others considered the Imperial Shag (*P. atriceps*) group to comprise multiple subspecies, including both Heard and Macquarie birds (Turbott 1990, BirdLife International (2004). Such a treatment consequently results in the Least Concern rating by BirdLife International (2004). .

3.3 Distribution

Heard Shags are restricted to breeding in approximately four colonies at Heard Island. There are no breeding records or observations from the McDonald Islands (Johnstone 1982, Vining 1983). On Macquarie Island, there are 23 recorded breeding sites for Macquarie Shags, with all but two sites restricted to offshore stacks or islets, or stacks attached to the shore (Brothers 1985). Not all sites are used each year, and birds may interchange between colonies. Macquarie Shags have also been recorded nesting at adjacent Bishop and Clerk Islets, 37 km south of Macquarie Island (Lugg *et al*. 1978, N. Brothers pers comm.).

Heard and Macquarie Shags are sedentary, making only local movements around their respective islands. Brothers (1985) reported that they are poor fliers, unable to make headway in strong winds (> 40 knots), and their morphology (small wings, heavy bones and water permeable plumage) restricted long range movements. Macquarie Shags are restricted to inshore waters during the breeding season, but may travel further offshore, up to 100km, during the winter season.

3.4 Population Size and Trend

Until recently, the total breeding population of Heard Shags was estimated to be between 100 and 200 pairs known from three colonies at Sydney Cove, Saddle Point and Stephenson Lagoon (Green 1997b). Roosting sites are more widespread and numerous (Pemberton and Gales 1987). In November 2001, a large colony of approximately 850 pairs on three terraces adjacent to a large macaroni penguin *Eudyptes chrysolophus* colony at Cape Pillar was discovered. The total breeding population is estimated at approximately 1100 pairs for the 2000/01 summer (Woehler in press).

The number of Macquarie Shags breeding on the island in the 1970s was estimated by Brothers (1985) at 660 breeding pairs, an estimate that does not include the nests recorded from Bishop and Clerk Islets, where Lugg et al. (1978) estimated 100 pairs. More recently,164 nests in three colonies were observed by Brothers (unpublished data).

A 2003 survey on Macquarie Island comprised an island wide search of all known and potential breeding sites. Eleven colonies comprising 472 nesting pairs were located in October 2003, although it is difficult to detect trends from these data, this figure represents 30 % fewer than the 660 pairs observed in 19 sites in the 1970s (M. Schulz and J. Lynn unpublished data).

Absence of comparable longitudinal data preclude assessment of population trends for either species of shag. Further systematic surveys are required to confidently assess trends.

3.5 Breeding Biology, Ecology and Diet

These are sedentary species that breed in colonies and are gregarious at roost sites and when feeding. Nests typically comprise a truncated column structure composed of mud, guano and vegetation. A clutch of 1 to 3 blue-green eggs being laid in October-November, although eggs have been observed in late September on Macquarie Island (Brothers 1985). On Macquarie Island most chicks hatch by late December, and are independent of adults by mid-February (Brothers 1985). The timing of egg laying for Heard Shags can vary widely, with the earliest eggs being laid from mid September, this lability in breeding season being interpreted as an adaptation to exploit periods of high food availability (Green 1997b).

Breeding success is problematic to assess given the habit of the young birds moving from their nests before becoming fully independent of parents. During three seasons on Macquarie Island, Brothers (1985) estimated mean success rates of 57-61%, reflecting a production rate of 1.0 to 1.9 chicks per nest. A similar breeding success

rate of 59% has been observed for Heard Shags, where nests produced an average of 1.9 chicks per nest (Green 1997b).

During the breeding season, adult Macquarie Shags forage for only 2-4 hours at a time, feeding their chicks ca 6 times per day (Brothers 1985). The Macquarie Shags diet consists almost entirely of two species of benthic fish, whereas the Heard Shag feeds mainly on polychaete worms and fish. At Heard Island, the shags fed exclusively on polychaete worms during the non breeding season, but switched to a diet of notothenid fish when feeding chicks (Green and Williams 1997). Compared with other shag species, Heard Shags appear to perform shorter and shallower dives, suggesting that adequate food is available in shallow waters around the island.

There are no data on adult or juvenile survival rates for either species, the mobility of birds among colonies making such assessments difficult. Brothers (1985) reported that banding records showed that Macquarie Shags can live for at least 13 years.

3.6 Threats specific to the Herald Shag and Macquarie Shag

Both Heard and Macquarie Shags are considered threatened because the populations are small and restricted in distribution. As a result, the birds could be adversely affected by effects of climate changes on sea temperature and food supply (Garnett *&* Crowley 2000) in addition to other threats that affect small and vulnerable species of seabirds (see Part A).

Heard Island is predator free, so that the threat that may be posed by feral pests remains absent on this island. In contrast, cats were identified as a possible predator of Macquarie Shag chicks, with cats being regularly observed on the periphery of colonies (Selkirk *et al*. 1990). Cats have since been eradicated from Macquarie Island, but rats have been observed in disused nest bowls on Macquarie Island (M, Schulz and J. Lynn unpublished data).

The two major causes of mortality of Macquarie Shag nestlings were predations by skuas, *Catharacta lonnbergi*, and starvation (Brothers 1985). Severe weather conditions likely contribute more than any other factor to mortality in both species, with fluctuations in breeding success being attributed to frequently inclement weather for Heard Shags (Pemberton and Gales 1987). The effects of adverse weather on breeding success may be manifested not only be physical destruction of nests but also by restricting access to available prey. On Macquarie Island up to 90% mortality of shag nestlings has been observed after a single storm (N. Brothers pers comm. in Pemberton and Gales 1987). Storms on Macquarie Island have also been directly implicated in the death of adults when colonies are wave-washed and in severe winter storm events (M. Schulz and J. Lynn unpublished data).

Human mediated deaths have also been recorded for both species, with fatal strikes with radio masts being recorded for both locations (Brothers 1985, Green 1997), although fewer mortalities are generally reported at Heard Island. The shallow and inshore foraging behaviour of the shags makes them unlikely candidates for interactions with commercial fishing operations around Heard and Macquarie Islands. A total prohibition on commercial fishing within 13 nautical miles of Heard Island likely minimises against potential interactions with the shags. Fishing is also prohibited within 3 nautical miles of Macquarie Island, and the only recorded

interaction of a Macquarie Shag interacting with fishing vessels relates to an occasion on a trawler targeting toothfish *Dissotichus* spp. in 2002 when a bird "landed on the bow of a boat, and flew off leaving a few drops on blood" (AFMA unpublished data).

3.7 Issues and Recommendations

- On Macquarie Island, conduct annual island-wide breeding census, incorporating visits to all sites known to have been used for breeding. Surveys to be timed and recorded so that meaningful assessments of population status and inter-annual variation can be drawn.
- The presence/status of the Macquarie Island shag population breeding on Bishop and Clerk Is should be assessed.
- Complete surveys of Heard Shag populations to be undertaken when possible in order to assess population status.
- Progress feral pest eradication program on Macquarie Island to mitigate possibility of rat predation on eggs and chicks.
- Ensure effective quarantine programs at all breeding sites to minimise introduction of pests.
- Where possible long radio and HF dipole aerials should be replaced by whip aerials to reduce the incidental morality caused by bird strike.
- All colonies to be protected and managed in such a way that human disturbance is minimised.
- Maintain current prohibitions of fishing in waters immediately adjacent to the breeding islands. .

3.8 References

BirdLife International. (2004) Threatened birds of the world 2004. CD-ROM. Cambridge, U.K: BirdLife International.

Brothers, N. P. (1985) Breeding biology, diet and morphometrics of the King Shag, *Phalacrocorax albiventer purpurascens*, at Macquarie Island. Australian Wildlife Research 12: 81-94.

Garnett, S.T. & Crowley, G.M. (2000) The Action Plan for Australian Birds. Environment Australia: Canberra. .

Green, K. (1997a) Biology of the Heard Island Shag *Phalacrocorax nivalis*. 1. Breeding behaviour. Emu 97: 60-66.

Green, K. (1997b) Biology of the Heard Island Shag *Phalacrocorax nivalis*. 2. Breeding. Emu 97: 67-75.

Green, K. and Williams, R. (1997) Biology of the Heard Island Shag *Phalacrocorax nivalis*. 3. Foraging, Diet and Diving Behaviour. Emu 97: 76-83.

Harrison, P. (1983) Seabirds: An identification guide. Sydney: Reed

Johnstone, G.W. (1982). Zoology. Pp. 33-39 in Expedition to the Australian Territory of Heard and McDonald Islands 1980. Eds C. Veenstra and J. Manning. Division of National Mapping, Technical Report 31, Canberra.

Lugg, D.J., Johnstone, G.W., and Griffin, B.J. (1978). The outlying islands of Macquarie Island. Geogr. J. 144: 277-87.

Marchant, S. and Higgins, P.J. (eds). (1990) The Handbook of Australian, New Zealand and Antarctic Birds. Volume 1. Oxford University Press, Melbourne.

Pemberton, D. and Gales, R. (1987) Notes on the status and breeding of the Imperial Cormorant, *Phalacrocorax atriceps* at Heard Island. Cormorant 15: 33-40.

Selkirk, P.M., Seppelt, R.D., and D.R. Selkirk (1990) Subantarctic Macquarie Island: environment and biology. Cambridge University Press, Cambridge.

Shirihai, H. (2002) *The complete guide to Antarctic wildlife*. Princeton University Press, Princeton.

Turbott, E. G. (Convenor) (1990) Checklist of the birds of New Zealand and the Ross Dependency, Antarctica. 3rd Edition. Random Century, Auckland.

Vining, R. (1983). Heard Island 1983 Scientific Reports. Garvan Institute of Medical Research, Sydney

Woehler, E.J. (in press) Status and conservation of the seabirds of Heard Island. In Green K & Woehler EJ (eds) Heard Island: Southern Ocean Sentinel. Surrey Beatty, Sydney.

Table 3.9: Summary of biological information for Heard Shag and Macquarie Shag

	Heard Shag	Refs	Macquarie Shag	Refs
Common name	**Heard Shag**		**Macquarie Shag**	
Scientific name	*Phalacrocorax nivalis*		*Phalacrocorax purpurascens*	
Conservation status				
—Australia EPBC	Vulnerable		Vulnerable	
—BirdLife Int.	Least Concern (see text)	G	Least Concern (see text)	G
Australian breeding localities	Heard Island	A	Macquarie Island, Bishop and Clerk Islets.	A, D
Extra-limital breeding localities	None	A	None	A
Foraging localities	Local waters around Heard Island	B	Local waters around Macquarie Island and Bishop & Clerk Islets.	C
Annual breeding pairs				
— Aust populations	1100	E	About 700	B
— Global	as above (endemic species)		as above (endemic species)	
Australian % of global population	100%		100%	
Breeding frequency (annual/biennial)	Probably annual		Probably annual	
Clutch size	1-3	F	1-3	B
Breeding success — % chicks fledged from eggs laid	Variable, ca 59% in one season	F	Variable, ca 57-61% mean for three seasons	A, B
Age at first breeding	No data		2 years, but most breed at 4 years or later	B
Juvenile survival	No data		No data	
Adult survival	No data		No data, birds can live for at least 13 years	B
Nest site	Surface nesting. Truncated cone nests composed of mud, guano and vegetation	G	Surface nesting. Truncated cone nests composed of mud, guano and vegetation	B
Nesting behaviour	Colonial	A	Colonial	A
Breeding season	Typically Sep -Feb	F	Typically Oct-Feb	B
Food / Foraging	Shallow-inshore waters, targeting polychaete worms and notothenid fish	C	Inshore waters, targeting benthic fish	B

Refs: A — Marchant and Higgins 1990; B — Brothers 1985; C — Green and Williams 1997; D — DPIWE unpublished data; E — Woehler in press; F — Green 1997; G — BirdLife International 2004;

4. ANTARCTIC TERN (NEW ZEALAND) AND ANTARCTIC TERN (INDIAN OCEAN) — CONSERVATION ISSUES

Antarctic Tern (New Zealand)	*Sterna vittata bethunei*
Conservation status	Native subspecies
BirdLife International Status	Least Concern
EPBC Status	Endangered
Antarctic Tern (Indian Ocean)	*Sterna vittata vittata*
Conservation status	Native subspecies
BirdLife International Status	Least Concern
EPBC Status	Endangered

4.1 General Introduction

The Sterninae, a sub-family of the Laridae, is comprised of the terns and noddies, a cosmopolitan group of seabirds, with narrow pointed wings and long pointed bills, They are mostly slimmer, longer-tailed and more aerial than gulls. The sub-family comprises about 42 species in seven genera.

The Antarctic Tern is a medium-sized tern (length 32-36 cm, wingspan 72-79 cm) with grey body and wings, white rump, a white deeply forked tail, and distinctive black cap that reaches down to the bill. The bill and feet are red, becoming brighter in the breeding season. It is found in the southern oceans and resembles the Arctic Tern from which it may be difficult to separate. However, many local Antarctic Terns are in breeding plumage when migrant Arctic Terns are in non-breeding plumage (Harrison 1983). The adult in breeding plumage is light grey above with black cap and white cheek stripe, white rump and tail, bright red bill, legs and feet. The adult in non-breeding plumage has a diagnostic combination of white forehead and crown, smudged grey underbody and dark red bill, legs and feet (Higgins and Davies 1996).

In Australian territory, the Antarctic Tern (New Zealand), *Sterna vittata bethunei*, breeds on Macquarie Island and the Antarctic Tern (Indian Ocean), *Sterna vittata vittata*, breeds on Heard Island.

4.2 Taxonomy

Higgins and Davies (1996) recognised 42 species in seven genera in the sub-family Sterninae. However, the number of genera varies, Moynihan (1969) recognised only three and others have recognised as many as 10. Higgins and Davies (1996) followed the arrangement of Christidis & Boles (1994) and Sibley & Monroe (1990). The monophyly of the genus *Sterna*, recognised by Higgins and Davies (1996), has been challenged by the electrophoretic study of Hackett (1989). There are three other subspecies of *Sterna vittata*, occurring in the South Atlantic Ocean, *georgiae*, *tristanensis* and *gaini*. (Higgins and Davies 1996)

4.3 Distribution

The movements of the Antarctic Tern are not fully understood due to confusion with other terns (Harrison 1983). This is particularly so at the sub-species level. Components of the populations of the sub-species *vittata* and *bethunei* appear to be partly migratory. The non-breeding range of all populations is poorly known.

Antarctic tern (New Zealand)

The Antarctic tern (New Zealand) breeds on Macquarie Island. The Australian population has been estimated at 50-250 mature adults (Garnett and Crowley 2000). However, Schulz and Gales (2004) recorded 24 breeding pairs in late November – early December 2003 — this census may have excluded some late-nesting pairs. There are no estimates of former abundance for the Australian population before exotic predators were introduced, but the population was apparently small in the early 20th century (Hamilton 1894, Falla 1937). Some individuals from the Macquarie Island population appear to remain in the area throughout the year (R. Clarke and M. Schulz unpublished), whilst others may disperse as far north as Australia and New Zealand. Otherwise little is known outside the breeding season (Garnett and Crowley 2000). Extralimitally, it breeds on Stewart Island, New Zealand and on New Zealand's subantarctic islands. The global population of this subspecies is considered to be less than 1,000 breeding pairs (Higgins and Davies 1996, Taylor 2000).

Antarctic tern (Indian Ocean)

The Antarctic tern (Indian Ocean) breeds only on Heard Island. Garnett and Crowley (2000) estimated the Australian population to comprise 50-250 mature adults, while Woehler (in press) estimated the Heard Island population to be between 100 and 200 breeding pairs. . There are no estimates of former abundance for this population before the 1970s. Extralimitally, the Antarctic tern (Indian Ocean) breeds on subantarctic islands of the Indian Ocean (Crozet Is, Kerguelen Is, Prince Edward Is). The global population has been estimated to be less than 2,000 breeding pairs (Higgins and Davies 1996, Weimerskirch *et al*. 1989).

4.4 Population size and trend

Garnett and Crowley (2000) assessed Australian populations of the Antarctic tern (New Zealand) and Antarctic tern (Indian Ocean) as endangered. Both subspecies were estimated to have Australian populations of 50-250 mature adults, with 100 and 200 breeding individuals respectively (see also Schulz and Gales 2004). Woehler (in press) estimated the Heard Island population to be between 100 and 200 breeding pairs, which would suggest a maximum total population of approximately 500 individuals at HI. While these populations were considered to be stable, the restricted geographic distribution of both subspecies was considered precarious for their survival (Garnett and Crowley 2000). In Australia, the area of occupancy was estimated to be 2 km^2 for the Antarctic tern (Indian Ocean), and 3 km^2 for the Antarctic tern (New Zealand).

BirdLife International (2004) recently assessed the global conservation status *Sterna vittata* at the species level as Least Concern. This species has a large range, and the global population was estimated to be 140,000 individuals.

4.5 Breeding Biology, Ecology and Diet

Biological and ecological knowledge has been well summarised by Higgins and Davies (1990). Table 4.9 provides a summary of known biological information for the two subspecies.

Antarctic terns breed colonially, with colonies rarely exceeding 40 widely-spread nests at any one locality. At Macquarie Island most birds nest singly rather than colonially (G.Copson unpublished; Schulz and Gales 2004). The clutch is invariable one and eggs are laid in a shallow pebble-or shell-lined scrape on the ground on rocky beaches and glacial moraines. On Macquarie Island, the majority of nests are located on offshore stacks (Schulz and Gales 2004) in sites that are not frequented by seals. At Heard Island, laying occurs between October and January, and fledging of the chicks occurs between January to May (Downes *et al*. 1959). On Macquarie Island egg-laying is more protracted and extends to the end of December and possibly to March (M.Schulz unpublished), similar to that on New Zealand's sub Antarctic Islands (Bailey and Sorensen 1962).

The parents attend their young for several weeks after fledging, (Woehler and Clippingdale undated). During incubation an adult tern will leave its nest when an observer approaches within 25 metres, and call loudly to attract the attention of other members of the colony who return and add to the clamour (Downes *et al*. 1959, Woehler unpubl. data).

Antarctic Terns are gregarious feeders that fish in flocks of up to several hundred birds. Typically they forage inshore in the kelp zone up to 200m from the shore, where they feed on small fish and plankton (Higgins and Davies 1996). They also scavenge in the intertidal zone for stranded littoral organisms including small crustaceans, polychaetes and shell fish (Woehler and Clippingdale undated). They normally feed by hovering 2-15m above the sea, dipping or plunging into the water to catch their prey. At Macquarie Island birds are more regularly seen foraging alone (R. Clarke and M. Schulz unpublished), perhaps reflecting the small size of the local populations.

4.6 Threats specific to Antarctic Terns

Both subspecies of the Antarctic Tern are considered threatened because the populations are small, restricted in distribution, and therefore vulnerable to stochastic events such as storms and cyclones (Garnett and Crowley 2000).

Successful Antarctic Tern breeding is thought to be severely affected by disturbance and predation (Peter *et al*. 1988). Heard Island is predator free and hence there is no immediate threat posed by feral pests. However, maintenance of strict quarantine procedures is essential to ensure this situation remains. Cats on Macquarie Island were identified as possibly the most significant predator preventing pairs from breeding successfully (Rounsevell and Brothers 1984). Cats have since been eradicated from Macquarie Island, but rats still remain. Rats are thought to be the primary cause of failure to breed on the main island at Macquarie Island (M. Schulz and J. Lynn unpublished data) — the virtual restriction of breeding to offshore stacks may be due to the absence of rats at these sites.

Adult Antarctic terns co-operate to defend their colonies. However, skuas and kelp gulls still occasionally manage to take eggs or chicks from unattended nests in colonies following disturbance events (Woehler and Clippingdale undated).

Because of the Reserve status and isolation of both Macquarie and Heard Islands, there are no current threats to the avifauna from direct exploitation, competition from commercial fisheries or pollution. A total prohibition on commercial fishing within 13 nautical miles of Heard Island and within 3 nautical miles of Macquarie Island likely minimises against potential interactions with Antarctic terns at these sites. The shallow and inshore foraging behaviour of the Antarctic Tern also makes them unlikely candidates for interactions with commercial fishing operations.

Visitor access to breeding sites should be strictly controlled to minimise the impact on eggs and chicks as both are very cryptic and easily trampled by unwary visitors. The presence of visitors at nesting sites may also cause birds to leave eggs and chicks unattended, exposing them to the risk of predation by skuas and gulls.

4.7 Issues and Recommendations

- Continue monitoring of breeding population size and breeding success on Macquarie Island.
- Conduct monitoring program for breeding population and assess breeding success on Heard Island using minimal impact non-invasive techniques.
- Progress feral pest eradication program on Macquarie Island to mitigate possibility of rat predation on eggs and chicks.
- Continue rabbit control on Macquarie Island
- Ensure effective stringent quarantine programs at all sites to minimise the introduction of pests.
- All colonies to be managed in such a way that human disturbance is minimised.

4.8 References

Bailey, A.M. and Sorensen, J.H. (1962). Subantarctic Campbell Island. Proceedings of the Denver Museum of Natural History 10.

BirdLife International. (2004). Threatened birds of the world 2004. CD-ROM. Cambridge, U.K: BirdLife International.

Christidis, L. and Boles, W.E. (1994). The taxonomy and species of birds of Australia and its Territories. Royal Australasian Ornithologists Union Monograph 2. RAOU: Melbourne.

Downes, M.C., Ealey, E.H.M., Gwynn, A.M. & Young, P.S. (1959). The Birds of Heard Island. ANARE Report Ser.. B. 1.

Downes, M.C., Ealey, E.H.M., Gwynn, A.M. and Young, P.S. The birds of Heard Island. ANARE Reports Series B. Volume 1. Zoology. Antarctic Division, Dept of External Affairs: Melbourne.

Environment Australia. (2001). Macquarie Island Marine Park Management Plan, http://www.deh.gov.au/coasts/mpa/macquarie/plan/

Gardenfors, U., **Rodriguez, J.P., Hilton-Taylor, C., Hyslop, C., Mace, G., Molur, S. & Poss, S.** (1999). Draft Guidelines for the application of the IUCN Red List Criteria at national and regional levels. Species 31-32:58-70

Garnett, S.T. & Crowley, G.M. (2000). The Action Plan for Australian Birds 2000. Environment Australia: Canberra.

Hamilton, A. (1894). Notes on a visit to Macquarie Island. Trans. Proc. N.Z. Institute 27:559-579

Harrison, P. (1983). Seabirds: An identification guide. Sydney: Reed

Higgins, P.J. & Davies, S.J.J.F. (eds). (1996). *The Handbook of Australian, New Zealand and Antarctic Birds. Volume 3.* Oxford University Press, Melbourne.

Peter, H.-U., Bannasch, R., Bick, A., Gebauer, A, Kaiser, M. Moenke, R. &

Zippel, D. (1988): Effects on anthropogenic influences on abundance and reproduction of Antarctic birds and seals in the southern parts of King George Island.- Fifth SCAR Symposium on Antarctic Biology. Abstracts,66

Rounsevell, D.E. & Brothers, N.P. (1984). The status of seabirds on Macquarie Island. Pp. 587-592 in Status and conservation. Pp. 609-625 in Status and conservation of the world's seabirds. ICBP Tech. Publ. No. 2. J.P. Croxall, P.G.H. Evans & R.W. Schreiber (eds). ICBP, Cambridge, U.K.

Schulz, M. and Gales, R. (2004). Breeding of the Antarctic Tern (*Sterna vittata bethunei*) on Macquarie Island. Notornis 51: 114-116.

Taylor, G.A. (2000) Threatened Species Occasional Paper No.16, Action Plan for seabird conservation in New Zealand, Part A, Department of Conservation, Biodiversity Recovery Unit, Wellington, NZ

Weimerskirch, H., Zotier, R. & Jouventin, J. (1989). The avifauna of the Kerguelen Islands. Emu 89:15-29

Woehler, E. & Clippingdale, M. (undated). http://www.aad.gov.au/default.asp?casid=1476

Woehler, E.J. (1991). The status and conservation of the seabirds of Heard Island and the McDonald Islands. ICBP Tech. Publ. 11:263-277.

Table 4.9: Summary of biological information for Antarctic tern (Indian Ocean) and Antarctic tern (New Zealand)

	Antarctic tern (Indian Ocean)	Refs	Antarctic tern (New Zealand)	Refs
Common name	**Antarctic tern**		**Antarctic tern**	
Scientific name	*Sterna vittata vittata*		*Sterna vittata bethunei*	
Conservation status				
— Australia EPBC	Endangered		Endangered	
— BirdLife Int.	Least Concern		Least Concern	
Australian breeding localities	Heard Island		Macquarie Island	
Extra-limital breeding localities	Subantarctic islands of the Indian Ocean (Iles Crozet, Iles Kerguelen, Prince Edward Is)	C	Stewart Is, NZ and New Zealand's subantarctic islands.	C
Foraging localities	During summer they feed in waters close to the shore.	C	During summer they feed in waters close to the shore. In winter they forage at the edge of the ice and in patches of unfrozen inshore waters.	C
Annual breeding pairs		C		C
— Aust populations	50-250 mature adults		50-250 mature adults	E
— Global	1-2,000 pairs on Iles Kerguelen. Low numbers on Prince Edward Is & Iles Crozet		Up to 1,000 birds breeding on NZ subantarctic islands.	
Australian % of global population	<1%	C	<1%	C
Breeding frequency (annual/biennial)	Annual		Annual	
Clutch size	One	D	One	D
Breeding success — % chicks fledged from eggs laid	Unknown?		Unknown?	
Age at first breeding	Possibly 3-4 years	D	Possibly 3-4 years	D
Juvenile survival	?		?	
Adult survival	Generation time 10 years.	C	Generation time 10 years.	C
Nest site	Among rocks and glacial moraine near the coast, scree slopes, poorly vegetated moraines	C	Usually on live vegetation, occasionally in unvegetated crevices. On Macquarie Island breeds mainly on offshore stacks.	C E
Nesting behaviour (colonial / dispersed pairs)	Loosely colonial to solitary	D	Solitary	E
Breeding season	Summer	D	Summer (Oct – March)	E
Food / Foraging	Feed on fish, crustaceans and other marine invertebrates in kelp beds in waters close to the island during summer.	C	Feed on fish, crustaceans and other marine invertebrates in kelp beds in waters close to the island during summer.	C

Refs: A – Woehler and Clippingdale (undated); B — BirdLife International 2004; C - Garnett and Crowley 2000; D — Higgins and Davies 1996; E — Schulz and Gales 2004.

5. AUSTRALIAN LESSER NODDY — CONSERVATION ISSUES

Australian lesser Noddy	***Anous tenuirostris melanops***
Conservation Status	Endemic Species
BirdLife International Status	Least Concern
EPBC Status	Vulnerable

5.1 General Introduction

The Sterninae, a sub-family of the Laridae, comprises the terns and noddies, a cosmopolitan group of seabirds, with narrow pointed wings and long pointed bills, They are mostly slimmer, longer-tailed and more aerial than gulls. The sub-family comprises about 42 species in seven genera.

The Australian lesser noddy *Anous tenuirostris* is a small dark-plumaged, tropical tern (length 29-34 cm, wingspan 57-64 cm) with a long slender straight bill, long narrow wings and slightly wedge-shaped tail. It is confined to the tropical and sub-tropical Indian Ocean. The Australian subspecies of the Australian lesser noddy *A. T. melanops* breeds only on three islands in the Houtman Abrolhos, off Western Australia, where it nests in mangrove trees. Typical adults are dark brown with a diffuse pale grey cap. The sexes are similar and there is no seasonal variation in plumage (Higgins and Davies 1996, Surman and Wooller 1995).

5.2 Taxonomy

There are few taxonomic issues associated with this species. The Australian lesser noddy is sometimes considered conspecific with black noddy, *Anous minutus,* which occurs in the Pacific and Atlantic Oceans (Higgins and Davies 1996).

5.3 Distribution

Anous tenuirostris melanops is only known to breed in Houtman Abrolhos, where colonies on Pelsaert, Wooded and Morley Islands occupy a total of 5 ha. Birds appear to remain near the breeding islands all year (Higgins and Davies 1996). A population thought to be *A.t.melanops* possibly breeds in the Ashmore Reef, however the subspecific identity has not been confirmed (Stokes and Hinchey 1990).

Nominate *tenuirostris* breeds extralimitally in the tropical and subtropical Indian Ocean at the Seychelles, Cargados Carajos Shoal, Reunion I, Agalengas I, Chagos Archipelago and the Maldives (Higgins and Davies 1996).

The oceanic range of the Australian lesser Noddy is largely unknown. They may be mostly sedentary, returning to breeding islands to roost during non-breeding season. They possibly leave the islands for short periods and the feeding range from islands is probably extensive. Gales can displace birds many hundreds of kms (Higgins and Davies 1996; Harrison 1983).

5.4 Population size and trend

Although numbers vary considerably among years and colonies, the population is considered to be stable (Garnett and Crowley 2000). Total numbers early in the 20th century were possibly as low as 20,000 pairs (Burbidge and Fuller 1989, Johnstone and Storr 1998). Guano mining during the 19th century and early 20th century coincided with the disappearance of birds from Pelsaert Island sometime between 1899 and 1907 (Burbidge and Fuller 1981). Colonies re-established sometime between 1913 and 1936 (Fuller and Burbidge 1992). Fluctuations in abundance of their prey species may explain the variation in breeding numbers (Garnett and Crowley 2000). Breeding colonies on Pelsaert, Wooded and Morley Islands have been observed since the early 19th century and records are summarised by Higgins and Davies (1996).

Garnett and Crowley (2000) assessed Australian populations of the Lesser Noddy as vulnerable. The population was estimated to be 100,000 breeding birds, and while the population was considered to be stable, the very tiny area in which this subspecies breeds could be badly affected by catastrophic events (Garnett and Crowley 2000). The area of occupancy was estimated to be 3km^2.

BirdLife International (2004) recently assessed the global conservation status *Anous tenuirostris* at the species level as Least Concern. This species has a large range, and the global population was estimated to be 1,200,000 individuals.

5.5 Breeding Biology, Ecology and Diet

Table 5.9 provides a summary of known biological information for the subspecies.

Biological and ecological knowledge has been summarised by Higgins and Davies (1996). The Australian lesser noddy represents one of only three marine terns to build substantial nests. On Houtman Abrolhos, Australian lesser noddies breed in dense clumps of mangrove up to 4m tall. Nests are constructed of seaweed *Ulva lactuca*, gathered from the surrounding sea and lagoons, held together by excreta and placed in the fork of a mangrove (Johnstone and Coate 1992). On Ashmore Reef, birds possibly of this species were thought to be nesting in low bushes of Sesbania Pea *Sesbania cannibina* (Stokes and Hinchey 1990). Australian lesser noddies nest colonially, and move colonies periodically because nesting birds retard tree growth, resulting in tree death (Higgins and Davies 1996).

A detailed breeding biology study on Pelsaert Island was carried out by Surman and Wooller (1995). Breeding success there was found to be 47% with the main determinant of breeding success being site selection. Sites protected from strong WNW winds were more likely to succeed than exposed nests, with storms causing extensive egg loss from the more exposed nests. On Pelsaert Island egg laying occurred from late August to early December with a peak in September. The first eggs hatched at the end of September. Other studies show egg laying from August through to March or early April (Higgins and Davies 1996).

The foraging habitat of Australian lesser noddies is virtually unknown. They feed by ‘dipping’, taking prey from or just below the surface of water without alighting. They may forage out to sea or close inshore to breeding islands, including outside fringing reefs, feeding on small squid and fish (Higgins and Davies 1996). They roost mainly in mangroves, and sometimes rest on the beaches.

5.6 Threats specific to the Australian lesser noddy

The Australian lesser noddy at present faces few threats to its survival in the Houtman Abrolhos. Garnett and Crowley (2000) estimated the population to comprise 100,000 breeding birds, and although inter-annual variation in breeding is apparent, they considered the population to be stable.

There is very little evidence of human interference, although the islands are often visited by fishing parties, yacht crews and groups of naturalists (Johnstone 1992, Johnstone and Croate 1992) Camping on Pelsaert Island is prohibited except by permit and disturbance caused by humans is minimal at present (Fuller and Burbidge 1992). The Fisheries Management Paper No 117 (Department of Fisheries 2002) considers wildfire as a risk to the Houtman Abrolhos but it is unlikely that mangroves would be significantly affected by fire.

A number of exotic plant and animal species have been introduced to the Houtman Albrolhos islands. Feral animals known to have occurred on the islands include rabbits, rats and cats. A successful black rat and cat eradication program was carried out in the Easter Group. Ongoing African boxthorn eradication programs occur on the islands in the Southern Group. The Fisheries Management Paper No 117 (Department of Fisheries 2002) recommends surveys of exotic plants and animals on the Albrolhos Islands to establish the species present and to develop a plan for their removal or management. It also recommends the preparation and implementation of a management plan for preventing the arrival of exotic flora and fauna

The following potential threats are listed by Garnett and Crowley (2000):

- catastrophic destruction by cyclones
- pollution from oil spills that could damage birds and mangroves
- sea level rises associated with global warming affecting the mangroves required for breeding
- commercial fishing potentially affecting food supplies

5.7 Issues and Recommendations

- The existence of Australian lesser noddies at Ashmore reef requires confirmation.
- Should Australian lesser noddies still occur at Ashmore Reef, establish their taxonomic affinity, and whether or not breeding occurs. All colonies should be managed in such a way that human disturbance is minimised.
- Maintain monitoring and management of breeding islands at Houtman Abrolhos.
- Implement the recommendations of the Fisheries Management Paper No.117 (Department of Fisheries 2002) in relation to exotic plant and feral animal control and quarantine procedures to prevent introduction of exotic plants and animals.

5.8 References

BirdLife International. (2004). Threatened birds of the world 2004. CD-ROM. Cambridge, U.K: BirdLife International.

Burbidge A. A. and Fuller, P. J. (1989) Numbers of breeding seabirds on Palsaert Island, Houtman Abrolhos, Western Australia, Corella 13: 57-61

Burbidge A. A. and Fuller, P. J. (1991) A million seabirds, Landscape, 6: 17-23

Department of Fisheries (2002) Fisheries Management Paper No 117, Management of the Houtman Albolhos System, December 1998

Fuller, P. J., Burbidge A. A. and Owens R. (1994) Breeding seabirds of Houtman Abrolhos, Western Australia: 1991-1993, Corella 18:97-113.

Fuller, P.J. and Burbidge, A.A. (1992). Seabird Islands No. 215. Pelsaert Island, Houtman Abrolhos, Western Australia. Corella 16:47-57.

Garnett, S.T. & Crowley, G.M. (2000). The Action Plan for Australian Birds 2000. Environment Australia: Canberra.

Harrison, P. (1983). Seabirds: An identification guide. Sydney: Reed

Higgins, P.J. & Davies, S.J.J.F. (eds). (1996). *The Handbook of Australian, New Zealand and Antarctic Birds. Volume 3.* Oxford University Press, Melbourne.

Johnstone, R.E (1992). Seabird Islands No. 217. Morley Island, Easter Group, Houtman Abrolhos, Western Australia. Corella 16:160-162.

Johnstone, R.E & Coate, K. (1992). Seabird Islands No. 216. Wooded Island, Easter Group, Houtman Abrolhos, Western Australia. Corella 16:155-159.

Stokes , T. and Hinchey, M. (1990) Which small noddies breed at Ashmore Reef in the indian Ocean? Emu 90: 269-271

Surman, C.A. and Wooller, R.D. (1995) The Breeding biology of the Lesser Noddy on Palsaert Island, Western Australia, Emu 95: 47-53

Table 5.9: Summary of biological information for Australian lesser noddies

	Australian Lesser noddy	Refs
Common name	**Australian lesser noddy**	
Scientific name	*Anous tenuiriostris melanops*	
Conservation status		
— Australia EPBC	Vulnerable	B
— BirdLife Int.	Least Concern	A
Australian breeding localities	Houtman Albrolhos – colonies known on Pelseart Is., Wooded Is. and Morley Is.	B, D
Extra-limital breeding localities	Only known to breed in Australian localities listed above.	B
Foraging localities	Foraging habitat is virtually unknown. They may forage out to sea or in seas close to breeding islands, including outside fringing reefs	CD
Annual breeding pairs		
— Aust populations	100,000 breeding birds	B
— Global	100,000 breeding birds	
Australian % of global population	100%	B
Breeding frequency (annual/biennial)	Annual	C
Clutch size	One	C, D
Breeding success — % chicks fledged from eggs laid	47% - Pelsaert Island study	D
Age at first breeding	Possibly 3-4 years.	C
Juvenile survival	Unkown	
Adult survival	Unknown	
Nest site	Builds nests in White Mangroves *Avicennia marina*, which occur in small scattered patches on a few islands of the Houtman Albrolhos. Nesting colonies move periodically because nesting birds retard tree growth and sometimes kill trees.	B
Nesting behaviour (colonial / dispersed pairs)	Colonial	B
Breeding season	Spring and through summer	C, D
Food / Foraging	Feed by 'dipping', taking prey from or just below the surface of water without alighting. Feeds on small squid and fish in nearby waters.	B, C

Refs: A — BirdLife International 2004; B — Garnett and Crowley 2000; C — Higgins and Davies 1996; D — Surman and Wooller 1995