Action Plan for Seabird Conservation in New Zealand

Part A: Threatened Seabirds

THREATENED SPECIES OCCASIONAL PUBLICATION NO. 16

Department of Conservation
Te Papa Atawhai

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by Graeme A. Taylor

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Juvenile Campbell albatross, Campbell Island, 1984

Breeding only at the northern end of Campbell Island in the New Zealand subantarctic, Campbell albatross forage widely in the Tasman Sea and around New Zealand. Large numbers of birds have been caught on tuna long-line fisheries and the breeding population rapidly declined between 1970 and the early 1980s. Juvenile birds are particularly at risk from fisheries' impacts.

Pitt Island shag, Chatham Island, 1987

A 1997 census over the entire breeding range on the Chatham Islands found 669 breeding pairs at scattered sites.

Chatham albatross adults and chick, The Pyramid, 1993

Chatham albatross breed only on The Pyramid, Chatham Islands. The habitat on the island was severely damaged by a severe storm in 1985, and nest sites are now precariously placed on steep barren rock faces. Adult birds have been caught on long-line fisheries near the Chatham Islands and off South America.

CONTENTS

PART A: THREATENED SEABIRDS

Abbreviations used in Parts A and B

CMS	Conservation management strategies
DDT	dichlorodiphenyltrichloroethane
DOC	Department of Conservation
EEZ	Exclusive Economic Zone
ENSO	El Nino/Southern Oscillation
HANZAB	Handbook of Australian, New Zealand and Antarctic Birds
HBW	Handbook of the Birds of the World
IR	infra red
IUCN	International Union for Conservation of Nature and Natural Resources
LEDs	light-emitting diodes
MSA	Maritime Safety Authority
NIWA	National Institute of Water and Atmospheric Research Ltd.
OSNZ	Ornithological Society of New Zealand
PCB	polychlorinated biphenyls
PCDD	polychlorinated dibenzo-*p*-dioxins
PCDF	dibenzofurans
RHD	rabbit haemorrhagic disease
4WD	four-wheel-drive

Fairy tern chick, Mangawhai Estuary, 1983. Photo: R. Parrish

Fairy terns are New Zealand's rarest bird species. About 30 individuals were present in 1999, and breeding was confined to three coastal sites in Northland. Human disturbance, predation, and storm events are the main threats to this species

Sooty tern colony, Macauley Island, 1988

Sooty terns nest only at the Kermadec Islands in the New Zealand region. Trampling by feral goats destroyed colonies on Macauley Island prior to 1970 and predation by feral cats and Norway rats has all but eliminated colonies on Raoul Island.

Black-fronted tern on nest. Photo: W. Hutchinson

Black-fronted terns only nest on South Island braided rivers. Populations have declined throughout their breeding range. Predation by introduced mammals and weed infestation of riverbeds are the main threats to this species.

Abstract

New Zealand has the most diverse seabird community in the world. Eighty-four species breed in New Zealand, including 35 species (42%) that are endemic (breed nowhere else). These seabird species are further split into 96 taxa (subspecies), half of which are endemic to New Zealand.

This document reviews the conservation status of 94 taxa (two grebe species are excluded). Part A covers the 47 seabird taxa considered threatened by the new IUCN criteria (taxa listed as Critical, Endangered, or Vulnerable), and also four taxa listed as Data Deficient. Part B covers the 43 seabird taxa that are not considered threatened by the same criteria (these are listed as either Near Threatened or Least Concern).

New Zealand seabirds are exposed to a wide range of threatening processes.The main threats are predation from introduced mammals, fisheries interactions including capture of seabirds on long-lines, hand-lines, set-nets, and trawl nets, loss of nesting habitat from weed encroachment, shingle extraction on riverbeds, coastal development, and human disturbance of nesting colonies. Long-term changes in the marine environment have also triggered declines in seabird species such as penguins and albatrosses. It appears that oceanic water temperatures have increased since the 1950s and this has altered the distribution and availability of food.These environmental changes may also affect the quality of nesting habitat on small offshore islands. Potential threats include the risk of new pest mammal species colonising near pristine offshore islands, oil spills and increasing marine pollution, fires destroying breeding habitats, and disease outbreaks.

This document lists the priority management requirements for each seabird taxon.These include preventing the spread of introduced mammalian species to near pristine islands (i.e. managing biosecurity and quarantine risks, especially on visits to offshore islands), removing pest mammal and bird species from offshore islands, controlling predators and browsers at mainland breeding colonies, managing visitor access and disturbance at key breeding sites, securing the legal status of important breeding colonies, and developing strategies to manage fisheries impacts, especially from long-lining and set-nets.

The population status of New Zealand seabirds is reviewed in this document. Many new population estimates are presented.The rarest seabird species in New Zealand is the fairy tern (about 30 individuals known), but the species at greatest risk of extinction is probably the Chatham Island taiko (about 100 individuals known). A number of other species have declining populations (e.g. Chatham petrel, erect-crested penguin, grey-headed albatross, black-fronted tern) and these species need regular monitoring and protection. The accuracy of population estimates is still very coarse for most seabird taxa.The best estimates are for very rare species or some large surface-nesting species. The priority survey and monitoring needs of each taxon is listed.

There is still little understanding of the basic population dynamics of most New Zealand seabird taxa. Work is urgently required on some species to assess whether or not declines have been caused by changes in adult survival rates, reduced breeding success, and/or a lack of recruitment of chicks back to breeding colonies. Other priority research needs include further work on the breeding biology and breeding cycle of most species, diet and understanding the potential for interactions with fisheries, movements of seabirds during the breeding season and migration paths after breeding, resolving outstanding taxonomy issues, developing techniques to establish new seabird colonies, and understanding the social behaviour and vocalisations of many seabird taxa.

1. Purpose

The Department of Conservation's Strategic Business Plan 1998-2002 (Department of Conservation 1998) assessed important tasks that needed to be undertaken in the next 5 years and outlined goals and objectives for achieving these tasks. Seabird conservation initiatives are included under the Natural Heritage Goals: 1.1 Integrated Management and 1.2 Marine Environment. One target direction of the Strategic Business Plan was to provide adequate recovery plans, or determine recovery action where a formal plan is not warranted, for all Category A, B and C species (Molloy & Davis 1992) by the year 2002. The *Action Plan for Seabird Conservation in New Zealand, Part A: Threatened Seabirds* achieves this target for seabirds by listing priority recovery actions for all threatened seabird taxa in New Zealand. The current document complements those species recovery plans that have been published or are currently drafted for publication. For some seabird taxa, a more detailed prescription of objectives and tasks are required by Department of Conservation (DOC) managers. These recovery plans will be published separately.

This action plan for seabirds provides DOC staff and other seabird specialists with a brief summary of the status, threats, and priority actions required for each seabird taxa. The document hopefully will increase public awareness of the urgent conservation needs of New Zealand seabirds. The goal of the *Action Plan for Seabird Conservation in New Zealand* is to promote recovery actions that will improve the conservation status of seabird taxa, prevent further seabird declines, and secure the long-term future of seabird populations in New Zealand.

The key objectives of this document are:

1. To update the conservation status of seabird taxa in New Zealand.
2. To describe the threats to seabirds and summarise conservation work undertaken to date.
3. To prioritise conservation actions needed to initiate or continue the recovery of each threatened seabird taxon. This will ensure that all DOC staff and research providers direct their survey, monitoring, research and management efforts to national priority seabird taxa at priority sites.
4. To list conservation actions needed to maintain healthy populations of non-threatened seabird taxa.
5. To provide information to DOC staff on seabird census, monitoring and research methodologies to ensure that projects are designed to achieve their stated objectives.
6. To ensure that a co-ordinated approach is taken by DOC staff managing seabird taxa that occur in more than one conservancy.
7. To make people more aware of their responsibilities for protecting seabird colonies, especially when visiting offshore islands.

8. To maximise the opportunities to record useful seabird observations by highlighting current knowledge gaps.

9. To stimulate and direct post-graduate research topics and also studies by the Ornithological Society of New Zealand (OSNZ) and private individuals.

2. Scope and limitations

This document covers all seabird species and taxa that breed in New Zealand or on its outlying islands. Excluded from the species accounts are New Zealand dabchick (*Poliocephalus rufopectus*) and Australasian crested grebe (*Podiceps cristatus australis*). These taxa are members of a world-wide bird family that frequents coastal waters, but in New Zealand, neither taxon visits the open ocean. This document also does not cover those seabird taxa that breed outside New Zealand but regularly visit New Zealand seas or turn up here as vagrants.

All threatened seabird taxa are discussed in Part A and non-threatened seabird taxa in Part B. In each document, taxa are arranged in alphabetical order of their scientific names. An index of scientific and common names is provided at the back of each document to help locate the text about each seabird taxon. The measures outlined in this document are actions that will provide some conservation benefits to seabirds. Individual actions are listed in order of priority with those actions that are essential or high priority likely to be funded by government agencies when resources are available. Medium or lower priority actions may be funded in the future by government agencies or are suitable to be carried out by universities, local government agencies, private individuals, or interest groups such as OSNZ.

The *Action Plan for Seabird Conservation in New Zealand* is not a legally binding document. The actions outlined will help define the future direction of seabird work in New Zealand, but each action still needs to fit within the framework of other planning documents prepared under the Conservation Act, e.g. Conservation Management Strategies (CMS). This action plan is designed to cover a 10-20 year working period. This is an appropriate timeframe for seabirds because all species are long-lived and changes to their conservation status require long-term solutions.

3. Sources of information

The main source of information about New Zealand seabirds is the comprehensive summary compiled in the *Handbook of Australian, New Zealand and Antarctic Birds* (HANZAB) Volume 1 (Marchant & Higgins 1990) and Volume 3 (Higgins & Davies 1996). These volumes were used extensively to collect information about population distribution and abundance, biology and ecology, threats, and research needs. Unreferenced information on these topics in the *Action Plan for Seabird Conservation in New Zealand* is sourced from HANZAB unless more recent references are quoted.

The *Handbook of the Birds of the World* (HBW), Volumes 1 and 3 (del Hoyo et al. 1992, 1996) was used as the main source of taxonomy in the action plan. HBW taxonomy is conservative and lists all the published subspecies. Evidence for some of these subspecies is weak and needs further work to resolve the taxonomy. HBW was useful for reviewing seabird ecology and threats, and providing a global assessment of seabird distribution. Note that the taxonomy used in the *Checklist of the Birds of New Zealand and the Ross Dependency, Antarctic* (Turbott 1990) and HANZAB sometimes vary with that presented in HBW.

The recently revised taxonomy of albatrosses (Nunn et al. 1996, Robertson & Nunn 1998) has been incorporated in the action plan. The common names for albatross species follows the consensus reached by people attending the Inaugural Albatross Conference held in Hobart in 1995 (Gales 1998). The taxonomy of shags proposed by Siegel-Causey (1988) is also incorporated this document. Information on animal pest eradications has been sourced from Veitch & Bell (1990), Veitch (1995) or from the DOC Island Animal Pest Eradications Database (maintained by Biodiversity Recovery Unit, DOC, Wellington).

Where possible the latest seabird research findings have been included in this document, and a full reference section is presented to introduce readers to the relevant seabird literature. Further information about reference texts and seabird information systems are presented in Appendix 2.

4. General introduction to seabirds

New Zealand is a country well known for its unique landbirds such as the kiwi and kakapo. Today, 73 native landbird species breed in New Zealand. Of these species, 63% are endemic; that is, they breed no where else in the world. Few people, however, appreciate that in an international context, New Zealand is the world centre for seabird diversity. Most New Zealanders would be surprised to learn that more native seabird species breed in New Zealand than native landbirds. Currently, 84 seabird species breed in New Zealand, 42% of which breed nowhere else in the world.

The majority of New Zealand's seabirds have undergone substantial population declines and breeding range contractions similar to that suffered by landbirds since the arrival of humans in New Zealand 1000 years ago (Worthy & Holdaway 1993). However, unlike landbirds, there have been very few seabird extinctions since humans arrived in New Zealand (Holdaway 1989). The extinct seabirds include the New Zealand pelican (*Pelecanus novaezealandiae*), Chatham Island steamer duck (*Pachyanas chathamica*) (Holdaway 1989), Scarlett's shearwater (*Puffinus spelaeus*) (Holdaway & Worthy 1994), Auckland Island merganser (*Mergus australis*) (Turbott 1990), and at least one undescribed petrel species from the Chatham Islands (Bourne 1967). However, there is no need for complacency. Several seabird species are now amongst the rarest and most critically endangered of New Zealand's breeding birds. These include the Chatham Island taiko, Chatham petrel, and New Zealand fairy tern. The fate of many other seabird species will depend on whether we can overcome a wide range of threats to these species during the next few decades.

4.1 CHARACTERISTICS OF SEABIRDS

Seabirds have evolved from a wide range of different taxonomic groups. Common to all is that they spend some part of their life cycle feeding over the open sea. This separates seabirds from waders that feed in the littoral zone or on shorelines and from species that regularly roost at sea such as ducks and swans. Seabirds have water-resistant feathering (from oils in the preen gland) that enable them to fully immerse in salt water. They have webbed feet that allows them to swim in water and can readily become airborne off the water. Most seabirds have short legs and powerful wings or flippers. All have bills with sharp hooks, points, or filters which enables them to catch fish, cephalopods, crustaceans, and plankton. Lastly, seabirds can drink saltwater and have physiological adaptations for removing excess salt.

4.2 ECOLOGY OF SEABIRDS

Seabirds have evolved to exploit different types of food. The main food groups in the ocean are fish, cephalopods, crustaceans, and plankton. Seabirds share this resource by feeding either on one group exclusively or on a variety of food groups. The size of the seabird will dictate how large or small a prey item it will consume. Some birds stay predominately over land and feed over rivers, lakes, and farmland, only occasionally venturing to inshore seas. Others feed in harbours, estuaries, or bays. Some species forage out over the continental shelf and along the shelf break. Species with long wings and rapid flight are able to forage far out over deep pelagic water. Some seabirds only catch prey on or above the surface (e.g. flying fish, insects, plankton) whereas other species shallow dive. Some seabirds are adapted for deep diving and catch most of their food deep in the water column or on the sea floor (e.g. penguins, shags, and shearwaters). Seabirds also divide up the food resource by foraging only in water of certain temperatures. Thus there are tropical, sub-tropical, temperate, subantarctic, and Antarctic specialists. Some species remain in the same region throughout their life while others migrate to distant oceans in the non-breeding season. Finally, some species are scavengers/opportunists and a few are predators of other seabirds.

The choice of nesting habitat also helps to reduce competition between seabirds. Some species nest inland on riverbeds or lake margins, others nest on open beaches, sandspits, or shellbanks. Some prefer cliff ledges, rocky islets, or rock caves. Other nest in grasslands, coastal shrublands, or under tall forest. Most seabirds are surface nesters but some groups specialise in nesting in burrows or rock crevices, e.g. petrels and blue penguins.

4.3 LIFE HISTORY TRAITS OF SEABIRDS

All but a few species of seabirds are long-lived. The only exception appears to be diving petrels. Most seabird species can survive up to 20 years and 30-40 years is typical for the oldest individuals. A few groups such as albatrosses can live for 50-60 years. With such longevity, it is reasonable to suppose that seabirds have delayed sexual maturity. A few species have been recorded nesting as yearlings, e.g. red-billed gull, blue penguin. Diving petrels and yellow-eyed penguins can begin nesting as 2-year-olds. The majority of seabirds don't start nesting until they are 3-6 years old and a few species of albatross and petrels delay nesting until they 8-15 years old. In these late developers, individuals don't return to colonies until they are 2-6 years old. Most seabirds have a strong natal site fidelity and typically return to the same breeding colony where they were reared, or nest in the general vicinity. This tendency is strongly developed in albatrosses and some petrels. Seabirds also have a tendency to mate for long periods with the same partner, and albatross pairs almost always remain together unless the partner fails to return to the colony.

The number of eggs laid varies between seabird families. Albatrosses and petrels lay only 1 egg per year and do not replace it if it is damaged or lost soon after laying. Other species such as gannets lay 1 egg but can replace it if the egg is lost. Most penguins lay 2 eggs but some raise only one chick and kick out the second egg. Generally no replacement laying is possible. Other species lay 1-3 eggs and can lay up to three clutches if eggs are damaged or lost, e.g. blue penguins, gulls, and terns. At the other extreme, shags lay 2-5 eggs, can replace clutches and also have several breeding seasons in the same year.

Incubation in albatrosses and petrels extends over 40-75 days and chicks take 50-280 days to rear. In other species such as gulls and terns, incubation is completed in 20-25 days and chicks fledge in 20-40 days.

As a general rule, the lower the potential reproductive output, the higher the adult survival rates and longevity. Species with high adult survival and high reproductive output such as black-backed gulls are some of the most successful seabirds in New Zealand while species with low reproductive outputs and attempting to breed in the presence of introduced predators are typically our most threatened, e.g. Chatham Island taiko.

5. New Zealand seabirds in a global context

New Zealand is an archipelago of over 330 islands (greater than 5 ha) (Atkinson & Taylor 1992). From the sub-tropical Kermadec Islands in the north to subantarctic Campbell Island in the south, the archipelago extends over 23° of latitude. To the west of New Zealand is the Tasman Sea and the eastern coast of Australia. To the east is the Pacific Ocean with no land mass south of latitude 35° until the continent of South America is reached 9300 km from Wellington. South of New Zealand is the Southern Ocean extending to the Ross Dependency in Antarctica at latitude 78°S. From satellite images, New Zealand appears as a thin strip of land surrounded by the largest area of ocean on the planet.

Not surprisingly, New Zealand is a haven for seabirds. When New Zealand separated from the supercontinent of Gondwana 60-80 million years ago, it became the largest land area on the planet free of ground-dwelling terrestrial mammals. This chance combination of a large land area free of mammalian predators and the largest available area of ocean habitat enabled a very diverse seabird fauna to evolve in New Zealand.

At present, 84 species (96 different taxa) of seabirds breed in the New Zealand archipelago, the greatest diversity of seabirds anywhere in the world (Table 1). These include 35 endemic species (42% of all breeding species) and 49 endemic taxa (51% of the breeding taxa). Nowhere else in the world are so many unique seabird species confined to one country. For example, while Australia has the second highest seabird diversity with 78 species, only 12 are endemic (15%) and these include birds from the Australian Dependencies of Heard, Macquarie, Lord Howe, Norfolk, and Christmas Islands. By comparison, the British Isles (which has a similar land area to New Zealand) has only 34 seabird species and no endemic species.

World-wide, there are 359 seabird species and 633 recognised taxa (del Hoyo et al. 1992, 1996; Robertson & Nunn 1998) (Table 1). Nearly a quarter of the world's 359 seabird species breed in New Zealand (only Australia has a similar percentage). Most strikingly, almost 10% of the world's seabird species breed only in the New Zealand region. These figures support the claim that New Zealand is the 'seabird capital of the world'.

New Zealand's seabird fauna includes representatives from 12 of the 20 seabird families. The best represented are the penguin, albatross, petrel and shearwaters, and shag families. New Zealand has a particularly high diversity of albatrosses, petrels, and shearwaters. Thirteen of the 24 taxa of albatross breed in New Zealand including nine forms that breed nowhere else. Thirty-one of the 109 taxa of petrels and shearwaters breed in New Zealand, including 14 taxa that breed nowhere else.

TABLE 1. NUMBERS OF SEABIRD SPECIES IN THE WORLD AND NUMBERS BREEDING IN OR VISITING NEW ZEALAND

		WORLD BREEDING SPECIES		NEW ZEALAND BREEDING SPECIES		VISITORS/ VAGRANTS TO NEW ZEALAND	
FAMILY	COMMON NAME	NO. of SPECIES	NO. of TAXA	NO. of SPECIES	NO. of TAXA	NO. of SPECIES	NO. of TAXA
SPHENISCIDAE	penguins	17	26	6	10	8	10
GAVIIDAE	divers/loons	4	6	-	-	-	-
PODICIPEDIDAE	grebes	10	20	2	2	-	-
DIOMEDEIDAE	albatrosses	24	24	13	13	7	7
PROCELLARIIDAE	petrels, shearwaters	70	109	28	31	20	23
HYDROBATIDAE	storm-petrels	20	36	4	5	2	3
PELECANOIDIDAE	diving petrels	4	9	2	4	-	-
PHAETHONTIDAE	tropicbirds	3	12	1	1	1	1
PELECANIDAE	pelicans	7	12	-	-	1	1
SULIDAE	gannets	9	19	2	2	1	1
PHALACROCORACIDAE	shags	39	57	12	13	-	-
FREGATIDAE	frigatebirds	5	11	-	-	2	2
ANATIDAE	marine ducks	18	27	-	-	-	-
SCOLOPACIDAE	phalaropes	2	2	-	-	2	2
CHIONIDIDAE	sheathbills	2	5	-	-	-	-
STERCORARIIDAE	skuas	7	10	1	1	4	4
LARIDAE	gulls	51	78	3	3	-	-
STERNIDAE	terns, noddies	43	121	10	11	8	8
RYNCHOPIDAE	skimmers	2	4	-	-	-	-
ALCIDAE	auks, puffins	22	45	-	-	-	-
TOTAL		359	633	84	96	56	62

Another feature of the New Zealand seabird fauna is the high proportion of species that have a pelagic lifestyle. Most of the albatrosses, petrels, shearwaters, storm-petrels, penguins, tropicbirds, boobies and some terns forage far from land over deep ocean waters beyond the continental shelf. Overall about 60% of New Zealand seabird species regularly forage more than 50 km offshore while the remaining species tend to feed over inshore waters but occasionally are found well away from land.

Migration is rare in New Zealand land birds. Only two species of cuckoo and one wader annually migrate beyond New Zealand each winter. However, migration is a prominent feature of New Zealand seabirds. Twenty-five taxa are known to migrate annually to seas outside the New Zealand region and other taxa may yet be added to this list. Nine petrel taxa regularly spend the New Zealand winter in the North Pacific Ocean, eight taxa (five albatrosses and three petrels) regularly migrate to the Eastern Pacific Ocean, three albatross taxa migrate to the South Atlantic Ocean and five taxa (two petrels, two terns, and gannets) migrate to Australia each winter.

6. Legal status of seabirds and their habitat (marine and terrestial)

All New Zealand seabird taxa are protected by the Wildlife Act 1953 and its subsequent amendments, except for southern black-backed gulls. Seabirds are protected from persecution throughout New Zealand and its Exclusive Economic Zone (EEZ) which extends 200 nautical miles (320 km) offshore (Ministry for the Environment 1997). Sooty shearwaters and grey-faced petrels are protected species but may be killed subject to conditions set by the Minister of Conservation in a gazette notice (Ministry for the Environment 1997). Chicks of these two species can be legally harvested at gazetted sites by iwi with manawhenua over these sites.

New Zealand seabirds breed at a large number of sites, both coastal and inland. Many of the key breeding sites (see Appendix 3) are on public land administered by DOC but a large number of seabird colonies are also on private land with freehold or leasehold titles, or land under joint Maori ownership. Thousands of tiny islands, islets and rocks have no legally recorded ownership title but are generally either lands of the Crown or Maori Customary Land. These unclaimed sites are frequently used by colonies of seabirds such as petrels, penguins, shags, gulls, and terns. Coastal foreshore below mean high water spring tide is Crown administered land. Seabirds regularly nest on land above this zone (e.g. dunes, rock outcrops, headlands, coastal forest etc.). These coastal zones may be controlled by government agencies, regional authorities, local iwi, or private landowners. There are few general rules. People seeking permission to visit these sites, or especially to manage threats to seabirds at these sites, will need to consult with the appropriate owners. DOC statutory land managers, regional councils, or adjacent landowners can often assist with ownership advice. Similar issues arise on riverbeds. Most braided riverbeds are Crown land administered by Land Information New Zealand under the Land Act, but management of these habitats is covered by a wide variety of organisations. Regional councils are responsible for the sustainable management of water resources. District councils are responsible for land management and issue consents for shingle extraction and grazing rights. DOC has a mandate to protect the natural and historic resources of riverbeds and to undertake weed and pest control (Hughey & Warren 1997).

Many New Zealand seabirds nest on offshore or outlying islands administered by DOC. These have a range of legal protection status under the Reserves Act 1977 or Wildlife Act 1953, e.g. National Reserve, Nature Reserve, Wildlife Refuge, Wildlife Sanctuary, Scenic Reserve, Scientific Reserve. The principles of visitation to these islands are covered by CMS prepared by DOC Conservancy Offices. Access to DOC administered islands will be controlled by the requirements of the reserves or local CMS. Generally only seabird work that is of conservation benefit and can not be done elsewhere will be approved by the local conservator.

7. Ngai Tahu special relationship with seabirds

The Ngai Tahu Claims Settlement Act 1998 acknowledges the special relationship that the Ngai Tahu people have with seabirds. Some seabirds are of particular significance as taonga species. These include titi (sooty shearwater, Hutton's shearwater, common and South Georgian diving petrel, Westland black petrel, fairy and broad-billed prion, white-faced storm petrel, Cook's and mottled petrel), toroa (albatrosses), tawaki (Fiordland crested penguin), tara (terns), pokotiwha (Snares crested penguin), korora (blue penguin), koau (black, pied and little shags), and hoiho (yellow-eyed penguin).

In acknowledging this special relationship with seabirds, DOC will ensure that the views of Te Runanga are given particular regard when considering the development of any plan or policy decision concerning any of the taonga species listed above.

Of particular relevance is the association Ngai Tahu people have with titi. The descendents of the original Ngai Tahu owners of Rakiura (Stewart Island) have a traditional right to harvest titi from the small islands adjacent to Rakiura known as the Titi (or Muttonbird) Islands. This right has been exercised since the sale of Rakiura to the Crown. The Titi Islands are owned by either named beneficiaries or by Te Runanga. Entry to the islands is restricted to Rakiura Maori and their whanau for the period April - May only. Entry to the islands outside these times is prohibited. The Crown enjoys an advisory relationship with Ngai Tahu over the management of conservation values of the Titi Islands.

Threats to the survival of some seabird species include that of predators such as rats, cats, and weka. It is acknowledged that any plans to eradicate weka, a taonga species, will be considered only after consultation with Ngai Tahu.

8. Threats to seabirds

8.1 INTRODUCED MAMMALS

The introduction of alien species to new environments has had probably the greatest impact on seabird populations on a global scale. Many seabird species breed on offshore or oceanic islands principally to avoid the impacts of mammals. Pacific rats (kiore) and dogs (kuri) reached New Zealand and the Chatham Islands with the first Polynesian settlers. The establishment of these alien species in New Zealand resulted in the extinction of at least one seabird species (Holdaway & Worthy 1994) and affected the distribution and abundance of small seabirds such as storm petrels, prions, diving petrels, and little shearwaters (Worthy & Holdaway 1993, Worthy 1998). European colonisation had an even greater impact on New Zealand seabird populations. Between 1769 and 1990, 53 species of mammals were brought to New Zealand for the purposes of farming, sport, and pest control. Of these introductions, 32 species established wild populations (King 1990).

The most serious threat to seabird populations is from mammalian predators such as Norway rats, ship rats, kiore, cats, stoats, ferrets, pigs, and dogs. All these predators are capable of killing adults and chicks of seabird species, and some of these predators take eggs. The smallest seabird species are at greatest risk, especially storm petrels, diving petrels, and terns. Introduced mammalian herbivores also affect seabirds by destroying habitat, trampling nests (killing adults, eggs, and chicks), increasing erosion, reducing nesting cover or competing for burrows. Problem species include goats, rabbits, possums, deer, chamois, wild sheep, and feral cattle.

The eradication of pest mammals is an important management technique to protect seabird species. Fortunately New Zealand is a world leader in this field, and there have been a large number of successful eradications of a wide array of pest species (Veitch & Bell 1990, Veitch 1995). A high conservation priority over the next 10 years is to continue to remove introduced mammals from all offshore islands where eradication can be assured and to control pests on inshore islands with important seabird populations. Managing biosecurity risks is important for seabirds. Pest mammal species are absent from many offshore islands and adequate quarantine measures are needed to ensure that new introductions are avoided. There is also a need to improve techniques for the control of mammals on the mainland to ensure that pest populations remain low without developing resistance to the management techniques. Priority mainland sites for seabird protection include fairy tern breeding sites, Hutton's shearwater, Westland petrel and yellow-eyed penguin colonies, and braided riverbeds with populations of black-fronted terns and black-billed gulls.

8.2 AVIAN PREDATORS - WEKA

Weka were introduced to a number of offshore islands by Maori, and also sealers and whalers, who used them as a food item. Weka are a natural predator of seabirds on the mainland and inshore islands (they can swim up to 1 km offshore). Weka can remove eggs and chicks from surface-nesting birds. They are also capable of entering larger petrel burrows and attacking petrel chicks. Adults of smaller petrel species are attacked on the surface at night. Weka had a marked impact on seabird populations on Whenua Hou (Codfish Island) (especially mottled and Cook's petrels) (West 1990) and still have an impact on seabirds nesting on Solander Island (mottled petrel, prions, Fiordland crested penguin) and the Open Bay Islands (fairy prion, Fiordland crested penguin) (St Clair & St Clair 1992). The removal of weka populations from remote offshore islands (sites where they have been introduced by humans) would help to restore the dynamic relationship between seabirds, plants, reptiles, and invertebrate communities on these islands.

8.3 DISEASE

The prevalence of avian diseases in New Zealand birds is poorly understood (Threatened Species Unit 1993). Rockhopper penguin adults and chicks were killed in small numbers by outbreaks of avian cholera (*Pasteurella multocida*) in 1985 and 1986 (de Lisle et al. 1990, Cunningham & Moors 1994). Symptoms of avian pox virus (blisters and crusted sores) have been observed on seabirds such as grey-faced and black petrels (G. Taylor pers. obs.) and may have caused the death of some northern royal albatrosses in 1997 (C. Robertson pers. comm. 1998). Other albatross species are known to be affected by a viral disease related to avian pox virus (Gales 1993, Alexander et al. 1997). Avian malaria antibodies have been recorded in penguin species in New Zealand (Graczyk et al. 1995), and other seabird groups are likely to have been exposed to this disease. Malarial antibodies were detected in all populations of yellow-eyed penguin that were sampled (including birds from subantarctic Campbell Island). One population of southern blue penguins also had malarial antibodies present but none was detected in eastern rockhopper penguins from Campbell Island. Graczyk et al. (1995) considered that the death of yellow-eyed penguins on the Otago Peninsula in 1990 probably resulted from an outbreak of avian malaria. Diseases such as Lymes disease are spread by seabirds in the Northern Hemisphere. Potential vectors for these diseases include nest fleas, ticks (*Ixodes* spp.), land-leeches (*Ornithobdella* sp.), sandflies, mosquitoes, and rodents. The variety of avian diseases currently present in New Zealand seabirds needs closer examination. Some diseases will not lead to death of seabirds except when the birds are stressed by other factors such as poor nutrition or temperature extremes (Threatened Species Unit 1993).

8.4 FIRE

Fortunately New Zealand has a damp maritime climate and major fires are unlikely to occur outside of the period November to April. Summer droughts greatly increase the fire danger in eastern and northern New Zealand.The seabird colonies at greatest risk of fires occur on the Kermadec Islands, Three Kings Islands, northern offshore islands, Cook Strait islands, Otago coastline, Chatham Islands, and Antipodes Island. All these sites can have long dry periods and the grass or forest habitats become tinder dry. If fires do occur, the remoteness of these sites make it very unlikely that the fires will be put out by human intervention. Islands with a surface layer of peat have a high fire risk potential. Peat fires can burn for years and are very difficult to extinguish even using modern equipment. Species at greatest risk are surface-nesting birds in dense scrub or tussock that cannot readily escape fire, e.g. yellow-eye penguins and albatross species, or burrow-nesting birds such as petrels and blue penguins. These birds are likely to suffocate from smoke inhalation, or be burnt in their burrows or when trying to escape from the burrow. If the fire occurs at night, then large numbers of non-breeders on the surface may also be killed. Probably the worst time for a fire to occur would be at night during the incubation period of a seabird species or during the moult period of penguins. A large scrub fire at Te Rere Reserve (Southland) killed over 60 adult yellow-eyed penguins in February 1995. Many of these birds were ashore during the annual moult (Sutherland 1999).

8.5 WEEDS

A problem weed for petrels nesting on islands around the New Zealand mainland is boxthorn.This plant is transported to islands by starlings and other landbirds. The shrubs form large dense bushes and have stiff thorns. Petrels flying into the shrubs are frequently snared on the thorns and killed (Cox et al. 1967). If boxthorn is allowed to cover an island, then the shrubs may prevent petrels reaching their burrows.

On the mainland, the planting of coastal margins in marram grass and pine plantations has restricted habitat for seabirds. Species affected include New Zealand fairy tern and Caspian tern (Parrish & Honnor 1997). Marram grass also stabilises dunes causing the profile of beaches to change.The dune base becomes very steep and large wide expanses of sand disappear, sites typically used by nesting seabirds.

On riverbeds, the dense growth of willows, lupins, broom, and gorse has covered shingle braids and limits the available nesting habitat (Balneaves & Hughey 1990). It also provides cover for rabbits and their predators (Hughey & Warren 1997). Black-fronted terns and black-billed gulls are particularly at risk from the spread of weeds on braided riverbeds (O’Donnell 1992, Maloney et al. 1999).

8.6 LOSS OF NESTING HABITAT

Seabird colonies may become displaced by the change in vegetation cover on islands, coastlines, lake margins, or riverbeds. For species that prefer open ground, the regrowth of sedges, shrubs or forest after a fire may cause populations to shift to new breeding sites. The removal of browsing mammals such as goats, sheep, cattle, and rabbits from islands has sometimes initiated new problems for seabirds. For example, on Macauley Island, after a century of burrows being crushed by feral goats, the island has quickly regenerated into a dense sward of the native sedge *Cyperus ustulatus* after feral goats were eradicated in 1970 (Taylor & Tennyson 1988). This plant has changed the distribution of surface-nesting sooty terns. Birds now breed only in the few pockets of grassland left on the plateau (G.Taylor & A.Tennyson unpub.) and will eventually only breed on cliff ledges, or the shoreline of the island. Similarly masked boobies will also be forced to nest on cliff-tops. Some petrels such as wedge-tailed shearwaters are unable to fly out from the sedge and either have to scramble to cliff tops or shift their colonies. Eventually ngaio shrubland will overtop the sedge and the situation will improve for some seabird species.

Some petrel species are unable to nest in dense scrub or vines and will be excluded from an island until it regenerates into more open mature forest. On Rangatira Island (Chatham Island group), dense thickets of *Muehlenbeckia* vine have covered the open grasslands after the removal of sheep, and only the smallest petrels are able to penetrate these vines and reach their nest sites (West & Nilsson 1994).

On some islands and mainland sites, excessive rainfall may cause soil subsidence destroying burrows. Hillside erosion and slips may also destroy burrows. On the Sisters and Forty-fours, a severe easterly storm in 1985 stripped the islands bare of vegetation and soil cover. The albatrosses that nest on these islands have been unable to construct proper nest sites and subsequently there has been greatly increased egg mortality. To compound the problem most of the breeding population of the normally biennially nesting northern royal albatross now nests annually owing to low breeding success, thus further limiting nest site availability (Robertson 1998).

On riverbeds, hydro dams or irrigation schemes may reduce water flow and prevent flooding of rivers. This stops the process of shingle islands being moved and prevents removal of vegetation (especially weeds) from the riverbed. Hydro lake development has also decreased the available habitat for riverbed breeding species (Hughey & Warren 1997, Maloney et al. 1999). The extraction of gravel from riverbeds has had a major impact on nesting birds in Southland (W. Cooper pers. comm. 1999).

8.7 COMPETITION FOR NEST SITES

Where nesting habitat has become greatly restricted, competition for nest sites may be an important factor limiting populations. For surface-nesting species, colonies can be closely packed and pecking distances set the minimum nesting area available. In these dense colonies, gathering sufficient nest material is a problem and birds resort to stealing neighbours' nesting material.The availability of suitable open ground or cliff ledges becomes the main limiting factor for surface-nesting species. For crevice- or burrow-nesting species, competition can be very intense. Intra-specific fights for available sites can often be fatal in some species (e.g. Imber et al. 1998). Inter-specific competition for burrows may lead to eggs or chicks being ousted or killed (Imber et al. 1998,West 1994). Examples of where this occurs are between broad-billed prions and Chatham petrels on Rangatira Island (West 1994, P. Gardner pers. comm. 1997), grey-faced petrels and flesh-footed shearwaters on northern offshore islands (G. Taylor unpub.) and southern blue penguins and sooty shearwaters on Taieri Island (B. McKinlay pers. comm. 1998). In hard or rocky substrate, burrows may take months or years to dig out and defending a site is therefore critical for successful breeding. In soft friable soils where burrows are easily dug, competition is more likely to occur over favourable locations such as near take off spots or where the ground is less prone to flooding. Petrels are habitual users of burrows however and will try to retain the same site from year to year.

8.8 COASTAL DEVELOPMENT

The public interest in seaside recreation has lead to a greatly increased demand for coastal development, especially over the past 30 years. More remote parts of the coast are being opened up by the development of seaside settlements and resorts, both as permanent housing and camping grounds.There is also increased pressure from industry and commercial developers to reclaim harbour land and coastal margins for siting new industries, buildings, wharves, and marinas. Each development increases human activity at the coast and greatly reduces the availability of remote sandspits, shellbanks, beaches and rocky headlands where terns, gulls, shags, and a few petrel species might nest. The increase of people walking, exercising dogs, swimming, fishing, picnicking, riding horses, and driving motorbikes and 4WD vehicles on the coast will significantly reduce breeding success at mainland seabird colonies and may eventually push some species to nesting only on offshore islands

The amount of development on offshore islands is relatively low in New Zealand and most sites are protected as reserves or have restricted public access. Maintaining the integrity of these habitats in future years will be essential to preserving seabird populations in New Zealand. However, some species such as New Zealand fairy terns and Caspian terns require sandspits, sandy beaches and shellbanks for nesting sites, and islands will not provide a safe breeding refuge for these sensitive species (Parrish & Honnor 1997, Ell 1999).

8.9 HUMAN DISTURBANCE

Apart from the increased activity in coastal areas mentioned above, deliberate human disturbance of seabird colonies is not common in New Zealand. Most people are aware that wildlife is protected and deliberate vandalism of nesting colonies is rare. The seabird species most at risk are those nesting on beaches, especially at sites where people can drive motorbikes or 4WD vehicles through nesting colonies (Ell 1999). Some birds are shot illegally, especially shags. Most human disturbance is often unintentional owing to ignorance of seabird behaviour. People venture out onto shellbanks or sandspits to catch fish, upsetting nearby colonies. Sometimes people exercise their dogs on the beach and allow the dogs to chase roosting and nesting birds (Ell 1999). The use of Controlled Dog Areas as allowed under the Conservation Act Amendment 1996 should help to identify those sites where taking dogs should be restricted.

People undertaking research on seabirds need to be aware of the potential impacts of their activities on seabird populations and ideally should monitor the impact of their research (both negative and positive) by using undisturbed control populations. Banding or marking of birds needs to be carried out under the supervision of experienced operators to reduce the risk of injuries to birds. In the future, ecotourism interests (both commercial and private) will increasingly seek out remote places to view wildlife and the desire of people to have close encounters with wildlife may increase human disturbance of seabird colonies. The benefits of increased advocacy for seabirds and wild places in general will need to be carefully weighed against the level of disturbance that these seabird populations can tolerate.

8.10 COMMERCIAL AND CULTURAL HARVESTING

Cultural harvest of seabirds is governed by Section 6 of the Wildlife Act 1953 and Section 50 of the Reserves Act 1977. Only two seabird species are currently harvested by iwi. Sooty shearwater (titi or muttonbird) chicks are taken annually by descendants of Rakiura Maori on traditional islands off Stewart Island (Wilson 1979). The families live on the islands during the harvest and control the level of the take in their manu (or birding ground) (Wilson 1979). Titi are sold commercially throughout New Zealand. The Rakiura Titi Committee administers the claims of descendants seeking the right to take titi and ensures that birders abide by the Muttonbird Islands (Titi) Regulations 1978. These regulations are currently being redrafted as a result of the Ngai Tahu Claims Settlement Act 1998. The effects of the harvest on titi populations is currently being studied by a team from the University of Otago in conjunction with the Rakiura Titi Committee. The preliminary results are produced in a newsletter *Titi Times* produced by the Department of Zoology, University of Otago.

In the north, grey-faced petrels (oi or northern muttonbird) are taken on traditionally harvested islands by iwi with manawhenua over those sites. A permit is needed to harvest grey-faced petrel chicks and only a few islands are legally available for the traditional harvest. The season is November and December. Grey-faced petrel chicks cannot be sold, and the level of the take is small, usually to satisfy the needs of particular iwi.

Elsewhere, there are occasional unauthorised harvests of seabirds and a renewed interest in taking birds. For example, on the Chatham Islands, titi have been taken from Rangatira Nature Reserve and a few albatrosses have been taken from The Pyramid, Forty-fours, and Sisters in recent years (Robertson 1991). In the Marlborough Sounds, iwi have muttonbird rights but have forgone their traditional harvest since the 1960s. Even so, there are occasional unauthorised harvests still happening in this region (M. Aviss pers. comm. 1998).

The harvest of seabirds raises a number of conservation issues, notably, what is the maximum sustainable yield of these species, and are current harvests exceeding this level in view of the new threats to these seabird species in the changing marine environment? The potential impact of people visiting these islands also needs to be assessed. Fires have been used in the past, especially on the northern offshore islands, as a means of opening up dense shrubby vegetation and improving access for harvest of seabirds. Fortunately, this method is no longer used. Petrel burrows can be damaged by human trampling, especially on islands with friable soils. The ability of petrel populations to recover from any damage to burrows will vary between each island site. There is also a risk of weeds or rodents being introduced amongst stores and equipment used to harvest the seabirds. Prevention of pest introductions is vital to preserve the harvested seabird populations and to protect other species that inhabit the islands. In recent years, quarantine efforts by muttonbirding parties have greatly improved as awareness of the damage caused by pests has grown. Pest eradications have also occurred on some of the northern offshore islands and southern Titi Islands and other pest eradications are proposed. Rakiura iwi have initiated proposals to remove rodents from several of the southern Titi Islands.

8.11 VOLCANIC ERUPTIONS

New Zealand has several active volcanoes including three islands (White, Curtis, Raoul) which are important seabird colonies. White and Raoul Islands have erupted in the past century and Curtis Island has been uplifted by volcanic activity since the 1920s. Both surface- and burrow-nesting seabirds nest on these islands. A large volcanic eruption depositing ash over the surface would probably destroy the colonies of the burrow-nesting seabirds and may entomb adults in the nest. Adult surface-nesting seabirds are more likely to escape a volcanic eruption. Fortunately, the life history strategy of seabirds makes them well adapted to minimise the impact of a one-off volcanic eruption. The worst impact would come from loss of breeding adults. However, at any given time, over half the total population is usually away from the breeding island foraging at sea. Seabird species are long-lived and can cope with the effects of total nest failure in one season.

8.12 FISHERIES INTERACTIONS

Until the 1980s the impact of fisheries on seabird populations was poorly known (King 1984). The decline of albatross populations in the South Atlantic and Indian

Oceans alerted seabird experts to an international problem (Weimerskirch & Jouventin 1987). Brothers (1991) estimated that 44,000 albatrosses were killed annually on Japanese longlines set in the Southern Ocean during the period 1981-86. Since that time the level of observer coverage has increased and the assessment of seabird capture rates have been calibrated against factors such as area of fishing activity, season, and year (e.g. Klaer & Polacheck 1997). Recently, mitigating factors such as use of bird scaring devices (tori lines), night setting, and development of underwater setting devices have been studied and investigated as ways of reducing bird catch from long-lines (Alexander et al. 1997, Barnes & Walshe 1997, Brothers et al. 1999). However, long-lining is a widely used technique for a range of fish stocks and the impacts of many fisheries on seabird populations are still poorly known. Small numbers of seabirds caught on individual vessels may add up to significant totals when spread across all fleets fishing in the Southern Ocean. Line fishing by recreational fishermen also occasionally results in seabird captures especially when fishing amongst schools of kahawai. Species most often caught include gulls and shearwaters.

DOC administers funds derived from a Conservation Service Levy on fishers. This levy is being used to increase observer coverage on fleets fishing in the New Zealand EEZ, to investigate mitigation techniques (e.g. underwater setting devices – see Barnes & Walshe 1997, Smith & Bentley 1997) and to detect population trends in seabird species most likely to be affected by fishing interactions (see Walker & Elliott 1999).

The Ministry of Fisheries and DOC are currently developing a national plan of action that sets out how the incidental capture of seabirds by long-line and trawl vessels will be addressed over the next 5 years. The document will address topics such as level of observer coverage, population monitoring, measures to reduce seabird bycatch, and catch limits for seabirds.

Apart from long-lining, other fishing techniques have had a major impact on seabirds. The North Pacific drift-net fishery targetting squid, salmon, and other fish stocks was active from the 1960s until it was phased out in 1992 (Alexander et al. 1997). Vast lengths of nets were laid out just below the surface. Hundreds of thousands of seabirds were caught as bycatch including New Zealand trans-equatorial migrants such as sooty shearwater, Buller's shearwater, and flesh-footed shearwater (King 1984, Ogi 1984, Tennyson 1990). No monitoring occurred of these seabird populations during this period therefore it is not possible to state what impact drift nets had on breeding populations.

Closer to the coast, inshore set nets are frequently used by commercial and recreational fishers. There are numerous reports of seabirds being caught in set nets. Shags, penguins, and shearwaters are the species at greatest risk, especially during daylight hours. Most inshore diving seabirds are daytime feeders but some will forage on moonlit nights. From a seabird conservation perspective, changes are needed in the way set nets are used to minimise impacts to seabirds. Discussions are needed with commercial and recreational fishers to develop practical guidelines for the use of set nets. Ideally, nets set during the day should be attended by fishers so that the net can be retrieved if the operator suspects that seabirds have been caught. Set nets should be placed in positions and areas that are far enough away from breeding colonies or high use areas to adequately reduce the threat of bycatch in these nets. For example, because estuaries, harbours, and river mouths are frequently used by diving birds, set nets should not be used in these areas. Nets placed overnight close to seabird colonies greatly increases the risk of seabird bycatch. Penguins returning to breeding colonies or landing beaches at dusk are especially vulnerable to set nets. Ideally, nets should not be set overnight within 1 km of key breeding colonies. If nets are set overnight away from colonies then sinking the nets deeper than 20 m will reduce the risk to diving seabirds. These nets should be retrieved as early as possible the next day.

Around New Zealand and in the high seas, Russian trawlers used a net-sonde monitor cable to detect when fish had entered the net. This metal cable was suspended behind ships and whipped and moved in the swell and winds. Observers in the late 1980s reported that large numbers of seabirds were striking these cables and being injured (such as breaking wings) or being killed outright (Bartle 1991). A campaign was launched by conservation groups and this resulted in the banning of net-sonde monitor cables from the New Zealand EEZ in 1992 (Anon 1997).

The current impact of trawl fisheries on seabird populations is unclear. Trawl fisheries can be beneficial to seabirds by providing new food sources (Thompson 1992, Prince et al. 1998) but incidental captures of seabirds and removal of prey species may also affect seabird populations. Deep-sea trawling of species such as squid, hoki, southern blue whiting and scampi still contributes to incidental seabird bycatch. White-capped albatross and sooty shearwater are the species most frequently killed by these fishing methods (DOC fisheries observer data unpub.). However, some fishing operations may also have benefited some seabird species by improving breeding success as a result of the supplementary food available to birds, e.g. discarded offal and other fisheries waste (Freeman 1998, Sagar et al. 1999). For other seabird species, the large scale purse-seining of inshore fish species such as kahawai, mackerel, and trevally may have had a negative impact on populations. Species such as white-fronted terns, Hutton's and fluttering shearwaters which typically feed in association with schooling fish are at greatest risk. These larger fish drive smaller fish nearer the surface and this enables seabirds to capture these small fish. In southern New Zealand, large quantities of squid are harvested each year and this group is an important part of the diet of many pelagic species (many squid species die after spawning and float to the surface where they become available to seabirds). There is, however, no knowledge of whether the amount of squid taken is having a competitive impact on seabird populations.

Another incidental factor associated with commercial fishing is birds striking ships, especially ships which are brightly lit at night. Small nocturnally active petrels are at greatest risk as they are easily confused or attracted by bright lights (Warham 1990). Ryan (1991) reported that many smaller petrels were attracted to bright deck lights on lobster boats anchored at night off islands with large seabird colonies in the South Atlantic Ocean. On nights with fog and low cloud, petrels would fly into the superstructure and be killed outright, or landed in the scuppers and got coated in oil residues. Some birds got trapped in alcoves on the boats such as under life-raft covers. These same problems could occur with ships working close to New Zealand seabird colonies. Surprisingly, a study of fisheries impacts on squid-jiggers operating in the New Zealand EEZ reported no incidental seabird mortality (Blezard & Burgess 1999). These ships are lit up at night with hundreds of 2000 watt lamps. The observers reported that seabirds adopted peripheral locations at the extreme range of the vessel's lights and appeared to be deterred by the lights.

8.13 POLLUTION

A range of pollutants are entering the marine environment. These include untreated sewage, discharges from factories and freezing works, storm water run-off, agricultural wastes and effluents, pesticides, herbicides, fertilisers used in agricultural and horticultural production, rubbish including plastics from cities and shipping, chemicals used in paints, and oil and petroleum products. Pollutants can have direct impacts by killing birds if ingested, fouling plumage and killing the birds by removing water-proofing properties or by entanglement. Indirect effects include altering the food chain, bioaccumulation of toxins in food items, reducing egg shell thickness, or increasing infertility.

The impact of these pollutants will also depend on the life history strategy of individual species. For example, birds that feed in pelagic waters of the southern ocean near New Zealand are least likely to encounter pollutants. Those that feed in inshore waters around New Zealand are more at risk whereas those that migrate to the northern hemisphere or to the seas off South America are likely to be exposed to the greatest levels of pollutants.

8.14 PLASTICS/MARINE DEBRIS

Plastics are ingested by most seabirds, especially the pelagic species of petrels and albatrosses (Bourne & Imber 1982, Harper & Fowler 1987, Ryan 1987a,b, 1988). The birds tend to pick up bright coloured pieces and these in turn are fed to chicks. Plastic pollution is not as important in the southern hemisphere as it is in the northern hemisphere where colonies of species such as Laysan albatross on Midway Island are littered with millions of plastic items and thousands of birds die annually, possibly as a result of dehydration, blockages or toxicants released from the high levels of plastics in their gut (Auman et al. 1998). Some birds get plastic items caught around their neck, head, wings, and feet. Giant petrels and southern black-backed gulls, which often scavenge prey items, are prone to ingesting plastic or getting entangled in plastics (G. Taylor pers. obs.).

8.15 OIL SPILLS/OIL EXPLORATION

Oil affects seabirds directly through coating the plumage of birds and reducing the water-proofing properties of the feathers (del Hoyo et al. 1992). Also, as birds preen the oiled plumage, residues are ingested and these affect the metabolism of seabirds (Warham 1996). Oil is discharged at sea in a variety of ways but waste engine oil is a regular contributor. The worst impacts are from oil spillages resulting from a ship-wreck, especially oil-carrying tankers. Oil and gas exploration is also carried out in seas off New Zealand and there is a potential hazard from oil escaping from rigs. Currently, oil contamination appears to be a minor cause of seabird death in the New Zealand region (Taylor 1996, 1997) but New Zealand birds may be at risk from oil spills when on migration to the North Pacific or coasts of Australia and South America. Examples include sooty shearwaters killed in the *Exxon Valdez* oil spill off Alaska in 1989 and possibly Hutton's shearwaters in the *Iron Baron* oil spill off Tasmania in 1995. Petrels have a strong sense of smell, and some species may be able to detect and avoid oil spills (del Hoyo et al. 1992). The effectiveness of dealing with oiled seabirds is a matter of some debate. Sharp (1996) reviewed the effectiveness of programmes to rescue oiled seabirds in North America and elsewhere, and concluded that cleaning and treating oiled seabirds could not be justified because the median survival period after release was just 6 days. However, the successful rehabilitation of blue penguins following the *Iron Baron* oil spill in Tasmania (Hull et al. 1998) and African penguins following the Apollo Sea oil spill off South Africa (Underhill et al. 1999) provide examples where seabird rescue attempts can be justified. It may prove that some species are more robust and tolerant of oil contamination than other species. So far, attempts to save penguins seem justified.

New Zealand has a three tier response to oil spills which involves the Maritime Safety Authority (MSA), regional councils, and industry. The role each plays is dependent on the severity and location of a spill. In general, major spills are dealt with by the MSA, medium spills by regional councils, and minor spills by the shipper or industry responsible for the spill. Each agency is also responsible for contingency planning at the relevant national, regional, or local level. The costs of rescue and rehabilitation of oiled seabirds is recovered from the polluter. Massey University has been contracted to handle the rehabilitation of oiled seabirds and may be assisted in this regard with field support from regional councils and DOC staff.

8.16 HEAVY METALS/CHEMICAL CONTAMINANTS

Heavy metals are released into the oceans by volcanic activity, erosion, and by effluent run-off from industrial sites. New Zealand seas have significant levels of mercury and arsenic owing to volcanic activity. Birds are able to mobilise and store some heavy metals in their feathers (Warham 1996). These are moulted every 1 to 2 years. Chemical contaminants (e.g. polychlorinated biphenyls (PCB), polychorinated dibenzo-*p*-dioxins (PCDD), dibenzofurans (PCDF), and DDT group chemicals) have entered the marine environment from pesticides used in agriculture and horticulture, and effluent discharge from industrial sites. These chemicals are dispersed in marine ecosytems by atmospheric transport (Jones 1999). Birds ingest these chemicals and heavy metals as part of their diet. Contaminant levels accumulate up through the marine food chain and top order predators such as seabirds are liable to absorb higher doses than their prey. Some individuals in a population have higher levels of contaminants in their tissues than other members of the population. Organochlorines have been implicated in the declining breeding success of some North Pacific seabird species, e.g. black-footed albatross, by reducing egg shell thickness which leads to a higher incidence of egg breakage and crushing (Ludwig et al. 1998). However, examination of thin and thick egg shells from northern royal albatross breeding on the Chatham Islands showed no significant relationship between concentrations of organochlorine contaminants and shell thickness (Jones 1999).

8.17 GLOBAL SEA TEMPERATURE CHANGES

Average sea temperatures in the southern ocean have increased by 0.5°C since the 1950s (Allan et al. 1996, Cunningham & Moors 1994). The cause of this change is not known but may be linked to global warming contributors such as increased levels of carbon dioxide in the atmosphere. There are also regional sea temperature changes that are part of the ENSO cycle (El Nino/Southern Oscillation) that cause sea temperatures to warm or cool in some years (Allan et al. 1996). These changes are likely to have profound effects on seabirds as they will influence the distribution and abundance of plankton, crustaceans and predatory fish and squid that feed on these species at oceanic upwellings and convergence fronts. Some impacts may be gradual such as a reduction in breeding success as birds need to forage further from colonies and hence chicks starve in nests or eggs are abandoned by incubating partners. Other impacts are catastrophic and involve mass food failure in one or more seasons. Adult birds may occasionally starve but typically birds do not attempt to nest, breeding attempts are abandoned or breeding success is very low in catastrophe years. The occurrence of such catastrophes has been documented in the tropical Pacific (Warham 1996) but similar events are less well known here. The massive decline in rockhopper penguin breeding pairs at Campbell Island (94% since the 1940s) is considered to be the result of global sea temperature changes since the 1950s (Cunningham & Moors 1994). A slight cooling period in the 1960s resulted in a temporary increase in rockhopper penguin populations in the early 1970s. Temperature changes can also alter the terrestrial environment of nesting seabirds by changing plant growth patterns around nest sites or causing overheating of nesting birds. For example, northern royal albatross at Taiaroa Head have had problems in recent years with high temperatures and low soil moisture levels causing eggs to dry out on hatching (resulting in hatching failure), incubating adults suffering heat stress, and an increased impact of fly strikes on hatching chicks (Robertson 1998).

8.18 MARINE BIOTOXINS

Since the early 1990s, there has been an increasing awareness of the presence of toxic algal blooms in New Zealand coastal waters. Some algae produce biotoxins that are capable of killing seaweed, molluscs, crustaceans, and even fin-fish species. There is no direct evidence that these algal blooms cause deaths in seabirds but observations of illnesses, respiratory complaints, and skin irritations reported by people exposed to biotoxins suggest that seabirds could be at risk.

There are also potential food chain effects if biotoxins kill off marine invertebrates and small fish over large areas of ocean habitat. The unexplained die-offs of inshore feeding seabirds such as blue penguins and common diving petrels may be connected to marine biotoxins occurring in years with unusual weather patterns.

9. Conservation status of New Zealand seabirds

The International Union for Conservation of Nature and Natural Resources (IUCN) has an internationally recognised system of threat categories and these are used to compile the 'IUCN Red List'. In recent years, the systems used to assess the conservation status of species have been revised to include more quantitative assessments. The latest version (IUCN 1994), (see summary in Appendix 1), was used to assess the conservation status of all New Zealand seabird taxa. Forty-seven seabird taxa were ranked as threatened (Critically Endangered, Endangered, or Vulnerable) by this process. In 1994, DOC assessed the conservation status of bird taxa using its own priority ranking system (Molloy & Davis 1992). The results of this assessment were presented in Tisdall (1994). The Molloy and Davis threat categories include Category A (highest priority) Category B (second priority), Category C (third priority), and Category O (species threatened in New Zealand but secure in other parts of their range). The Tisdall (1994) results are presented in this document for each seabird taxa.

The two ranking systems were used to assign seabird taxa into groupings of similar threat status. The initial weighting was based on the IUCN category (because this incorporates the most recent information on the status of seabird populations) and secondary weighting on Molloy & Davis categories (Tables 2-5). Taxa with equal IUCN and Molloy & Davis ranking are listed in taxonomic order.

Part A also includes four taxa not considered threatened by IUCN criteria but for which the distribution, population size, or trends are so poorly known that IUCN threat status is uncertain. These taxa are listed as 'Data Deficient' (Table 6). This assessment indicates that more information is required and acknowledges the possibility that future research will show that a threatened classification is appropriate. Determining the threat status of these taxa is a high priority and will enable these taxa to be classified in future IUCN rankings.

TABLE 2. NEW ZEALAND SEABIRD TAXA LISTED AS CRITICAL OR ENDANGERED BY IUCN CRITERIA

SPECIES	COMMON NAME	IUCN RANK	MOLLOY & DAVIS RANK
Pterodroma magentae	Chatham taiko	Critical	Category A
Pterodroma axillaris	Chatham petrel	Critical	Category A
Sterna nereis davisae	NZ fairy tern	Critical	Category A
Thalassarche eremita	Chatham albatross	Critical	Category B
Diomedea sanfordi	Northern royal albatross	Endangered	Category B
Thalassarche chrysostoma	Grey-headed albatross	Endangered	Category B
Puffinus huttoni	Hutton's shearwater	Endangered	Category B
Eudyptes sclateri	Erect-crested penguin	Endangered	Category B
Eudyptula m. albosignata	White-flippered penguin	Endangered	Category B
Leucocarbo onslowi	Chatham Island shag	Endangered	Category B
Sterna albostriata	Black-fronted tern	Endangered	Category B
Pterodroma cookii	Cook's petrel	Endangered	Category C

TABLE 3. NEW ZEALAND SEABIRD TAXA LISTED AS VULNERABLE BY IUCN CRITERIA (RANKED AS SECOND PRIORITY SPECIES BY MOLLOY AND DAVIS CRITERIA)

SPECIES	COMMON NAME	IUCN RANK	MOLLOY & DAVIS RANK
Diomedea gibsoni	Gibson's albatross	Vulnerable	Category B
Diomedea epomophora	Southern royal albatross	Vulnerable	Category B
Thalassarche impavida	Campbell albatross	Vulnerable	Category B
Thalassarche nov. sp	Pacific albatross	Vulnerable	Category B
Procellaria parkinsoni	Black petrel	Vulnerable	Category B
Procellaria westlandica	Westland petrel	Vulnerable	Category B
Puffinus bulleri	Buller's shearwater	Vulnerable	Category B
Pachyptila crassirostris	Fulmar prion	Vulnerable	Category B
Megadyptes antipodes	Yellow-eyed penguin	Vulnerable	Category B
Eudyptes pachyrhynchus	Fiordland crested penguin	Vulnerable	Category B
Leucocarbo carunculatus	NZ king shag	Vulnerable	Category B

TABLE 4. NEW ZEALAND SEABIRD TAXA LISTED AS VULNERABLE BY IUCN CRITERIA (RANKED AS THIRD PRIORITY SPECIES BY MOLLOY AND DAVIS CRITERIA)

SPECIES	COMMON NAME	IUCN RANK	MOLLOY & DAVIS RANK
Diomedea antipodensis	Antipodean albatross	Vulnerable	Category C
Thalassarche bulleri	Buller's albatross	Vulnerable	Category C
Thalassarche salvini	Salvin's albatross	Vulnerable	Category C
Thalassarche steadi	White-capped albatross	Vulnerable	Category C
Pterodroma cervicalis	White-naped petrel	Vulnerable	Category C
Eudyptes robustus	Snares crested penguin	Vulnerable	Category C
Stictocarbo featherstoni	Pitt Island shag	Vulnerable	Category C
Leucocarbo chalconotus	Stewart Island shag	Vulnerable	Category C
Leucocarbo ranfurlyi	Bounty Island shag	Vulnerable	Category C
Leucocarbo colensoi	Auckland Island shag	Vulnerable	Category C
Leucocarbo campbelli	Campbell Island shag	Vulnerable	Category C
Sterna striata striata	NZ white-fronted tern	Vulnerable	Category C
Sterna striata aucklandorna	Southern white-fronted tern	Vulnerable	Category C

TABLE 5. NEW ZEALAND SEABIRD TAXA LISTED AS VULNERABLE BY IUCN CRITERIA (SPECIES NOT CONSIDERED THREATENED PREVIOUSLY BY MOLLOY AND DAVIS CRITERIA)

SPECIES	COMMON NAME	IUCN RANK	MOLLOY & DAVIS RANK
Eudyptes chrysocome filholi	Eastern rockhopper penguin	Vulnerable	Category O
Fregetta grallaria	White-bellied storm petrel	Vulnerable	Category O
Pterodroma pycrofti	Pycroft's petrel	Vulnerable	not listed
Procellaria a. aequinoctialis	White-chinned petrel	Vulnerable	not listed
Puffinus a. kermadecensis	Kermadec little shearwater	Vulnerable	not listed
Puffinus assimilis haurakiensis	North Island little shearwater	Vulnerable	not listed
Sula dactylatra fullagari	Masked booby	Vulnerable	not listed
Phalacrocorax v. varius	Pied shag	Vulnerable	not listed
Larus bulleri	Black-billed gull	Vulnerable	not listed
Sterna vittata bethunei	Antarctic tern	Vulnerable	not listed
Sterna fuscata kermadeci	NZ sooty tern	Vulnerable	not listed

TABLE 6. NEW ZEALAND SEABIRD TAXA LISTED AS DATA DEFICIENT

SPECIES	COMMON NAME	IUCN RANK	MOLLOY & DAVIS RANK
Pelagodroma marina albiclunis	Kermadec storm petrel	Data Deficient	Category B
Procellaria cinerea	Grey petrel	Data Deficient	Category O
Phoebetria palpebrata	Light-mantled albatross	Data Deficient	not listed
Pachyptila crassirostris eatoni	Lesser fulmar prion	Data Deficient	not listed

10. Conservation actions required for each threatened seabird taxon

This section provides a detailed account of the conservation actions required for each of the 47 threatened and four 'Data Deficient' seabird taxa breeding in New Zealand. The conservation status, distribution, population size, known and potential threats, and past conservation actions are summarised for each taxon. The future management actions, survey and monitoring needs, and research needs are prioritised for each taxon into categories E, H, M, and L as described below. Actions and needs within each category are further prioritised, e.g. H1 and H2.

Essential (E)

Those actions deemed essential to protect threatened seabird taxa from declining towards extinction. Basically, this is urgent work that is needed to halt an observed population decline or minimise a major threat to seabirds. These actions should be undertaken annually or started immediately.

High (H)

Those actions that help to define the conservation status of threatened taxa and improve our knowledge and understanding of the impacts of threatening processes on these taxa. This category also includes actions that protect seabird populations from the risk of local extinction. These are important actions that should be initiated within 5 years.

Medium (M)

Those actions which are expected to contribute long-term conservation benefits to threatened seabird taxa. These are useful actions that should be initiated in the next 10 years.

Low (L)

Those actions which improve our knowledge and understanding of seabird taxa or may contribute long-term conservation benefits to these taxa. These are desirable actions that could be undertaken in the next 20 years.

10.1 OVERVIEW OF PROPOSED CONSERVATION ACTIONS

The conservation actions recommended in the following seabird profiles are those that will provide protection for seabirds, improve our knowledge of their conservation status, or help in the development of methods that will overcome threats to seabirds. This section looks briefly at how these actions will benefit seabird populations.

Preventing pest species colonising seabird islands is an essential conservation action for many seabird taxa. People visiting offshore islands should ensure that adequate quarantine measures are in place to minimise the risk of pests being transported to the islands. Plans and procedures also need to be in place to respond effectively to reported pest invasions. Regular visits to vulnerable sites are needed to detect pest invasions before the losses are irretrievable. Plant and animal pest control will be necessary to maintain some seabird populations breeding in sites where eradication is not an option. Sometimes, fencing of habitats on larger islands or mainland sites will protect vegetation cover around seabird colonies or restrict the movements of domestic and feral stock. Animal eradications are a valuable means of permanently removing the impacts of pest species at important seabird breeding colonies or restoring islands suitable for re-establishment of seabird colonies. Further development of techniques to transfer seabirds to new sites or restore former seabird colonies at degraded sites is still required. These actions will reverse the long-term attrition of seabird colonies which has occurred since the arrival of humans in New Zealand. To achieve this aim of restoring seabird populations, information will need to be gathered on behaviour of birds, especially courtship displays and vocalisations, and research undertaken to improve our understanding of the processes by which birds establish new breeding colonies.

Management of seabird colonies requires a long-term commitment. This is best achieved at sites where human impacts are minimised and where access is guaranteed for conservation workers undertaking essential protection and monitoring tasks. Ideally, key seabird sites should be under government or local authority control or be protected by a conservation covenant with private landowners. Closer relationships need to be established between DOC and iwi over guardianship of seabird colonies on customary Maori land to help alleviate land-based threats to seabirds.

Information about seabird distribution and abundance is still poorly known for most species. Surveys of potential breeding habitats are needed for some species, and accurate baseline counts and census data are needed for most species. Monitoring of population trends is essential to accurately assess conservation status, especially now that the IUCN criteria are based on quantitative assessment criteria.

Knowledge of seabird population biology and ecology is poor for almost all seabird taxa. Further research is needed with a focus on those aspects that will provide the most conservation benefit to seabirds. In view of the threats listed above, the key research needs are understanding the population dynamics of species (survival rates of adults, recruitment patterns etc.) and learning more about their basic breeding biology (timing of breeding cycle, breeding success, and growth and condition of chicks).

The life cycle of seabirds away from land is the least understood part of their biology. Studies are needed on seabird movements, foraging zones, diet, feeding behaviour, diving ability and relationships with fisheries. Commercial long-lining, trawling and set nets kill many seabird species. Development of new and improved fishing practices are needed to mitigate seabird bycatch problems with these fisheries. Diet studies may reveal the importance of fisheries discards to the breeding success of seabirds that regularly forage behind ships (Cherel & Klages 1998), or reveal if changes in food availability are affecting population status (e.g. crested penguins) (see Cuningham & Moors 1994, Cooper et al. 1990).

The study of taxonomic relationships in seabirds needs further work to help assess the distinctiveness of populations. Taxonomy is a useful tool for ensuring that resources are adequately partitioned to protect biologically significant populations. Many subspecies have been described in the past. Some may warrant separation into full species whereas others are likely to be proven indistinguishable from other populations using modern taxonomic techniques. New genetic techniques are being developed to sex birds and look at relationships within populations. These techniques will improve our understanding of how populations interact, especially the extent to which gene flow occurs between geographically isolated seabird populations.

Seabird vocalisations may prove useful as a means of sexing individual seabirds as sexing by plumage or measurements is problematic in most seabird groups. The majority of seabird species studied in detail have been shown to have sexually dimorphic calls (Marchant & Higgins 1990, Warham 1996). Vocalisations are very important for seabirds (especially nocturnal species) during the selection of breeding partners. Attempts to establish new seabird colonies may depend on recording those seabird vocalisations that attract birds of both sexes to a new site. Seabird vocalisations are also being used as a taxonomic tool to assess the extent of isolation from other closely related populations (James & Robertson 1986, Bretagnolle 1995).

11. Threatened seabird taxa profiles

Antipodean Albatross *Diomedea antipodensis*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds only at Antipodes Island and Campbell Island. Birds forage over the South Pacific Ocean and much less frequently, the Tasman Sea. Satellite tracking studies indicate that incubating birds mainly forage east of New Zealand, and some male non-breeding birds disperse east to the seas off Chile (Nicholls et al. 1996, K. Walker & G. Elliott unpub.).

Population

The breeding population has recently been censused on Antipodes Island using ground counts of nesting pairs. There were at least 4635 pairs in 1994 (Clarke et al. 1995), 5757 pairs in 1995, and 5148 pairs in 1996 (J. Amey, K. Walker, G. Elliott unpub., Gales 1998). This indicates a global population of 33,000 individuals (Gales 1998). Warham & Bell (1979) estimated there were about 1000 pairs on Antipodes Island in 1969. This estimate is not directly comparable with recent census data as Warham & Bell mainly used vantage point counting techniques to estimate population size, which are known to underestimate numbers by up to 80% (Walker & Elliott 1999). The Campbell Island population is small: about 6 pairs breed each season and the population appears stable (P. Moore in Gales 1998).

Threats

There are currently few if any land-based threats to Antipodean albatross. Mice are the only introduced mammal on Antipodes Island and are unlikely to have any effect on albatross populations. On Campbell Island, Norway rats are present but chicks are successfully reared. There was no evidence from the study by Taylor (1986) that Norway rats affected albatross breeding success. Feral cats were too rare to have any impact on albatross populations and the cat population has possibly died out in recent years (Moore 1997). Fires could potentially have an impact on nesting habitat and would affect breeding success in the year that a fire occurred. Antipodes Island has a relatively dry climate and fires are a greater risk there than Campbell Island which has a very wet climate. Visitor impacts are currently minimal because access is restricted to Antipodes Island, and very few people visit the nests of birds breeding at Campbell Island. Disturbance of the Campbell Island population has probably decreased with the closure of the weather station. The few breeding pairs were sought after for photography in the past and birds were captured for banding studies. Fortunately there is no evidence of the banding problems observed in southern royal albatross populations on Campbell Island.

At sea, the main threat is long-line fishing (Gales 1998). Antipodean albatross formed 9% of the (identified) birds caught on southern bluefin tuna long-lines in New Zealand waters between 1988 and 1997 (Baird et al. 1998). Most of these captures occurred on vessels operating east of New Zealand.Two banded females from the Antipodes Island study area were killed on tuna long-lines off East Cape in 1997 and a banded male from the study area by a net sonde cable in 1998 (K. Walker & G. Elliott unpub.). The species forages widely over the South Pacific Ocean and Tasman Sea and therefore is at risk from oceanic long-lining in international waters. There have been no reports of this species being killed or injured by trawl fisheries (Bartle 1991, DOC fisheries observer data unpub.). There is no information available to assess if competition occurs with oceanic fisheries for food species preferred by Antipodean albatross. Little is known about the possible effects of pollutants such as plastics, chemical contaminants and oil spills but because the birds forage widely in the South Pacific and off South America, they could be at risk from a wide range of possible pollutants or oil spills.

Previous Conservation Actions

1. The species was studied in 1969 and an initial estimate was made of the breeding population (Warham & Bell 1979). Adult birds were banded on this expedition.
2. A large cohort of chicks (1000 birds) was banded on Antipodes Island in 1978. The diet of adults and chicks was studied by Imber (1992).
3. Birds on Campbell Island were banded by Meteorological Station staff and recently by DOC staff working on the island (mainly chicks on an opportunistic basis).
4. Cattle were eradicated from Campbell Island in 1984, and sheep were progressively eradicated from parts of the island in 1970, 1984, and 1990-92.
5. The breeding population on Antipodes Island was surveyed in 1994 and the first complete census was undertaken (Clarke et al. 1995).
6. A major study of Antipodean albatross commenced on Antipodes Island in 1994. A complete census of breeding birds was made in January/February from 1994-1996 inclusive. A large cohort of 2000 chicks were banded in November 1995. A study colony of breeding birds was mapped on North Plains and all breeding pairs were banded. This study aims to determine population demography traits such as adult survival, breeding success, and chick recruitment. Concurrent studies are also underway on adult dispersal and foraging zones using satellite transmitters (Nicholls et al. 1996, K. Walker & G. Elliott pers. comm. 1999).
7. The taxonomy of all albatross species has been revised recently (Nunn et al. 1996) and the Antipodean albatross has been raised to full specific rank (Robertson & Nunn 1998, Gales 1998).

8. Public awareness of the plight of albatross species has increased in recent years with media exposure and increased publication of work implicating oceanic fisheries in the decline of some albatross species (Gales 1998). Contact with the fishing industry has been initiated and investigations have started to determine ways of addressing the bycatch problem.

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

L1. Norway rats should be eradicated from Campbell Island.

Future Survey and Monitoring Needs

H1. The breeding population on Antipodes Island should be monitored for 10 years to detect annual variation in frequency of breeding, breeding success, and population changes in a defined study area. The total breeding population should be censused for a minimum of 3-4 consecutive years at 10-year intervals (since the species is a biennial breeder).

H2. All birds counted during an island-wide census should be checked for leg bands to help determine survival and recruitment rates of adults and chicks banded on Antipodes Island and to locate birds banded at other locations.

M1. Counts of breeding pairs at known sites should be carried out on Campbell Island whenever the opportunity arises. All birds found at Campbell Island should be banded. A full census of breeding pairs should be attempted in 3 consecutive years at 10-year intervals. This would need to be done in conjunction with a whole island census of the southern royal albatross population.

Research Priorities

H1. The breeding biology and population dynamics of the Antipodean albatross are being studied by K. Walker & G. Elliott. Information is being collected on breeding success, survival of adults, and recruitment of fledglings.

H2. The foraging zones and dispersal patterns of the Antipodean albatross are being studied by K. Walker & G. Elliott. The diet of this species is known only from collections made in November 1978 (Imber 1992). More work is needed to correlate diet with foraging zones and to determine if there are sexual differences in the type of food items consumed. The importance of fisheries waste in the diet or potential for competition with fisheries needs to be assessed.

M1. Previous banding and breeding data should be collated and analysed for Campbell Island birds.

L1. The annual cycle of Antipodean albatrosses has not yet been studied, including measurement of chick growth rates from hatching to fledging.

L2. Information is lacking on courtship behaviour and natal philopatry of non-breeding birds. This is best studied on Antipodes Island.

Antipodean albatross pair displaying, Campbell Island, 1987

Satellite tracking studies indicate that incubating birds mainly forage east of New Zealand, and some male non-breeding birds disperse east to the seas off Chile. Antipodean albatross formed 9% of the identified birds caught on southern bluefin tuna long-lines in New Zealand waters between 1988 and 1997.

Gibson's Albatross *Diomedea gibsoni*

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (D2)
Molloy and Davis rank:	Category B

Distribution

Breeds only at the Auckland Islands (Auckland, Adams, Disappointment). Disperses over Tasman Sea, South Pacific Ocean, and Southern Ocean. Limited satellite tracking studies indicate the species feeds mainly in the Tasman Sea or east of New Zealand during early incubation (Walker et al. 1995b, Elliott et al. 1995).

Population

A series of five counts of breeding pairs was conducted on Adams Island in 1991, 1993, 1994, 1995, and 1997; on Disappointment Island in 1993, and on Auckland Island in 1995 (Walker & Elliott 1999). These gave a mean total annual breeding population on the Auckland Islands of 5800 pairs (range 4826 – 7417 pairs) (Walker & Elliott 1999). The estimated total global population is probably 40,000 individual birds (Gales 1998). Robertson (1975) reported an annual breeding population of 7250 pairs in the Auckland Island group in 1972/73. This total included an estimated 7000 pairs on Adams Island. However, this figure was not based on a comprehensive census of breeding birds and therefore the count is not comparable with those in the 1990s. Repetition in 1997 of a 1973 transect count on one ridge on Adams Island indicated a 63% decline in the intervening 24 years (Walker & Elliott 1999).

Threats

There are currently few land-based threats to Gibson's albatross. Feral pigs may take eggs and kill unguarded chicks on Auckland Island. They are probably the key factor limiting the recovery of albatrosses on this island. Feral cats may also kill a few chicks on Auckland Island. Mice are also present on Auckland Island but are unlikely to have any effect on albatrosses. Both Adams and Disappointment Islands are free of introduced mammals. Fires could have an impact on nesting habitat and would affect breeding success in the year that a fire occurred. However, a large and widespread fire is unlikely to occur at the Auckland Islands because the islands have very high rainfall levels. Visitor impacts are minimal because access to Adams and Disappointment Islands is restricted and very few people visit birds breeding on Auckland Island.

At sea, the main threat is long-line fishing (Gales 1993, 1998). Gibson's albatross are caught on southern bluefin tuna long-lines in New Zealand and Australian seas (Murray et al. 1993, Brothers et al. 1998). This species formed 5% of the seabirds landed dead on tuna long-line vessels and returned for autopsy between 1988 and 1997 (Baird et al. 1998). Currently annual female survival is 2% lower than that of males (Walker & Elliott 1999). This difference may result from the more northerly dispersal of females (Walker et al. 1995b) and the subsequent higher chance of encountering long-line fisheries in the Australian and New Zealand EEZ's and the adjacent high seas. Males are also at risk in this area. A banded breeding male from the Adams Island study colony was killed on a tuna long-line off south-eastern Australia in 1996 (Brothers et al. 1998, Walker et al. 1991). There are no reports of Gibson's albatross being injured or killed in trawl fisheries (Bartle 1991, DOC fisheries observer programme unpub.). There is no information available to assess if competition occurs with oceanic fisheries for food species preferred by Gibson's albatross. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills, but because the birds forage widely over the Tasman Sea and Pacific Ocean they could be at risk from a wide range of possible pollutants or oil spills.

Previous Conservation Actions

1. Feral goats were eradicated from main Auckland Island in 1995.
2. The albatross populations on Adams, Auckland, and Disappointment Islands were studied in 1973 (Robertson 1975). A few food samples were collected for a study on the diet of this species (Imber & Russ 1975, Imber 1992).
3. A census of Gibsons's albatross chicks was carried out on Adams Island in 1989 (Buckingham et al. 1991).
4. A major study of Gibson's albatross commenced on Adams Island in 1991. Five counts of breeding birds were made in January/February between 1991 and 1997 (no count was made in 1992 or 1996) (Walker et al. 1991, 1995a, Walker & Elliott 1999). A study colony of breeding birds was mapped on the upper slopes of Adams Island and all breeding pairs were banded. Four cohorts of chicks have been banded in this study colony. The study aims to determine population demography traits such as adult survival rates and chick recruitment. The study area was also used to determine annual breeding success to calibrate with the island-wide census. Concurrent studies are also underway on adult dispersal and foraging zones using satellite transmitters (Walker et al. 1995b, Elliott et al. 1995).
5. The taxonomy of all albatross species has just recently been revised by Nunn et al. (1996), and they proposed that Gibson's albatross be raised to full specific rank (Robertson & Nunn 1998, Gales 1998).
6. Public awareness of the plight of albatross species has increased in recent years with media exposure and increased publication of work implicating oceanic fisheries in the decline of some albatross species (Gales 1998). Contact with the fishing industry has been initiated and investigations have started to determine ways of addressing the bycatch problem.

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

H1. Feral pigs and feral cats should be eradicated from Auckland Island.

Future Survey and Monitoring Needs

H1.The breeding population on Adams Island should be monitored for 10 years to detect annual variation in frequency of breeding, breeding success, and population changes in a defined study area.The total breeding population should be censused for a minimum of 3-4 consecutive years at 10-year intervals (because the species is a biennial breeder).

H2. All birds counted during an island-wide census should be checked for leg bands to help determine survival and recruitment of adults and chicks banded on Adams Island and at other locations.

M1. Counts of breeding pairs should be carried out on Disappointment and main Auckland Islands whenever the opportunity arises.A full census of breeding pairs should be attempted in 3 consecutive years to estimate annual breeding populations.

Research Priorities

H1. The breeding biology and population dynamics of Gibson's albatross are being studied by K.Walker & G. Elliott. Information is being collected on breeding success, survival of adults, and recruitment of fledglings.

H2. The foraging zones and dispersal patterns of Gibson's albatross are being studied by K.Walker and G. Elliott (see Walker et al. 1995b, Elliott et al. 1995).The diet of this species is known only from six food samples collected at the Auckland Islands (Imber & Russ 1975, Imber 1992). More work is needed to correlate diet with foraging zones and to determine if there are sexual differences in the type of food items consumed.The importance of fisheries waste in the diet or potential for competition with fisheries needs to be assessed.

L1. The annual cycle of Gibson's albatross has not yet been studied, including measurement of chick growth rates.

L2. Information is lacking on courtship behaviour and natal philopatry of non-breeding birds.This is best studied on Adams Island.

Southern Royal Albatross *Diomedea epomophora*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category B

Distribution

Breeds only at Campbell Island, Auckland Islands (Adams, Enderby, Auckland) and South Island (Taiaroa Head - hybrids only). Disperses widely over Tasman Sea and South Pacific Ocean during breeding season. Birds migrate after breeding to South Atlantic Ocean and probably have a circumpolar distribution in the Southern Ocean (Robertson & Kinsky 1972).

Population

Recent counts on Campbell Island found 6308 pairs in 1995 and 7787 pairs in 1996 (Moore et al. 1997a). This equates to a probable total population of 50,000 individuals (Gales 1998). By comparing different census techniques and correcting for nest failure the 1996 breeding population was estimated to be 8200-8600 pairs (Moore et al. 1997a).

The long-term population trend on Campbell Island is not clear because earlier counts and censuses used different techniques to those used in recent surveys. The vantage point counts used in the 1960s to 1980s probably underestimated the size of the breeding population. It is assumed that numbers had been reduced in the sealing, whaling, and farming era from overgrazing, burning, and predation (Atkinson & Bell 1973, Kerr 1976, Kerr & Judd 1978). Sorensen (1950a) estimated there were 5000 pairs in 1942, however this is probably a doubtful figure because it was based on a higher density estimate on Faye Ridge than occurs today, plus he overestimated the nesting area by a factor of two (P. Moore pers. comm. 1999). Westerkov (1963) counted 2278 pairs in 1958. Taylor et al. (1970) counted 4344 nests in 1969 and considered that their counts were at least 10% below the true number of nests. Dilks & Grindell (1983) summarised the results of six counts between 1976 and 1983. There were 5336 breeding pairs counted in 1976 and 4906 in 1977 but only 4575 nests were counted in 1980 and 4493 in 1981 suggesting the population may have reached a peak in the early to mid 1970s then declined through to the early 1980s. Alternative explanations for this pattern are that counting effort was variable, or the 1975-76 count was influenced by the earlier start to the census than most others, or a poor season in 1974-75 caused a greater number of failed breeders to return to breed the following year. Recent counts suggest that the population has been increasing since the mid 1980s as counts in study plots on Campbell Island have increased. At Col, numbers increased from 128 pairs in 1987-88 and have levelled off, fluctuating between 190-203 pairs from 1994-99 but at Moubray the increase has been steady from 344 pairs in 1987-88 to 564 pairs in 1998-99 (P. Moore pers. comm. 1999).

The population on Adams and main Auckland Island numbers about 17 pairs per annum (Gales 1998). The population on Enderby Island has been steadily increasing and 55 pairs were present in 1995 (Gales 1998). However, recent counts suggest that this population increase may have leveled off (S. Childerhouse pers. comm to P. Moore). No pure-bred *D. epomophora* currently breed at Taiaroa Head but 5 hybrid progeny occur at this colony (Robertson 1993a, Gales 1998).

Threats

There are currently few land-based threats to southern royal albatross. Brown skuas are natural predators of eggs, however this is not prevalent (apart from scavenging of abandoned eggs) (P. Moore pers. comm. 1999). Feral pigs probably take eggs and kill unguarded chicks on main Auckland Island. They are probably the key factor limiting the recovery of albatrosses on this island. Feral cats may also kill a few chicks on main Auckland Island. Cats may have taken a few chicks on Campbell Island because albatross bones were found in cat dens in 1984/85 (Taylor 1986). Cats were scarce on Campbell Island (Dilks 1979, Taylor 1986) and may have died out since the mid-1980s (Moore 1997). Norway rats have been reported killing young royal albatross chicks on Campbell Island (Taylor 1986) but presumably very few chicks are taken because breeding success is high (Moore et al. 1997a). Both Adams and Enderby Islands are free of introduced mammals. Feral sheep and cattle on Campbell Island, and feral cattle on Enderby Island caused some nest disturbance in the past and may have enabled brown skuas to take eggs or chicks. The effect of sheep grazing on albatross nesting was not resolved, because at times both species appeared to increase (Dilks & Wilson 1979). A potential long-term threat to the breeding habitat is the uphill encroachment of *Dracophyllum* scrub, possibly from climatic warming (Meurk 1982). Fires could have an impact on nesting habitat, as occurred during the farming period of 1895-1931 (Westerskov 1963, Meurk 1977), and would affect breeding success in the year that a fire occurred. However, a large and widespread fire is less likely at Campbell and Adams Islands because these islands have high rainfall levels. Fire is a threat at Enderby Island because it is relatively dry in the summer.

It is unknown what nett effect tourist visits have on albatross nesting. There is probably some impact from visitors because nervous birds are known to abandon nests when visited or handled, and these birds probably move sites in subsequent years. Other more tolerant individuals may become used to humans. Some birds were poorly banded on Campbell Island in past seasons and developed leg injuries from bands in-bedding in the tarsus (Moore et al. 1997a). Almost 36,000 southern royals have been banded on Campbell Island, with a peak in the 1960s and 1970s. About 2% have been injured, mainly as a result of poor banding technique. Some cohorts of chicks were more affected than others (P. Moore pers. comm. 1999). Most of the injured breeding birds at two study areas (c.200 nests each) have been caught and the bands replaced, however, injured birds remain undetected because banding occurred over the whole or large parts of the island in many years. The injured birds breed successfully although it is not known if differential mortality has occurred. There appears to be variable recovery of foot mobility once bands are removed. Although, currently, only trained people band this species, there are still occasional instances of the large R-bands springing open and injuring the birds.

At sea there is a moderate threat from long-line fishing. Small numbers of southern royal albatross were caught on southern bluefin tuna long-lines in the New Zealand EEZ between 1988 and 1997 (Baird et al. 1998). Birds have also been killed on tuna long-lines set off south-western Australia in summer and off Tasmania in summer and winter (Gales et al. 1998). Two banded southern royal albatross juveniles (banded as chicks on Campbell Island in 1991 and 1994) were caught on long-lines set off Tasmania in 1996 (Brothers et al. 1998). The species is also frequently caught by Japanese tuna long-liners fishing the high seas (Uozumi 1998). A few birds have been observed killed in trawl nets or associated warps and cables (Bartle 1991, DOC fisheries observer data unpub.). Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills but because the birds forage widely over the Tasman Sea, Pacific Ocean, and South Atlantic Ocean they could be at risk from a wide range of possible pollutants or oil spills.

Previous Conservation Actions

1. Cattle were eradicated from Campbell Island in 1984, and sheep were progressively eradicated from parts of the island in 1970, 1984, and 1990-92.
2. Feral cattle, rabbits, and mice were eradicated from Enderby Island in 1993.
3. A small number of southern royal albatross nests was studied by Sorenson (1950a) at Campbell Island during the 1940s. Most of work was on the breeding cycle and aspects of breeding biology.
4. The population at Campbell Island was censused in 1958, 1969, 1976, 1977, 1978, 1980, 1981, and 1983 (Westerkov 1963, Taylor et al. 1970, Dilks & Wilson 1979, Dilks & Grindell 1983).
5. Large numbers of each annual cohort of chicks were banded by Meteorological Station staff on Campbell Island from 1960 to 1987. A study of the breeding cycle and breeding success of southern royal albatrosses nesting on Col Ridge (Campbell Island) during the 1960s has been published recently (Waugh et al. 1997).
6. Two study areas were set up on Campbell Island in 1988 (Col Ridge and Moubray) to monitor more intensively breeding success, recapture banded adults and band chicks in these areas (Moore & Moffat 1990a). These study areas have been monitored annually since 1991-92 (Moore et al. 1997a).
7. The total breeding population was censused on Campbell Island in 1995 and 1996 (Moore et al. 1997a, c). A more reliable counting method was used at three index sites on Campbell Island in 1996-97 because the previous "total count" censuses have varied with effort and not been possible to reproduce (P. Moore pers. comm. 1999). These and the two study areas (Col and Moubray) will be used for future population trend data.
8. The breeding population was censused on Enderby Island in 1968, 1988, and between 1992-99 (Taylor, R.H. 1971, Taylor, G.A. 1988, C. Robertson in Croxall & Gales 1998, S. Childerhouse pers. comm. 1999). Forty-nine birds were banded in 1988 (Taylor, G.A. 1988) and further birds were banded in 1998.

9. A code of practice for visitors was established to ensure that nesting albatrosses were not handled or approached too closely to minimise disturbance of birds near walking tracks on islands with permitted access for ecotourism. A boardwalk was constructed on Campbell Island to lead tourists to the albatross breeding area and limit the area that they visit. Individual nest distribution at Col study area has been monitored from 1994-99.

10. The diet of Southern royal albatrosses on Campbell Island has been studied by Imber (1999) from samples collected between 1974 and 1997.

Future Management Actions Needed

H1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

H2. Feral pigs and cats should be eradicated from main Auckland Island.

M1. A better shaped or stronger band should be developed for royal albatrosses.

M2. Norway rats and feral cats should be eradicated from Campbell Island.

Future Survey and Monitoring Needs

H1. The long-term banding of adults and chicks on Campbell Island provides a valuable opportunity to determine survival and recruitment rates in this population. Leg bands should be checked when carrying out routine monitoring and census studies on Campbell Island. A thorough check of all breeding and non-breeding birds should be attempted to obtain band recoveries and check for band injuries. This would need to be done over a minimum of two breeding seasons over the entire island to maximise band recoveries.

H2. A full census of breeding pairs on Campbell Island was stopped after 1996 because of problems in standardising effort per unit area between seasons. By 1999, there had been 8 consecutive years of census counts in two study areas and 3 years of counts at three other sites. A repeat census of these five areas should be carried out over 3 consecutive years at 10-year intervals and an island-wide census attempted every 20 years.

M1. The breeding population on Enderby Island should be counted annually or whenever expeditions visit the island in January/February. A full census of breeding pairs should be attempted in 3 consecutive years at 10-year intervals.

M2. Visitor impacts need to be closely monitored, especially at Col Ridge on Campbell Island and on Enderby Island as some incubating birds are prone to abandoning nests if closely approached by humans. Nest distribution should be re-measured for 3 years every 10 years, bearing in mind any change may be unrelated to tourism.

L1. Monitoring is needed of vegetation changes on Campbell and Enderby Islands. An assessment is needed on whether or not vegetation encroachment is reducing available habitat for albatrosses.

L2. Counts of breeding pairs should be carried out on Adams and main Auckland Islands whenever the opportunity arises. A full census of breeding pairs should be attempted in 3 consecutive years at 10-year intervals.

Research Priorities

H1. The population dynamics of southern royal albatross still needs research. Information is needed on adult survival rates, fledgling survival rates and recruitment of juveniles to the breeding population, natal philopatry and species longevity. This information can be collected in conjunction with the survey task H1 above.

L1. Seasonal variation in types of food fed to chicks needs to be determined. More work is also needed to correlate diet with foraging zones (using satellite telemetry) and to determine if there are sexual differences in the type of food items consumed.

L2. The movements and dispersal patterns of adults and fledglings should be studied using satellite telemetry.

L3. The vocalisations of southern royal albatross have not been studied in detail and need to be referenced against the bird's sexual displays. Research is needed to determine the full range of calls and to determine if there are sexually dimorphic or individually recognisable calls. Comparisons are also needed with the calls of *D. sanfordi*. This may help explain the potential for interbreeding between these two species.

Northern Royal Albatross *Diomedea sanfordi*

Conservation Status: Endemic species

IUCN rank: Endangered (B1+B2c,e)

Molloy and Davis rank: Category B

Distribution

Breeds at Chatham Islands (Forty-Fours, Big Sister, and Little Sister), South Island (Taiaroa Head, Otago Peninsula) and Auckland Islands (Enderby Island). Disperses over Tasman Sea and South Pacific Ocean during breeding season with most birds feeding over the continental shelf. Birds migrate after breeding to the South Atlantic and Indian Oceans (Robertson & Kinsky 1972) and probably have a circumpolar distribution in the Southern Ocean (C. Robertson in Croxall & Gales 1998).

Population

Most birds breed at the Chatham Islands where there is an estimated breeding population of 6500-7000 pairs, equivalent to a projected total population of about 20,000 individual birds (Robertson 1998). Up to 27 breeding pairs occur at Taiaroa Head including 5 individuals which are hybrid progeny of *D. epomophora* x *D. sanfordi* pairings (Robertson 1998). Two individuals of *D. sanfordi*, both breeding with *D. epomophora* partners have been recorded on Enderby Island (Robertson 1998).

Threats

Habitat changes on the breeding grounds are presently having the most significant impact on northern royal albatross populations (Robertson 1998). An easterly storm which struck in 1985 removed most of the soil and vegetation covering from the Forty-Fours and Sisters Islands. Consequently, albatross nest sites are created from stones, or eggs are laid on bare rock. Hatching success is extremely low because eggs are broken, flooded in temporary ponds, or fail to hatch owing to high temperatures and low humidity in late summer. The problem is exacerbated by the normally biennial breeding pattern being disrupted by low breeding success so that most of the total breeding population nests annually. This can prevent the habitat from recovering because the birds strip all substantial vegetation in an attempt to create nest sites (Robertson 1998).

At Taiaroa Head, feral cats, stoats, and ferrets have killed chicks in some seasons but intensive pest control has minimised the impact of these predators (Ratz & Moller 1997). Norway rats are not known to have any impact on royal albatross chicks at Taiaroa Head. All other breeding colonies are free of introduced mammals. The colonies at both the Chatham Islands and Taiaroa Head have been subject to increased ambient temperatures and significant drying of habitat since the mid 1970s. Fly strike from the introduced blowfly (*Lucilia sericata*) and heat stress has been a major cause of egg and chick failure at Taiaroa Head since 1986 (Robertson 1998). In particularly warm years, some adults have died from heat exhaustion and possibly from an avian pox virus (C. Robertson pers. comm.

1998). Some negative impacts from high visitor numbers have been identified at Taiaroa Head. Breeding distribution has changed with birds preferring to nest away from public viewing areas (Robertson 1993a, 1998). Modifications to the observatory windows may resolve these problems (C. Robertson pers. comm. 1999). At Chatham Islands, harvesting of albatross chicks by local islanders was common in the past but has occurred infrequently in the past 20 years.

At sea, long-line fishing has a slight impact on northern royal albatross. Only two birds have been captured on tuna long-lines in the New Zealand EEZ and returned for identification between 1988 and 1997 (Baird et al. 1998). The high survival rate of adults and fledglings indicates that this form of mortality is not a major threat to the species (Robertson 1993a). The species regularly attends trawlers yet there are no confirmed records of northern royal albatross bycatch from trawl fisheries (DOC fisheries observer data unpub.). Little is known about the possible effects of pollutants such as plastics and oil spills. This species forages widely over the Tasman Sea, Pacific Ocean, and South Atlantic Ocean, so it could be at risk from a wide range of pollutants or oil spills.

A recent study of organochlorine contaminants in northern royal albatross found PCDD, PCDF, PCB and DDT group residues present at considerably lower concentrations than those reported from albatross species breeding in the North Pacific Ocean. The PCB levels in northern royal albatross were slightly higher than those found in Pacific albatross and Chatham albatross breeding at the Chatham Islands, but DDT group levels were lower than the levels found in Chatham albatross (Jones 1999). The hazard effects of these compounds are still at a low level and should not affect reproductive capability in the near future (Jones 1999). The decrease in egg-shell thickness observed at the Chatham Islands in the past 20 years does not appear to be caused by contaminants (Jones 1999) and may result from stress to birds owing to high nest densities on the breeding colonies (Robertson & Jones 1998).

Previous Conservation Actions

1. The colony at Taiaroa Head first established about 1919 and only concerted actions by Lance Richdale enabled chicks to be reared in the early years of this colony (Richdale 1939). Richdale (1942, 1950b, 1952) carried out the first studies on the breeding biology of this species. Eventually the colony was protected as a Nature Reserve and full time wardens appointed to look after the birds. These staff carry out a range of tasks including banding all chicks and new birds visiting the colony, monitoring nesting attempts, and hand-rearing or fostering eggs and chicks to maximise breeding success (Robertson 1993a). Important animal husbandry techniques have been developed at this site (Robertson & Wright 1973).

   In recent years water sprinklers have been added to increase soil moisture levels and cool nesting birds. Predator control is undertaken in the vicinity of the colony. The colony is now a major tourist attraction and has been fenced to control visitor access and to prevent dogs and other predators attacking the albatrosses. Wire lines at Taiaroa Head have been put underground to minimise the risk of bird strikes (Robertson 1993a, 1998). Aspects of the breeding biology and population dynamics of northern royal albatrosses has been studied at this colony (Robertson 1993a, 1993b, Robertson & Richdale 1993). The data collected on breeding success, adult and juvenile survival rates, recruitment, and longevity is the best available for a seabird population in New Zealand.

2. The populations on Chatham Islands were studied in the 1970s and 1990s. Counts were made of breeding populations and birds were banded. Basic breeding biology was studied during these periods (Robertson 1991, C. Robertson pers. comm. 1998).

3. The proposal to allow a legal harvest of toroa (albatrosses at the Chatham Islands) led to the initiation of new studies of northern royal albatrosses at the Chatham Islands by Robertson (1991). Most of the research was conducted on Little Sister and involved an assessment of population dynamics, breeding success, breeding biology, and the effects of habitat change on the breeding population. Aerial photographic surveys were undertaken to count numbers of breeding pairs and to determine breeding success at the Sisters and Forty-Fours colonies (Robertson & Sawyer 1994). Ground truthing of these photos was done to determine proportions of breeders and non-breeders ashore at the time of photography (C. Robertson pers. comm. 1999). Adults and chicks have been banded at the Little Sister colony (Robertson 1998).

4. Satellite tracking was carried out on adults from both the Taiaroa Head (Nicholls et al. 1994) and the Sisters colonies to monitor movements during the breeding season and dispersal after breeding (C. Robertson pers. comm. 1998).

5. Feral cattle, rabbits, and mice were eradicated from Enderby Island in 1993.

6. Imber (1991, 1999) studied the diet of northern royal albatrosses at Taiaroa Head and Chatham Islands from samples collected between 1973 and 1996.

Future Management Actions Needed

E1. Agreement needs to be reached with the private owners of the Sisters and the Forty Fours to enable on-going research programmes to continue on these islands. Access to these sites is needed to assist in long-term monitoring and protection of the albatross populations.

E2. Consideration should be given to techniques to increase hatching success on the Chatham Island colonies including construction of soil traps or wind shields. Artificial nest sites were trialled but were unsuccessful (C. Robertson pers. comm. 1999). Any modifications on the islands would need the consent of the island owners. Artificial incubation of eggs could improve hatching success but is likely to be logistically impossible at the Chatham Islands.

H1. The population at Taiaroa Head needs continuous management and protection to ensure that this unique mainland population continues to expand in the future. The population will require continued nest protection, intensive monitoring of breeding performance, nest manipulation where necessary, and the use of animal husbandry techniques to maintain this mainland population in the future and to ensure the ongoing advocacy benefits of having an accessible site for tourists to view an albatross colony.

M1. Ideally, the Sisters and Forty-Fours should be legally protected by a conservation covenant, in recognition of the unique values of these islands.

L1. Establishing a new colony in the Chatham Islands should be considered. Suitable sites might include the summit plateau on Mangere Island, the clears on Rangatira Island or parts of Pitt Island, e.g. Rangiauria. The initial establishment trials should begin by placing models (decoys) of albatrosses on these islands and using playback of northern royal albatross calls to lure birds to land (see Podolsky 1990 for methods).

L2. Establishment of new populations could also be trialled by transferring chicks to a new colony site in the Chatham Islands. If too few chicks are hatched, then artificial incubation of eggs and hand-rearing chicks could be considered.

Future Survey and Monitoring Needs

H1. The breeding populations at the Chatham Islands should continue to be monitored annually by aerial photography to assess trends in these populations.

H2. Further cohorts of chicks should be banded preferably at all Chatham Island colonies to determine future rates of recruitment to these colonies.

Research Priorities

M1. The movements and dispersal patterns of fledglings should be studied using satellite telemetry, and further banding of cohorts of chicks is needed at the Chatham Islands. Some additional satellite tracking of adults would be helpful. These will help to identify foraging zones and improve our understanding of threats to this species.

M2. More work is needed on the diet of northern royal albatrosses at the Chatham Islands. Sampling is needed to determine seasonal variation in the types of foods fed to chicks. Research is also needed to correlate diet with foraging zones and to determine if there are sexual differences in the type of food items consumed. These studies will help to determine potential conflicts or benefits to this seabird from commercial fishing operations.

L1. The vocalisations of northern royal albatross have not been studied in detail and need to be referenced against the bird's sexual displays. Research is needed to determine the full range of calls and to determine if there are sexually dimorphic or individually recognisable calls. This research would be best carried out at Taiaroa Head colony. Comparisons are also needed with the calls of *D. epomophora*. This may help explain the potential for interbreeding between these two species.

Eastern Rockhopper Penguin *Eudyptes chrysocome filholi*

Conservation Status: Indigenous subspecies

IUCN rank: Vulnerable (A1a, c)

Molloy and Davis rank: Category O

Distribution

Breeds on Campbell Island, Auckland Islands (Auckland, Disappointment, Adams), and Antipodes Islands (Antipodes, Bollons). Also breeds on Macquarie, Heard, Kerguelen, Crozet, Marion, and Prince Edward Islands. The distribution at sea is poorly known, but birds forage in cold subantarctic seas, probably north of the Antarctic convergence.

Population

The population on Campbell Island declined by 94% from the 1940s to 1985. Campbell Island had nine colonies and a total of 51,500 pairs in 1985 (Moors 1986, Cunningham & Moors 1994). Most colonies have continued to reduce in size from 1985 to the mid-1990s judging by photographs taken at standard photopoint sites (P. Moore pers. comm. 1998). There were 12 colonies at the Auckland Islands in 1973 and an estimated 5000 to 10,000 pairs (Bell 1975). However, a survey in 1990 found only 10 colonies (including 5 sites not reported in 1972) and an estimated total breeding population of 2700 to 3600 pairs (Cooper 1992). A survey on main Antipodes and Bollons Islands in 1995 found a maximum of 3400 pairs (A. Tennyson & G. Taylor unpub.). The previous population estimate in 1978 was 50,000 breeding pairs (Marchant & Higgins 1990). Photographs taken of colonies at Ringdove Bay (Antipodes Island) in 1950 by G. Turbott clearly show there has been a huge decline of rockhopper penguins at this site (from tens of thousands in 1950 to a few individuals in 1995). The population on Macquarie Island was thought to be 100,000-300,000 pairs in the early 1980s (Marchant & Higgins 1990). There is no recent estimate of population size but studies started in 1993 suggest that declines are also occurring at Macquarie Island (C. Hull pers. comm. to P. Moore). Similarly, the current status of rockhopper penguin populations in the Indian Ocean is unknown. There were an estimated 420,000 pairs on these subantarctic islands in the 1970s and 1980s (Woehler 1993 in Croxall 1998). The total world population of subspecies *filholi* has apparently declined by about 50% since 1940 (when at least 1.5 million pairs were present) to a current population of fewer than 780,000 pairs in 1995 (figures re-calculated from data presented in Croxall 1998).

Threats

There are no mammalian predators at Bollons, Adams, and Disappointment Islands. Only mice are present on Antipodes Island. Feral cats, pigs, and mice are present on Auckland Island. Norway rats are present on Campbell Island. Norway rats kill a few small chicks soon after hatching (Moors 1986). Feral cats were formerly present on Campbell Island but may have died out since the mid-1980s

(Moore 1997). Feral sheep, which were formerly present on Campbell Island, caused disturbance in colonies (trampled nests and caused temporary nest desertions leading to predation of eggs and chicks by brown skuas). Feral cats have not been recorded preying on chicks but are a potential threat at the Auckland Island colonies. All New Zealand subantarctic islands are nature reserves, and landing is restricted at all sites with penguins. Therefore human disturbance of colonies is minimal. Flipper bands used in past studies of rockhopper penguins may be a potential problem because they increase drag in the water, cause excessive feather wear, and can spring open (Fraser 1994, P. Moore pers. comm.). These bands need to be fixed and maintained on a regular basis. Transponders may provide a suitable alternative marking technique.

Rockhopper penguins could potentially be caught in trawl nets but there are no records of rockhopper penguins being caught in New Zealand subantarctic waters by this fishing method (DOC fisheries observer programme unpub.). Competition from fisheries may be a potential threat. There is a major fishery for southern blue whiting (a common prey species for this penguin in the New Zealand subantarctic) (Croxall 1998). The decline of rockhopper penguins at Campbell Island has been attributed to a slight warming of sea temperatures since the 1950s and change in the distribution of prey species (Cunningham & Moors 1994). These changes may also be having an impact on other rockhopper populations in the Pacific Ocean sector. Avian cholera has caused deaths of rockhopper penguin adults and chicks at Campbell Island (de Lisle et al. 1990) and may be a problem in some seasons at other rockhopper penguin colonies. Avian malaria antibodies were absent from rockhopper penguins sampled on Campbell Island (Graczyk et al. 1995) but were present in yellow-eyed penguins on the same island.

Previous Conservation Actions

1. Aspects of the breeding biology, social organisation, social behaviour, vocalisations, and morphometrics of this species were studied at Macquarie, Campbell, and Antipodes Islands (Warham 1963, 1972a, 1975).
2. The cause of the decline of rockhopper penguins at Campbell Island was studied in the mid 1980s (Moors 1986, Cunningham & Moors 1994). Detailed information was collected on the breeding cycle, breeding biology, diet, diseases, population distribution, abundance and trends in the population since the 1940s. Standard photopoints were established in 1984 and these photos have been repeated several times in subsequent years (P. Moore pers. comm. 1999). Additional work was conducted in 1987-88 (Moore & Moffat 1990a).
3. The effects of Norway rat predation on rockhopper penguin breeding success were studied by Taylor (1986).
4. A survey of rockhopper penguin colonies and estimates of population size were carried out at the Auckland Islands in 1972 (Bell 1975) and 1990 (Cooper 1992).
5. A survey of the distribution and abundance of rockhopper penguin colonies was carried out on Antipodes Island in 1995 (A.Tennyson & G.Taylor unpub.).

A sample of adult rockhopper penguins was banded at the northern colonies to monitor adult survival rates in this population.

Future Management Actions Needed

H1. Liaison is required with managers of other subantarctic island populations (Australia, France, and South Africa) to encourage surveys of rockhopper penguin populations and establish whether or not the decline is a Pacific Ocean phenomenon or is occurring throughout the range of the subspecies.

H2. An assessment is needed of the suitability of using flipper bands to monitor rockhopper penguin populations. An experimental trial is needed to assess survival rates of birds marked with transponders and/or flipper bands. A thorough check for banded birds at Campbell and Antipodes Islands is required for estimates of survival as well as to repair sprung bands.

M1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the known breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M2. Norway rats should be eradicated from Campbell Island.

M3. Feral cats and pigs should be eradicated from Auckland Island.

Future Survey and Monitoring Needs

H1. The permanent penguin colony photopoints on Campbell Island should be re-photographed every 5 years to monitor trends in this population.

H2. A census of breeding pairs at Penguin Bay, Campbell Island, should be carried out every 5 years. These should follow the methods used by Cunningham & Moors (1994). All the small colonies (Smoothwater Bay, Rocky Bay) should be checked every 5 years to determine if breeding is still occurring at these sites. An island-wide census and re-measurement of colony boundaries should be carried out every 10 years.

H3. The colonies at the Auckland Islands need to be checked by ground searches to accurately count breeding pairs at each site. Locations where colonies were seen in the 1970s also need to be checked to see if any evidence remains that penguins once nested at those sites.

H4. The largest remaining colony at the Auckland Islands should be monitored at 5-10 year intervals to determine trends in the population.

H5. The populations at Antipodes Island should be resurveyed at 10-year intervals to assess trends in the breeding populations. Permanent photopoints are also needed to help monitor colonies.

Research Priorities

H1. The diet of rockhopper penguins at the Auckland and Antipodes Islands is virtually unknown. Food samples should be collected from adults feeding chicks in several consecutive years to determine annual variations in the diet. The diet samples should be compared against those previously collected at Campbell and Macquarie Islands. Dive depths and dive profiles are also needed from Auckland, Campbell, and Antipodes Islands populations. These studies are needed to assess potential impacts on diet and food availability from global sea temperature changes and competition with fisheries.

H2. Research is needed on the distribution of prey species taken by crested penguin species to identify spatial variations in the distribution of prey, (i.e. correlate prey distribution with sea surface temperatures, underwater topography and nutrient levels), and assess seasonal and annual variation in prey distribution.

H3. The distribution and movements of rockhopper penguins at sea are unknown. Satellite transmitters (maximum weight 60 g) should be attached to adults during incubation and chick-feeding periods to determine local foraging range. Information is also needed on movements prior to moult and winter dispersal of adults once moult is completed. The dispersal of chicks in their first year at sea could also be examined.

H4. The population dynamics of rockhopper penguins are poorly known. An analysis is needed of band recovery data collected at Campbell Island between 1984 and 1995 to establish minimum adult survival rates, juvenile survival rates and percentage recruitment to natal colonies, and age of first pairing and breeding. Information is also needed on nest site and mate fidelity. The marked rockhopper penguin pairs at Anchorage Bay colony on Antipodes Island should be monitored regularly over the next 10 years and at least three cohorts of chicks need to be banded or tagged with transponders to assess juvenile survival rates.

H6. The taxonomy of rockhopper penguins needs further research. The western (or southern) rockhopper penguin, which breeds at the Falkland Islands and South America, is separable on the colour of the bare parts. The northern rockhopper penguin breeds on temperate islands in the South Atlantic and Indian Ocean and has large distinctive crests. The eastern rockhopper penguins in the Pacific Ocean sector are probably reproductively isolated from those in the Indian Ocean. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice. If the New Zealand and Macquarie Island birds are taxonomically distinct from those in the Indian Ocean, then these populations would be ranked as Critically Endangered.

L1. The breeding biology of rockhopper penguins has been studied in detail at Campbell Island. A comparison is needed from the Auckland and Antipodes Island populations to determine dates of peak laying, hatching, and fledging. Egg measurements are needed from the Auckland Islands. Information is needed on breeding success rates at Auckland and Antipodes Islands.

L2. The calls of rockhopper penguins were described by Warham (1975). Sexual, individual, and geographic variation in calls needs further study.

Fiordland Crested Penguin *Eudyptes pachyrhynchus*

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (A1a, C1, C2a)
Molloy and Davis rank:	Category B

Distribution

Fiordland crested penguins breed on the South Island mainland and adjacent offshore islands southwards from Bruce Bay. The species also nests on Solander Island, Whenua Hou (Codfish Island), and islands off Stewart Island. Recent comprehensive surveys of breeding colonies were published in *Notornis* (McLean & Russ 1991, Russ et al. 1992, McLean et al. 1993, Studholme et al. 1994, McLean et al. 1997). One pair formerly bred (in 1950s) at Palliser Bay, North Island. Outside of the breeding season, birds disperse around North and South Islands, and south to the subantarctic islands. The species is a regular vagrant to south-eastern Australia.

Population

The surveys listed above located 2260 nests. McLean et al. (1997) estimated that there are probably 2500-3000 breeding pairs of Fiordland crested penguins. Colonies with more than 100 breeding pairs occur between Paringa River and Jackson Head, Open Bay Islands, Cascade Point, Yates Point, Shelter Islands, Breaksea and adjacent islands, Solander Island, and Whenua Hou. The population status of the species throughout its breeding range is still unknown and will require long-term monitoring to assess changes. However, reports of large colonies in Dusky and Breaksea Sounds late last century suggest that the species has declined in the past 100 years (Hill & Hill 1987). A population of penguins studied on Open Bay Islands declined by about 33% between 1988 and 1995 (St Clair 1998).

Threats

Mustelids, especially stoats, are reported to take eggs and chicks on mainland colonies and may occasionally attack adult penguins (Warham 1974a, Morrison 1980). Domestic dogs may kill adult penguins (especially moulting birds), and disturb colonies near human habitation (Marchant & Higgins 1990). Norway, ship, and Pacific rats may also be predators of small chicks although there is no direct evidence of predation. Feral cats and pigs are potential predators but appear to be uncommon in areas where penguins currently nest. Weka have been observed taking eggs and chicks (St Clair & St Clair 1992) and are a threat at sites that are otherwise free of introduced predators, e.g. Open Bay Islands, Solander Island. Deer are present in some colonies and may trample nests or open up the habitat for predators. Possums are scarce or absent in most areas with penguins but may compete for nest sites. Human disturbance of colonies is currently only a slight threat because the birds generally nest in inaccessible sites. However, there is concern that increased nature tourism in South Westland may disturb breeding birds at some accessible colonies, causing nests to fail. The species is also sensitive to handling and requires care when carrying out research.

Fiordland crested penguins potentially could be caught in set nets near breeding colonies. Trawl nets are also a potential risk but there are no records of penguins being caught by this fishing method. Competition with fisheries for prey species may be a potential threat. The decline of other crested penguin species (e.g. rockhopper penguins at Campbell Island) has been attributed to a slight warming of sea temperatures since the 1950s and change in the distribution of prey species (Cunningham & Moors 1994). Regular marine perturbations associated with the ENSO cycle may also affect penguin populations in some years. The affect of oceanic changes on Fiordland crested penguin populations is currently unknown. Avian cholera has caused the death of rockhopper penguin adults and chicks at Campbell Island. Similar diseases may be a problem also in Fiordland crested penguin colonies. For example, sandflies (*Austrosimulium ungulatum*) carry a protozoan blood-parasite *Leucocytozoon tawaki*, and penguin chicks in creches have been infected by the parasite (Fallis et al. 1976).

Previous Conservation Actions

1. The breeding biology, social organisation, social behaviour, and vocalisations of this species were studied at Jackson Head colony (Warham 1974a).
2. Weka and possums were eradicated from Whenua Hou by 1985 and 1987 respectively.
3. Norway rats were eradicated from Hawea and Breaksea Islands in 1986 and 1988 respectively.
4. The diet of Fiordland crested penguins was studied at Jackson's Bay and Martin's Bay in 1984 (van Heezik 1989) and on Whenua Hou (Marchant & Higgins 1990).
5. Aspects of the breeding biology and population dynamics of Fiordland crested penguins have been studied at the Open Bay Islands (McLean 1990, St Clair 1990, 1992, Studholme 1994). Methods of sexing Fiordland crested penguins were demonstrated by Murie et al. (1991).
6. A series of distribution surveys and population counts was conducted over the entire breeding range between 1990 and 1995 (McLean & Russ 1991, Russ et al. 1992, McLean et al. 1993, Maloney et al. 1993, Studholme et al. 1994, McLean et al. 1997).
7. Population monitoring was initiated by DOC (West Coast Conservancy) in 1994 at three colonies (Jackson's Head, Murphy Beach, Monro Beach) in South Westland. Breeding success is being monitored, and adults and chicks are banded annually for a study of the population dynamics. In 1998 and 1999, transponders were applied to a sample of birds to assess whether band loss is occurring or if carrying flipper bands increases mortality rates in this species.
8. Population monitoring is being carried out by DOC (Southland Conservancy) at several sites in Fiordland and Southland (Martins Bay, East and West Shelter Islands, Breaksea Island, Whenua Hou). Nest sites have been mapped and tagged, and counts made of nests with eggs and chicks. Pest control has occurred at some sites. The aim is to assess breeding success at sites with

different combinations of predators. Monitoring commenced in 1994 and will run for 5 consecutive years at each location (M. Willans pers. comm. 1998).

8. Blood samples have been collected throughout the breeding range of Fiordland crested penguins for a study of genetic relationships between each penguin colony (I. McLean pers. comm. 1996).

Future Management Actions Needed

H1. Weka should be eradicated from Big Solander Island.

H2. A management plan for the Open Bay Islands should be developed by DOC and the local iwi to address the problem of weka predation on Fiordland crested penguins (and other species).

H3. Guidelines are needed to control visitor access to mainland penguin colonies. Accessible sites should be protected as Wildlife Refuges. Controlled Dog Areas should be declared around all accessible sites where Fiordland crested penguins breed. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies.

M1. An advocacy programme is needed to encourage set net users to adopt practices that will minimise seabird bycatch. Restrictions on the use of set nets near key Fiordland crested penguin colonies may be necessary to protect this species.

M2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching offshore island colonies. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

Future Survey and Monitoring Needs

H1. Monitoring should continue at several key sites in South Westland, Fiordland, and on Whenua Hou over the next 10-15 years to determine trends in the population. This will indicate whether or not the decline detected on Open Bay Islands is occuring at other locations. Accurate counts of nests are needed at each long-term monitoring site. Each site should have a baseline of 5 consecutive years of counts. Count series should be repeated again at each site after a 5-year gap. As a minimum, these sites should be monitored for 2 consecutive years in the repeat sequence.

M1. Surveys are needed of coastal areas not covered in the 1990s survey. These are listed in McLean et al. (1997).

M2. A repeat national census should be made in 10-20 years' time if individual monitoring sites indicate that the population is in decline.

Research Priorities

H1. The population dynamics of Fiordland crested penguins are still poorly known. An analysis is needed of band recoveries from birds on the Open Bay Islands to determine minimum adult survival rates, juvenile survival, nest site, and mate fidelity. The Jackson's Head study by DOC is aiming to collect information on age of first pairing and breeding, survival and mortality of adults and juveniles, recruitment of chicks, and natal philopatry.

H2. The movements of Fiordland crested penguins during the breeding season are poorly known. Radio transmitters should be attached to birds to determine foraging range. Studies should be carried out on birds from South Westland, Breaksea Island, and Whenua Hou colonies. Dive depths and dive profiles also need to be determined from birds in each of these geographical regions. Food samples should be collected from adults to correlate foraging zone with diet. Food samples should be collected in several consecutive years to determine annual variations in the diet.

H3. The effects of introduced predators on penguin breeding success needs to be assessed by comparing sites with different combinations of predators and penguins in the same breeding season. In particular, information is needed from a predator-free site (e.g. Breaksea Island), sites with weka only (e.g. Open Bay Islands), and a mainland colony with stoats and rats (e.g. Jackson Head).

M1. The distribution and movements of Fiordland crested penguins during the non-breeding season are unknown. Satellite transmitters (maximum weight 80 g) should be attached to adults in February at the completion of moult. The dispersal of chicks in their first year at sea also needs to be examined.

L1. The breeding biology of Fiordland crested penguins has been studied in detail at Jackson Head (Warham 1974a). Information on the peak of laying, hatching, and fledgling is needed from other colonies to find out if the breeding cycle varies throughout the geographic range.

L2. The calls of Fiordland crested penguins were described by Warham (1975). Sexual, individual, and geographic variation in calls needs further study.

Snares Crested Penguin *Eudyptes robustus*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds only at the Snares Islands (Main, Broughton, Toru, Rima). Moulting birds have been seen ashore on Macquarie, Campbell, Antipodes, and Chatham Islands. Birds are occasionally seen on South Island and Stewart Island beaches. The species is a scarce vagrant to Australia and Tasmania. There are virtually no sightings at sea away from the breeding islands. The distribution or migration of birds during winter is unknown. However, one bird has been recorded at the Falkland Islands (Lamey 1990), suggesting the species disperses widely after breeding.

Population

The breeding population in 1985-86 was estimated to be 23,250 pairs (19,000 pairs on Main Island, 3500 on Broughton Island, and 750 on Rima and Toru Islets, Snares Western Chain). The total population was estimated to be c54,000 birds. Population trends are uncertain. Possibly the population is stable or has increased slightly since the 1960s (Marchant & Higgins 1990).

Threats

There are no mammalian predators at the Snares Islands. The islands are Nature Reserves and landing is restricted. Therefore human disturbance of colonies is minimal. The species could potentially be caught in trawl nets but there are no records of Snares crested penguins being caught in subantarctic waters by this fishing method. Competition with fisheries for prey species may be a potential threat. An oil spill near the colonies would be a significant potential threat to this species. Other crested penguins in the New Zealand region have undergone huge population declines since the 1940s. This has been attributed to a slight warming of sea temperatures since the 1950s and change in the distribution of prey species (Cunningham & Moors 1994). There is no evidence that the same phenomenon has affected the status of Snares crested penguins.

Previous Conservation Actions

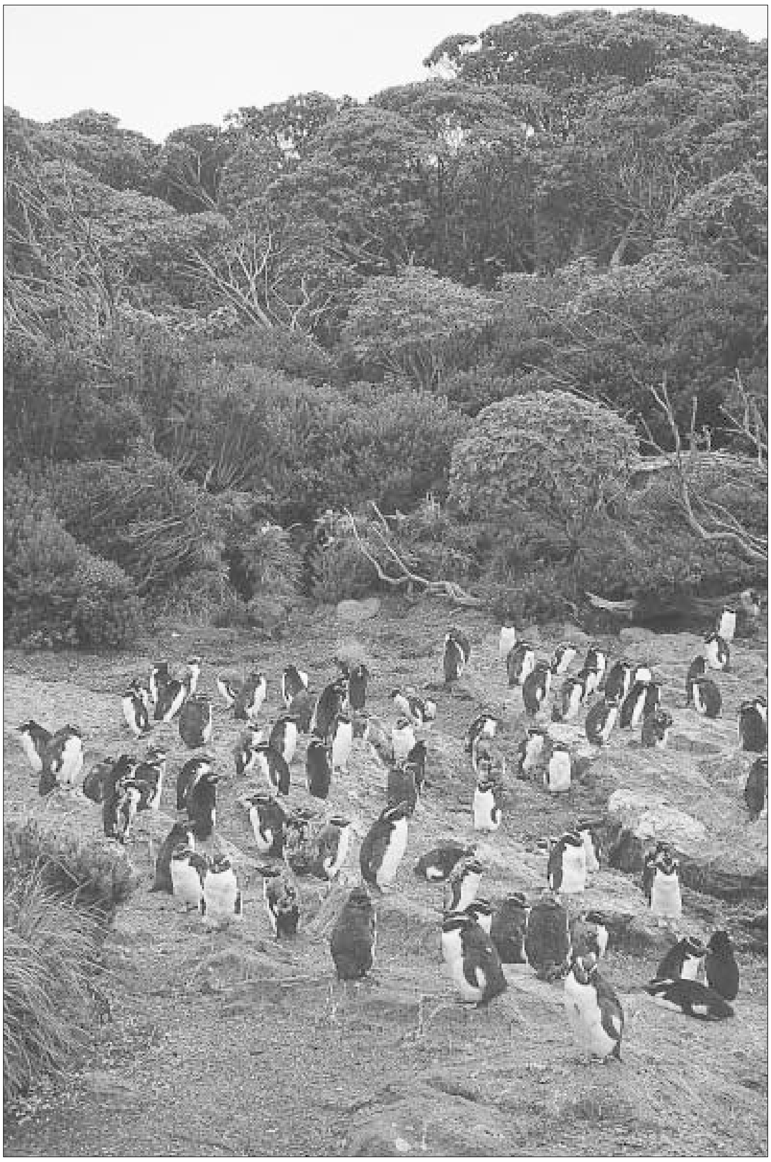
1. The breeding cycle, breeding biology, social behaviour, social organisation, and vocalisations of Snares crested penguins have been studied (Horning & Horning 1974, Warham 1974b, 1975).

2. The population on the Snares Western Chain was counted in February 1984 (Miskelly 1984). Further observations on the breeding cycle were made in December 1984 and January 1986. These demonstrated a 6-week difference in the breeding cycle between populations on the Western Chain and Main

Island. Measurements were also taken from birds nesting on both island groups (Miskelly 1997).

3. A census of Snares crested penguin chicks on Broughton Island and Main Island was made during the 1984/85 and 1985/86 seasons respectively. The number of breeding pairs on these islands was calculated from the chick counts and an estimate of breeding success per pair. A sample of chicks was banded in each season between 1982 and 1986 (Marchant & Higgins 1990).

4. Aspects of the breeding biology of Snares crested penguins were studied by Lamey (1992).



Snares crested penguin colony, The Snares Island, 1987

Snares crested penguins breed in small scattered colonies in *Olearia* forest on The Snares Islands. A census of the breeding population is needed during the incubation period to assess the current status of this species.

Future Management Actions Needed

M1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching The Snares. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

Future Survey and Monitoring Needs

H1. A census is needed of all breeding colonies in the Snares group. All previous counts have been conducted during the chick-rearing period. Counts are needed in October when adults are incubating eggs. The census should include all colonies in the Snares group. All banded birds seen during the island-wide census should be recaptured and rebanded.

M1. The census of breeding colonies should be repeated every 10 years to monitor trends in the population.

Research Priorities

H1. The population dynamics of Snares crested penguins still needs further study. Information is needed on age of first breeding, longevity, survival and mortality of adults and juveniles, recruitment of chicks, and natal philopatry. Potential problems include the difficulty of relocating returning juveniles in the large number of colonies present on the Snares Islands. Marking yearlings (with transponders or flipper bands) in November-January may also be helpful in establishing cohorts of known age because there appears to be a high level of mortality in the first year at sea.

M1. The diet of Snares crested penguins is still poorly known. Food samples should be collected from adult penguins feeding small, medium, and large chicks to determine seasonal variation in diet. Samples should also be collected in several consecutive years to determine annual variations in the diet. Dive depths and dive profiles also need to be determined.

M2. The distribution and movements of Snares crested penguins at sea is unknown. Satellite transmitters (maximum weight 75 g) should be attached to adults during incubation and chick-feeding periods to determine local foraging range. Information is also needed on movements prior to moult and winter dispersal of adults once moult is completed. The dispersal of chicks in their first year at sea also needs to be examined.

M3. The taxonomic status of the birds nesting on Snares Western Chain should be investigated. These birds apparently nest 6 weeks after the birds on the main islands and may be reproductively isolated.

L1. The chick-rearing period needs further study. There is little or no information on nestling period, chick growth rates, meal sizes, and feeding frequency by adults.

L2. The calls of Snares crested penguins were described by Warham (1975). Sexual and individual variation in calls needs further study.

Erect-crested Penguin *Eudyptes sclateri*

Conservation Status:	Endemic species
IUCN rank:	Endangered (A1a, B1+B2b, d, e)
Molloy and Davis rank:	Category B

Distribution

Breeds at Bounty Islands (Proclamation, Tunnel, Depot, Ruatara, Penguin, Lion, Spider, North Rock), Antipodes Islands (Antipodes, Bollons, Archway) and possibly Auckland Islands (Disappointment). Formerly bred at Campbell Island and on the South Island mainland at Taiaroa Head. The distribution at sea is poorly known. Birds moult ashore on all subantarctic islands in the New Zealand region, also South and Stewart Islands. Erect-crested penguins have been found ashore on Australian and North Island beaches. One bird was seen at the Falkland Islands between 1961 and 1966 (Woods 1988).

Population

There were an estimated 115,000 pairs on the Bounty Islands in 1978 (Robertson & Van Tets 1982). A ground count of nests on Proclamation Island (Bounty Islands) in November 1997 found 2774 breeding pairs (Clark et al. 1998). Andrea Booth & Jacinda Amey (pers. comm. 1999) estimated that there were 27,956 pairs of erect-crested penguins on the Bounty Islands in 1997 using the formula of 139,780 m^2 of suitable nesting habitat in the Bounty group and an average nest density of 0.20 pairs per m^2. Unfortunately, the 1978 and 1997 expeditions had different base maps for calculating island areas and therefore had different estimates of the areas of suitable nesting habitat. This limits the usefulness of direct comparisons between the two estimates.

The population at Antipodes Island in 1978 was thought to be similar in size to that on Bounty Islands in 1978 (Marchant & Higgins 1990) but recent surveys (1995) of all accessible colonies indicated a population of about 49,000 to 57,000 pairs (A. Tennyson & G. Taylor unpub.). Comparisons of photographs taken in 1978 and 1995 show an obvious contraction in colony areas at some sites. These indicate that the population has declined substantially in the past 20 years. One pair was found breeding on Disappointment Island in 1976 (Bartle & Paulin 1986). About 20-30 pairs occupied nest sites on Campbell Island in 1986-87 but no eggs or chicks were seen (Marchant & Higgins 1990). A few hundred birds formerly bred on Campbell Island in the 1940s (Bailey & Sorensen 1962). The total world breeding population of this species now appears to be about 81,000 pairs (±4000 pairs).

Threats

There are no mammalian predators at the Bounty Islands, Bollons, Archway, and Disappointment Islands. Only mice are present on Antipodes Island. Norway rats are present on Campbell Island. Feral sheep and cattle were formerly present, and feral cats may now be extinct (Moore 1997). The impact of these predators and browsers on erect-crested penguin breeding pairs was never studied. Presumably, erect-crested penguin chicks were killed by Norway rats, the same way that some rockhopper penguins chicks are taken each season. All the islands are Nature Reserves and landing is restricted at all sites except Campbell Island, which has a tourist visitor quota. Human disturbance of penguin colonies is minimal.

The decline of rockhopper penguins at Campbell Island has been attributed to a slight warming of sea temperatures since the 1950s and change in the distribution of prey species (Cunningham & Moors 1994). These changes may also be having an impact on erect-crested penguin colonies.

The species could potentially be caught in trawl nets, but there are no records of erect-crested penguins being caught by this, or any other fishing method. Competition with fisheries for prey species may be a potential threat. An oil spill near the colonies would be a significant potential threat to this species. Avian disease has not been recorded in erect-crested penguin populations but ticks and bird fleas (likely disease vectors) are found in the colonies. Avian cholera caused the deaths of rockhopper penguin adults and chicks in the 1980s (de Lisle et al. 1990), and disease could also occur in erect-crested penguin colonies in some seasons.

Erect-crested penguin pair at nest, Antipodes Island, 1995

Previous Conservation Actions

1. Aspects of the breeding biology, social organisation, social behaviour, and vocalisations of this species have been studied at Taiaroa Head (Richdale 1941b, 1950a), Antipodes Island (Warham 1972b), and Bounty Islands (Robertson & Van Tets 1982).
2. The distribution, nesting density, and abundance of erect-crested penguins was determined at the Bounty Islands in 1978 (Robertson & Van Tets 1982).
3. Cattle and sheep were eradicated from Campbell Island by 1984 and 1992 respectively.
4. The laying period and fate of first eggs was studied at Antipodes Island by Miskelly et al. (1990).
5. A census of breeding colonies was carried out on Antipodes Island in 1995. Information was also collected on the hatching period, and a study colony of banded adults was established in Anchorage Bay to monitor annual survival rates of adults (A.Tennyson & G.Taylor unpub.).
6. The breeding biology of erect-crested penguins was studied at Antipodes Island from September to November 1998 (L. Davis, Otago University). The research covered mating patterns, parental relationships to chicks (DNA), causes of breeding failure (including egg rejection), and diet. A partial census

was also carried out which indicated a continuing decline in numbers since the 1995 expedition.

7. Birds breeding on Proclamation Island (Bounty Islands) were censused in 1997 and data were collected on hatching dates and breeding success up to January 1998 (Clark et al. 1998). The total population of erect-crested penguins nesting at the Bounty Islands was estimated (A. Booth & J. Amey pers. comm. 1999).

Future Management Actions Needed

M1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching offshore islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

L1. Norway rats should be eradicated from Campbell Island. An eradication plan is currently being developed.

L2. Feral cats and pigs should be eradicated from Auckland Island.

L3. Mice should be eradicated from main Antipodes Island and main Auckland Island.

Future Survey and Monitoring Needs

H1. A sample of colonies should be ground counted at Antipodes Island every 5 years to monitor trends in the population. Photopoints from the 1978 and 1995 expeditions should be re-photographed at 5-yearly intervals.

H2. A repeat census of penguin nests on Proclamation Island (Bounty Islands) should be carried out every 5 years (in October or November when adults are incubating eggs) to monitor trends in this population.

H3. Aerial surveys and photographs should also be taken at the same time as the ground surveys on Bounty Islands to establish if aerial photography is a viable option for monitoring penguin colonies at this location.

M1. Surveys are needed at Disappointment, Campbell, and Auckland Island penguin colonies to see if any erect-crested penguins still nest at these locations. Surveys should be done between mid-October and mid-November.

M2. An accurate census should be made of all penguin colonies at the Antipodes and Bounty Islands at 10-20 year intervals.

Research Priorities

H1. The diet of erect-crested penguins is virtually unknown. Food samples should be collected from adult penguins feeding small, medium, and large chicks to determine seasonal variation in diet. Samples should also be collected in several consecutive years to determine annual variations in the diet. Dive depths and dive profiles also need to be determined.

H2.The distribution and movements of erect-crested penguins at sea is unknown. Satellite transmitters (maximum weight 100 g) should be attached to adults during incubation and chick feeding periods to determine local foraging range. Information is also needed on movements prior to moult and winter dispersal of adults once moult is completed.The dispersal of chicks in their first year at sea also needs to be examined.

H3. Research is needed on the distribution of prey species taken by crested penguin species to identify spatial variations in the distribution of prey, (i.e. correlate prey distribution with sea surface temperatures, underwater topography, and nutrient levels), and to assess seasonal and annual variation in prey distribution.

H4. The breeding biology of erect-crested penguins needs further study. In particular, studies are needed on chick growth rates, meal sizes and feeding frequency by adults, weights of chicks at fledging, and breeding success.

H5. The population dynamics of erect-crested penguins are unknown. Information is needed on age of first pairing and breeding, longevity, survival and mortality of adults and juveniles, recruitment of chicks, and natal philopatry. Information is also needed on nest site and mate fidelity. Potential problems include the difficulty of relocating returning juveniles in the large number of colonies present on the Antipodes Islands. The banded pairs at Anchorage Bay colony should be monitored and at least three cohorts of chicks need to be marked with flipper bands or transponders.

M1. The hatching period of erect-crested penguins is well known, but further information is needed on laying dates, incubation period, incubation shifts, and nestling period.

L1. The calls of erect-crested penguins were described by Warham (1975) but sexual, individual, and geographic variation in calls needs further study.The social behaviour and social organisation of erected-crested penguins prior to egg-laying is poorly known and needs further research.

Erect-crested penguin colony, Antipodes Island, 1995

Comparisons of photographs taken in 1978 and 1995 at Antipodes Island show a contraction in colony areas at some sites.These indicate that the erect-crested penguin population has declined substantially in the past 20 years. Sea temperature warming is likely to be a factor in the decline.

White-flippered Penguin *Eudyptula minor albosignata*

Conservation Status: Endemic subspecies

IUCN rank: Endangered (A1c,e, B1, B2a,b,e)

Molloy and Davis rank: Category B

Distribution

Breeds on Motunau Island and on Banks Peninsula, Canterbury. Birds disperse locally around eastern South Island (Otago to Cook Strait) (Challies 1998).

Population

Robertson & Bell (1984) estimated that there were 5000-10,000 pairs of white-flippered penguins. The most recent estimate of the total population is 2200 pairs (Challies 1998). A survey of Motunau Island in 1962 located 1100 penguin burrows (Cox et al. 1967). The most recent estimate on Motunau Island is 1650 breeding pairs, a modest increase since the 1960s (Challies 1998). The latest estimate for Banks Peninsula is a population of about 550 pairs. The numbers on Banks Peninsula have declined by at least 60-70% between 1980 and 1993 (Challies 1998).

Threats

The key land-based threats to white-flippered penguins are predation by ferrets and probably stoats and feral cats (Challies 1998). Ferrets take eggs and chicks and sometimes kill adult penguins. Ferret numbers are highest when rabbit populations peak. The fluctuating effort to control rabbits therefore has a direct effect on penguin survival on the mainland. Unrestrained dogs readily attack and kill adult penguins and chicks. Penguins are most vulnerable when moving between the sea and their burrow. People walking dogs at night in penguin habitat present a risk to this species. Most colonies are currently inaccessible to dogs and consequently dogs are only a local threat (Challies 1998). Rodent species don't appear to be a threat because adult penguins closely guard eggs and chicks. Cattle and sheep may potentially trample a few nests but usually penguins nest in sites which are not easily damaged (e.g. rock crevices, sea caves, hollows amongst tree roots). Fires are a potential risk to penguins especially during the moult (December to February). A few penguins may be squashed or injured by cars when crossing roads.

At sea, white-flippered penguins have been caught frequently in near-shore set nets, especially around Motunau Island (Challies 1998). The subspecies is unlikely to be captured by trawling or line fishing techniques. Most prey items are taken from the sea floor. There is no evidence that commercial or recreational fishing is impacting on prey availability. White-flippered penguins mainly eat small shoaling fish such as pilchards and anchovies (Marchant & Higgins 1990). Little is known about the possible effects of pollutants such as plastics and chemical contaminants. A large oil spill is a key potential threat to this subspecies. The birds nest in areas with moderate shipping volume (Port Lyttelton). Recent oil spills in Australia (e.g. *Iron Baron* off Tasmania) have shown that blue penguins are a primary victim of oil spills (Hull et al. 1998).

Previous Conservation Actions

1. Rabbits were eradicated from Motunau Island in 1963 (Cox et al. 1967).
2. The size of the white-flippered penguin colony on Motunau Island was censused in 1962 (Cox et al. 1967).
3. Long-term studies of white-flippered penguin population dynamics and breeding biology have been carried out for 28 years on Motunau Island and Banks Peninsula by Chris Challies (see Challies 1998, Dennis 1999). Monitoring of colonies and large-scale chick banding (>15,000 birds) has occurred at key sites. Chick transfers have been carried out over the past 10 years to enhance declining mainland colonies (Challies 1998).The impact of predators on white-flippered penguin populations has been assessed and a range of privately funded conservation measures initiated. Predator trapping started in 1981 and is now carried out by a network of volunteers around Banks Peninsula. Artificial nest boxes are used by many white-flippered penguins breeding on the mainland. Two small predator-proof fences have also been erected to protect vulnerable colonies (Challies 1998, Dennis 1999).
4. The genetic relationships of white-flippered penguins was compared with three blue penguin populations (Meredith & Sin 1988a). Morphometric comparisons were also made between these penguin populations (Meredith & Sin 1988b).
5. The behaviour and social interactions of white-flippered penguins were studied on Motunau Island and Banks Peninsula (Waas 1988a,b, 1990, 1995).
6. A ban was placed on nets set overnight around Banks Peninsula and Motunau Island in 1993.According to Challies (1998) this has been widely disregarded.
7. The near-shore distribution and seasonal abundance of white-flippered penguins were studied around Banks Peninsula between 1993 and 1997 (Brager & Stanley 1999).

Future Management Actions Needed

E1. An advocacy programme is needed to encourage set net users to adopt practices that will minimise seabird bycatch. Restrictions in the use of set nets near key white-flippered penguin colonies may be necessary to protect this species.

H1. Regionally important colonies of white-flippered penguins on the mainland should be protected from predators.Artificial nest sites should be provided if the habitat has been modified by human activity. (Volunteers are currently undertaking these tasks at some mainland colonies.)

H2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching Motunau Island.A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

H3. Penguin colonies should be identified as sensitive areas in Tier 1 (site) and Tier 2 (regional) oil spill contingency plans. The plans should contain details of the location and size of all penguin colonies in the area, and the appropriate wildlife response should be planned on this basis.

M1. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies. Controlled Dog Areas should be designated at all accessible mainland breeding colonies.

Future Survey and Monitoring Needs

H1. Monitoring of population trends should continue at Motunau Island and Banks Peninsula. A repeat population census is needed at least every 5 years.

Research Priorities

H1. The taxonomy of white-flippered penguins is controversial. Six subspecies of blue penguin were described by Kinsky & Falla (1976). However, studies by Meredith & Sin (1988a, 1988b) did not support the separation into subspecies. These findings were adopted by Turbott (1990). Recently, the studies by Meredith & Sin have been criticised because they sampled only three of the six subspecies and did not sample penguins over a wide geographic range (Marchant & Higgins 1990). A major review of blue penguin taxonomy is needed using modern DNA techniques and a comparison of plumage, bare part colours, anatomy, body measurements, vocalisations, and body lice.

H2. The results of the long-term research programme carried out by Chris Challies needs to be formally published. The results most needed for conservation purposes are the nest predation studies, chick translocation experiments, and population demography studies.

H3. The foraging ecology and diet of white-flippered penguins has not been studied. Movements at sea should be studied using radio transmitters attached to adults during incubation and chick rearing to determine foraging range and dive frequency. Dive depths and dive profiles are unrecorded for this subspecies. Knowledge of these behaviours will help to assess the risk from set-nets. Seasonal and annual diet preferences also need research.

White-bellied Storm Petrel *Fregetta grallaria grallaria*

Conservation Status: Indigenous subspecies

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category O

Distribution

The subspecies has been confirmed breeding on Macauley and Curtis Islands, Kermadec group, and probably also breeds on Haszard Islet and Cheeseman Island. Elsewhere, breeds on Roach Island and other small stacks off Lord Howe Island.

Population

The size of the population in New Zealand is poorly known. Only one dead fledgling and several adults have been seen on Macauley Island. On Curtis Island, one chick was found in 1982 (C. Miskelly) and 23 adults were caught spotlighting in 1989 (Tennyson & Taylor 1990a). Robertson & Bell (1984) estimated there were less than 1000 breeding pairs. Outside New Zealand, the population on Roach Island is estimated to exceed 1000 pairs (Marchant & Higgins 1990).

Threats

The species only breeds on predator-free islands or sites inaccessible to predators. On Macauley Island, adults were seen prospecting on vertical cliff ledges inaccessible to Pacific rats (Taylor & Tennyson 1988). A fresh dead chick was found on top of the southern cliffs of Macauley Island in 1966 (O'Brien 1966) and a corpse was found on a cliff-ledge in 1970 (Bell 1970). White-bellied storm petrels have been killed by cats on Lord Howe Island (Marchant & Higgins 1990). Raoul Island has feral cats, Norway and Pacific rats. These species are likely to prevent the subspecies colonising this island. The introduction of new mammalian predators to Macauley or Curtis Islands would be disastrous for this tiny species, which nests on the surface amongst dense vegetation or in rock crevices. Fires are also likely to be devastating, especially if they occurred during the breeding season (incubation period probably January-April). Volcanic activity on Curtis Island could potentially wipe out the main breeding population in New Zealand. Visitor access to these islands needs to be strictly limited to reduce the risk of fires occurring.

Previous Conservation Actions

1. Feral goats were eradicated from Macauley Island by 1970.
2. White-bellied storm petrel chicks were found on Macauley Island in 1966 (O'Brien 1966) and Curtis Island in 1982 (C. Miskelly).
3. A white-bellied storm petrel corpse was found on a cliff-ledge on Macauley Island in 1970 (Bell 1970).

4. Spotlighting for storm petrels was undertaken on Macauley Island in 1988 and on Curtis Island in 1989. Twenty-four birds (from both islands) were captured, banded, measured, weighed, and their plumage patterns described (Taylor & Tennyson 1988, Tennyson & Taylor 1990a). No other studies have been carried out on the New Zealand breeding islands.

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Kermadec Islands, especially Curtis Island. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may have caused an introduction. Rodent quarantine measures are essential for protecting white-bellied storm petrels.

H2. Pacific rats should be eradicated from Macauley Island.

M1. Norway and Pacific rats, and feral cats should be eradicated from Raoul Island.

M2. A new colony of white-bellied storm petrels should be established on Raoul Island once predators are removed. This will probably require the transfer of chicks from Curtis Island and the use of a tape playback system to lure adult birds. The colony should be established in rocky ground (boulders, crevices) near the coast.

Future Survey and Monitoring Needs

H1. All islands in the Kermadec group should be inspected every 3-5 years to ensure that rodents and other introduced mammals have not colonised these islands.

H2. Surveys are needed of Haszard, Cheeseman, and the Meyer Islets to determine if white-bellied storm petrels breed on these islands. Nocturnal spotlighting and

White-bellied storm petrel, Macauley Island, 1988

On Macauley Island, adults have been seen prospecting on vertical cliff ledges inaccessible to Pacific rats. Plans to eradicate rats from this island in the near future should improve the conservation status of this species.

attracting birds to bright lights has been used previously to sight this species. Loud tape playback of their calls may also be productive. Best times to survey for this subspecies are from October to April.

H3. Surveys are needed on Macauley and Curtis Island to estimate the size of the breeding population. Because nest sites are likely to be dispersed and found on cliff ledges and in rocky crevices or under boulders, a direct count of nests is probably not achievable. Nests might be located by listening for birds calling from nest sites or by eliciting responses by using tape playback of calls. Alternatively, capturing birds by spotlighting and mark/recapture studies may provide an estimate of the total population visiting the breeding islands.

Research Priorities

L1. The taxonomy of the four subspecies of white-bellied storm petrels and the closely related black-bellied storm petrel need resolving to determine the validity of each subspecies and even if separation of the two species is justified. Investigation is also needed on the polymorphic plumages of birds breeding at the Kermadec and Lord Howe Islands. What variety of offspring are produced by birds of different colour phases?

L2. The subspecies (and species) is poorly known. The breeding biology has not been studied and there is virtually nothing recorded about the basic breeding cycle (months of year birds attend colonies and spread of laying, hatching, and fledging dates etc.). People visiting the breeding islands should record activity on breeding cycle and details of any nests found.

L3. The diet of this species has not been studied. Food samples should be collected whenever possible and sent to Dr Mike Imber (DOC, Wellington) for analysis.

L4. The population dynamics of white-bellied storm petrels are unknown. Research on this subspecies is not practical at the New Zealand breeding colonies. It may be more suitable to undertake these studies at the colonies at Lord Howe Island group, or on other subspecies.

Black-billed Gull *Larus bulleri*

Conservation Status: Endemic species

IUCN rank: Vulnerable (A1a +c)

Molloy and Davis rank: not listed

Distribution

The species breeds only in the North and South Islands, mainly inland on braided riverbeds in the South Island. The key South Island strongholds are in Southland (Mataura, Oreti, Aparima, and Waiau Rivers) and Canterbury (Ashburton, Opihi, and Waiau Rivers) (Powlesland 1998). The species nests on sandspits, shellbanks, margins of lakes, and riverflats in the North Island. Black-billed gulls have been expanding their range northwards in the past 30 years and now nest at the Kaipara and Manukau Harbours (Habraken 1997). Birds disperse widely after breeding with some recorded inland over farmland, lakes, and rivers while most flock at coastal estuaries and over inshore seas. Birds regularly visit Stewart Island and have straggled to The Snares Islands.

Population

Robertson & Bell (1984) estimated that there were 100,000 to 1 million breeding pairs in New Zealand. However, the Ornithological Society of New Zealand (OSNZ) censused breeding colonies throughout New Zealand during the 1995 and 1996 breeding seasons. A total of 43,000 nests was found in 1995 and 48,000 nests in 1996 (Powlesland 1998). The vast majority (78%) of black-billed gulls breed on Southland riverbeds (33,500 pairs in 1996). In contrast to the expansion of the species' breeding range in the North Island, black-billed gulls have declined substantially in numbers and breeding range throughout the South Island in the past 10-20 years. For example, there were 84,900 breeding birds counted on the Oreti River in 1974. The count dropped to 63,300 in 1986 and the population subsequently declined to 33,392 breeding birds in 1995 and 15,308 in 1997. The Aparima River had 50,800 birds in 1985 (W. Cooper pers. comm. 1999). Southland OSNZ counts show that a minimum of 57,000 breeding pairs were using Southland rivers in 1985/86 but this population had declined by at least 30% to 33,500 pairs in 1996. The populations in the upper Waitaki catchment have also declined between the 1960s and 1990s. Six rivers have lost all breeding colonies, and there has been a significant decline in breeding density on the Ahuriri River. Only 90-200 pairs still nested in this region during the early 1990s (Maloney 1999).

Threats

Introduced predators are likely to be a key threat. Mustelids (especially ferrets) and feral cats take eggs, chicks, and occasionally adults of many species nesting on braided riverbeds (Sanders 1997). Hedgehogs are an important egg predator in the upper Waitaki Basin and probably elsewhere (Sanders 1997). Other possible introduced predators on riverbeds include possums and Norway rats. Norway rats take eggs and chicks at some North Island sites (e.g. Lake Rotorua)

(G. Taylor pers. obs.). Australasian harriers may be a threat to chicks once they leave the nest. Human disturbance of nesting colonies is increasing in tandem with increased industrial and recreational use of South Island rivers and North Island coastal areas. The modification of rivers (e.g. channel straightening and flood banks adjacent to rivers to protect adjacent farmland, hydroelectric development, gravel extraction for roading, and extraction of water for irrigation schemes) have all had a detrimental impact on river-nesting bird populations (Maloney 1999). The extraction of gravel from riverbeds is a significant threat in Southland, and has contributed to nest site flooding and loss of breeding habitat. Occupied nests have also been destroyed in some operations (W. Cooper pers. comm. 1999). A few birds may be shot illegally.

Recreational activities by people are greatly increasing on riverbeds and at coastal sites. Four-wheel drive vehicles in particular are being used to access remote areas on rivers (K. Brown pers. comm. 1999). People walking, fishing, hunting, swimming, or picnicking near black-billed gull nests can also cause nest failure or abandonment if they spend too much time near the nests. Uncontrolled dogs associated with people using rivers and coastal zones are a threat to eggs and chicks. Grazing of riverbeds by stock (sheep and cattle) may occasionally cause disruption in colonies although stock can be beneficial (outside of the breeding season) by reducing weed levels on riverbeds. Black-billed gull nests on sandspits, shellbanks, and margins of lakes are sometimes flooded by spring tides and storms. Flooding of nests by swollen rivers is also a natural hazard but availability of suitable nesting habitat on many braided riverbeds has been restricted by the infestation of weeds, especially willows and Russell lupins (Maloney et al. 1997, 1999). Weed encroachment is a major threat, especially in lowland Canterbury rivers (O'Donnell 1992, R. Maloney pers. comm. 1999). Future hydro scheme developments on braided rivers or water extraction for irrigation are also important potential threats to this species.

There is no information available about the effects of pollutants or plastics on black-billed gull populations but some chemical residues are likely because birds frequently feed on insects in recently ploughed pasture (where pesticides are used) and occasionally scavenge food from people, or visit refuse tips.

Previous Conservation Actions

1. The breeding biology of black-billed gulls was studied at Sulphur Bay, Lake Rotorua (Reid & Reid 1965).

2. The breeding biology, social organisation, behaviour, and calls of black-billed gulls were studied at Taieri and Ashley Rivers (Beer 1965, 1966; Evans 1970, 1982a,b).

3. The movements of black-billed gulls from the Lake Rotorua colonies was studied by Innes & Taylor (1984).

4. A series of riverbed surveys in the 1970s and 1980s mapped the distribution and numbers of black-billed gulls in Canterbury (O'Donnell & Moore 1983, Robertson et al. 1983, 1984). Annual population counts were made on the Ashburton River between 1981 and 1990 (O'Donnell 1992). Surveys have also

been made of bird populations in the Upper Waitaki catchment in the 1960s and 1990s (Maloney et al. 1997, Maloney 1999).

5. Counts of breeding birds were made by OSNZ members on Southland rivers between 1974 and 1997 (W. Cooper pers. comm. 1999).

6. The habitat of black-billed gulls in the Mackenzie Basin is being protected as part of Project River Recovery (Hughey & Warren 1997). Willows are being removed to maintain and restore breeding habitat (Maloney et al. 1999). Project River Recovery is also carrying out predator research (establishing causes of nest losses, and studying hedgehog home range and diet) and is conducting a public awareness campaign to minimise the impacts of recreational users on riverbed fauna (K. Brown pers. comm. 1999).

7. A study of the breeding biology, breeding success, plumages, and movements of black-billed gulls at Manukau and Kaipara Harbours commenced in 1995 (Habraken 1997, Crocker & Habraken 1998).

8. The distribution and size of black-billed gull breeding populations was censused by OSNZ in 1995, 1996, and 1997 (Powlesland 1998).

9. A new colony of black-billed gulls breeding at the Ruamahanga River (Wairarapa) in 1998/99 was monitored by DOC and regional council staff (A. Rebergen pers. comm. 1999).

10. Black-billed gull chicks have been colour-banded at lowland Canterbury colonies by OSNZ members since 1997. The aim of this project is to study movements and dispersal, and to examine the breeding biology of known-aged birds (Crocker & Habraken 1998).

Future Management Actions Needed

E1. Further loss of braided river habitat will have a detrimental impact on black-billed gull populations. Any proposals to establish further hydro-dams, remove gravel from riverbeds, or remove water for irrigation should be closely examined to see how they might impact on black-billed gull populations using that river.

H1. Nest protection may be needed at key colonies, especially if future research indicates that breeding success is adversely affected by introduced predators. In particular, nest protection may be needed in sites where rabbit populations have been reduced.

H2. Spraying or mechanical extraction of weeds on riverbeds may be required at sites outside of the upper Waitaki Basin if suitable nesting habitat continues to be lost to weed infestation.

M1. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting bird colonies. Controlled Dog Areas should be designated at all regionally significant breeding sites used regularly by black-billed gulls (especially in the North Island).

M2. Off-road users need to be informed and educated about the potential impacts of taking 4WD vehicles and motorbikes on riverbeds and beaches during the breeding season of gulls and other bird species.

Future Survey and Monitoring Needs

H1. The populations breeding on the Ashburton, Aparima, Mataura, and Oreti Rivers ideally should be monitored annually in November or December. Otherwise, at least two consecutive annual counts of breeding pairs should made every 5 years to establish population trends.

M1. Black-billed gull population trends should be monitored by regular counts at several North Island sites (ideally annual counts). Key sites include Lake Rotorua, Manukau and Kaipara Harbours, and Miranda. A count of all nesting pairs is needed between November and January.

M2. The OSNZ national census of black-billed gull breeding colonies and pairs should be repeated at least every 10 years.

Research Priorities

H1. More information is needed on breeding success of South Island birds to determine which factors have the most influence on annual breeding success. In particular, do mammalian predators and/or large black-backed gull colonies impact on breeding success?

H2. The population dynamics of black-billed gulls are unknown. Information is needed on age of first breeding, adult survival rates, juvenile recruitment and survival, natal site fidelity, pair bond fidelity, and species longevity.

H3. Research is needed on the movements of black-billed gull populations within and between braided river systems to determine the fidelity of individuals to breeding sites and river systems. Do birds stay together as colonial groups even if they change breeding sites? Adults need to be colour-banded to assess the extent of local movements.

L1. The movements of black-billed gulls after the breeding season needs more detailed study, especially birds nesting in the South Island. Adults and chicks need to be colour-banded to determine if individuals from the same colony stay together after breeding, whether birds go to the same winter quarters each year, and do juveniles remain with adults over the winter?

L2. The seasonal and annual changes in plumages and bare parts in breeding and non-breeding adults, chicks, first- and second-year birds still need critical description. These changes should be documented from colour-banded birds of known age.

L3. The growth rates of black-billed gull chicks have not been assessed. Research is needed to assess the effect of multiple clutches on growth rate and the mechanisms of brood reduction in this species. The role of parents and non-breeders during creching of chicks also needs investigation.

L4. Very few adult and juvenile black-billed gulls have been weighed. Weights are needed to collect information on seasonal and annual condition of gull populations.

Campbell Island Shag *Leucocarbo campbelli*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds only on Campbell Island and adjacent offshore islands and stacks. Birds disperse over adjacent seas generally within 10 km of the main island (G. Taylor pers. obs.).

Population

In 1975, 1300 nests were counted in a census of all colonies on Campbell Island. The breeding population was estimated to be 2000 pairs and the total population (breeding and non-breeding) was considered to be about 8000 birds (van Tets 1980). Robertson & Bell (1984) estimated that there were less than 1000 breeding pairs.

Threats

There are no apparent threats to the population of Campbell Island shags. Norway rats are present on Campbell Island but observations made in 1984/85 (G. Taylor unpub.) suggest they had little or no effect on shag breeding success. Campbell Island shags nest on ledges on vertical cliffs, which probably limited the impact of feral cats. There have been no cat sightings on Campbell Island since 1985 and the population may have died out (Moore 1997). Sheep and cattle were unlikely to have had access to nesting colonies in the past but may have restricted some colonies from expanding out onto vegetated ledges adjacent to cliff breeding sites. Visitors pose no threat to the species. Fishing is not permitted within the species' natural range so there is no problem with fisheries bycatch. Potentially the main threat would be a large oil spill near Campbell Island, but the chances of this occurring are very low.

Previous Conservation Actions

1. The distribution of nesting colonies was surveyed in 1975 and an estimate made of the breeding population (van Tets 1980).
2. Nesting behaviour and displays were studied by G. van Tets in 1975 (Marchant & Higgins 1990).
3. Cattle and sheep were eradicated by 1984 and 1991 respectively.

Future Management Actions Needed

M1. Norway rats should be eradicated from Campbell Island.

M2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching Campbell Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may have caused an introduction.

Future Survey and Monitoring Needs

H1. A repeat census of the breeding population should be undertaken in the next 5 years to compare with the population estimate from 1975. This should be a comprehensive island-wide survey including visits to the offshore stacks. Best timing is early spring (October-November).

Research Priorities

L1. The Campbell Island shag is a poorly known species. There has been no research on the basic ecology or breeding biology of this species. Social organisation and behaviour are little known, and there have been no studies on vocalisations. The timing of breeding, laying dates, descriptions of eggs and nestlings, incubation period, incubation shifts, chick growth rates and nestling period, post fledgling dependence period etc. are all unknown and need study.

L2. The diet of the Campbell Island shag is unknown. Research is needed on types of food eaten, foraging range, dive profiles, and seasonal variation in diet and foraging activity.

L3. The taxonomy of all the subantarctic shags and the pink-footed (*Leucocarbo*) shag species (king shag, Chatham Island shag, and Stewart Island shag) needs reviewing to determine relationships. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

L4. The population dynamics of all subantarctic shags are unknown. There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. This information would be nearly impossible to collect at Campbell Island owing to difficulty in getting access to nest sites and catching adult birds. A study is best undertaken on the closely related Stewart Island shag or on Auckland Island shags at Enderby Island.

New Zealand King Shag *Leucocarbo carunculatus*

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (D1 + D2)
Molloy and Davis rank:	Category B

Distribution

Breeds only on islands in the Marlborough Sounds, South Island. Colonies occur at Duffers Reef, North Trios (2 sites), Sentinel Rock, and White Rocks. King shags formerly bred at D'Urville Peninsula and on Te Kuru Kuru (Stewart) Island. The species is mostly confined to the Cook Strait region but a few birds have been observed on the South Island coast at Farewell Spit and Oamaru.

Population

The population was estimated in Marchant & Higgins (1990) as less than 300 birds. Recent surveys by Schuckard (1994) censused the total population of this species for the first time. He found 524 birds and 166 nests at five breeding colonies in 1992.

Threats

All nesting colonies are found on predator-free islands although ship rats briefly colonised Duffers Reef but were eradicated by 1983 (Murphy 1984). King shags are highly vulnerable to human disturbance and do not tolerate people landing on breeding islands or even the close approach of boats (within 100 m). Commercial fishing boats, tourist charter boats and leisure craft and yachts can therefore have a significant impact on breeding success. Low flying aircraft also disturb the birds. There is a slight risk to this species from fishing techniques such as line-fishing and trawling. Bottom feeding shag species are sometimes caught in crayfish pots and this may pose a slight risk. However, set-netting, especially near the breeding colonies, presents a major risk to this species. King shags are sometimes shot illegally to supposedly protect local fish stocks. The risk of oil spills is moderately high owing to the volume of shipping through Cook Strait and in the Marlborough Sounds.

Previous Conservation Actions

1. Counts have been conducted at breeding colonies in the 1950s, 1960s, and recently in the 1980s. Some observations on breeding biology were made during these surveys (Nelson 1971, Marchant & Higgins 1990).
2. Ship rats were eradicated from Duffers Reef in 1983 (Murphy 1984).
3. A complete census of the total population of king shags was carried out in 1992. Studies were also conducted on foraging range and diving behaviour, and daily and seasonal movements from colonies (Schuckard 1994).
4. The diet of king shags in Pelorus Sound was studied by Lalas & Brown (1998).

Future Management Actions Needed

E1. All breeding grounds need to be legally protected and a code of practise adopted with local commercial charter-boat operators and fishers to minimise disturbance of colonies. It is recommended that no boat approach closer than 100 m from the colonies during the breeding season (March to August). Educational material should be made available to local (Nelson, Marlborough, Wellington) boat and yacht clubs pointing out the threatened status of this species and the risk of disturbing the birds by approaching too closely to nesting colonies.

H1. An advocacy programme is needed to encourage set net users to adopt practices that will minimise seabird bycatch. Restrictions in the use of set nets near king shag colonies may be necessary to protect this species.

H2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching king shag breeding colonies. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. Techniques need to be developed to establish shags at new colony sites. The most promising techniques probably include using models and tape recordings to lure birds to new colony sites.

Future Survey and Monitoring Needs

H1. A census of each breeding colony should be carried out at 5-year intervals using the methodology described in Schuckard (1994).

Research Priorities

H1. The population dynamics of all New Zealand pink-footed (*Leucocarbo*) shags are unknown. There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. The population of king shags may be too small and sensitive to collect this information. Initially the studies should be started on Stewart Island or Auckland Island shags. However, banding cohorts of king shag chicks with a single colour-band for each year class and a second colour for each colony site may be possible and should be considered if disturbance of birds can be minimised. This information will help to determine the extent of inter-colony movement and indicate any differences in recruitment rates of chicks into each breeding population. Banding will also establish whether or not breeding adults remain faithful to the same nesting colony.

H2. The breeding biology of king shags has not been studied in any detail. The timing of the breeding season (pairs displaying at nests, eggs or chicks present) and laying dates (months of year that eggs are laid), descriptions of nests, eggs and nestlings, and clutch size have been partly studied but need more detailed observations. There is no information on incubation period and shifts, chick growth rates and nestling period, post fledgling dependence period etc. The opportunity to research these parameters of the breeding cycle will depend on either developing remote study techniques (nest cameras, weighing platforms etc.) or an acceptance that limited research will temporarily impact on the birds. Alternatively, some of this information may be collected from closely related species, e.g. Chatham Island shag, Stewart Island shag.

L1. The taxonomy of all the subantarctic shags and other pink-footed (*Leucocarbo*) shag species in New Zealand (e.g. Chatham Island shag and Stewart Island shag) needs reviewing to determine relationships. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

L2. The diet of king shags was examined by Lalas & Brown (1998). However, annual and geographical variations in the diet still need to be assessed. Every opportunity should be taken to collect diet samples (e.g. regurgitations or pellets from adults or chicks, or stomach contents of drowned birds or corpses found on the breeding grounds).

King shags at Duffers Reef. Photo: A.Cox

King shags nest only in the Marlborough Sounds, South Island. Surveys in 1992 found 524 birds and 166 nests at five breeding colonies.

Stewart Island Shag *Leucocarbo chalconotus*

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (C2a)
Molloy and Davis rank:	Category C

Distribution

Breeds only in southern New Zealand. The species is found between Timaru and Foveaux Strait. Colonies occur at Maukiekie Island (Moeraki); Wharekakahu Island, Taiaroa Head (Otago Peninsula); Green Island (near Dunedin) (Lalas 1993); Papa-kaha (Bluff Harbour); and in Foveaux Strait [Omaui, Pig, Whero, Jacky Lee, Kane-te-toe, Rarotoka (Centre), Whenua Hou (Codfish Island) and Zero Rock] (Marchant & Higgins 1990, Cooper & McClelland 1992, W. Cooper pers. comm. 1999). Birds disperse locally over shallow coastal inshore waters (within 15 km of land).

Population

Robertson & Bell (1984) estimated there were 1000 to 5000 pairs of Stewart Island shags. Lalas (1983) carried out the only national census of all breeding locations of this species in a single year (1981) and found 1800-2000 breeding pairs. There were 900-1000 pairs in Otago and 900-1000 pairs in Southland in 1981 (Lalas 1983, 1993). The population in the Otago region increased rapidly from 950 breeding pairs in 1979/80 to 1850 pairs in 1987/88, and breeding range also expanded during the 1980s. Numbers dropped after a failed breeding season in 1990/91, and the Otago population was estimated to be 1500 pairs in 1992/93 (Lalas 1993). The species is capricious in its choice of breeding sites and will abandon old colonies and establish at new sites (Watt 1975). The breeding population on Kanetetoe Island declined from 400-500 pairs in 1911 to 15 pairs in 1968. The population on Rarotoka Island declined from over 600 nests in 1955 to a total population of "no more than 600 birds" in 1975 (Watt 1975). Only 25 nests were present in 1991 (Cooper 1991). Lalas (1993) showed that some birds moved from the Taiaroa Head colony to a new colony site on Wharekakahu Island in 1980, and the colony on Green Island rapidly expanded in the early 1980s.

Threats

Most nesting colonies are found on predator-free islands although the colony at Taiaroa Head is on the mainland and is exposed to mustelids, cats, and rodents. The species is also very sensitive to human disturbance and will temporarily abandon nests if disturbed on the breeding colony. There is a small risk to this species from fishing techniques such as line-fishing and trawling. Bottom feeding shag species are sometimes caught in crayfish pots and this may be a slight risk for this species. Stewart Island shags are regularly caught as singletons in set nets. The current impact on this species from set-netting in Otago Harbour seems insignificant (Lalas 1993). However, set-netting near the breeding colonies presents a major risk to this species. The species is sometimes shot illegally to supposedly protect local fish stocks. The risk of oil spills is moderate owing to the relatively low volume of shipping through Foveaux Strait and around Otago Peninsula.

Previous Conservation Actions

1. Watt (1975) summarised changes in the populations of Stewart Island shags and the effects of shag colonies on island flora and fauna.
2. The feeding biology of Stewart Island shags was studied by Lalas (1983). The distribution and abundance of breeding colonies was assessed in 1981, and counts of Otago colonies were made between 1979 and 1993 (Lalas 1993).
3. Nest counts were made at colonies on Omaui, Pig, and Rarotoka Islands in the 1990s (Cooper 1991, Cooper & McClelland 1992, W. Cooper pers. comm 1999).

Future Management Actions Needed

H1. An advocacy programme is needed to encourage set net users to adopt practices that will minimise seabird bycatch. Restrictions in the use of set nets near Stewart Island shag colonies may be necessary to protect this species.

H2. Colonies at mainland sites should be protected from predators and fences used to exclude mammalian pests.

H3. Pest quarantine measures are needed to prevent new animal and plant pest species reaching offshore island shag colonies. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. All colonies need some form of legal protection (covenant areas, wildlife refuge, nature reserve) to protect birds from human disturbance. There is evidence that the species can become habituated to certain levels of disturbance but defining what is an appropriate level of disturbance needs further investigation.

M2. Techniques need to be developed to establish shags at new colony sites. The most promising techniques probably include using models and tape recordings to lure birds to new colony sites.

Future Survey and Monitoring Needs

H1. The current distribution and abundance of this species in Southland is poorly known. A survey is needed to locate all breeding colonies, and a census of breeding pairs is needed at each site.

M1. An annual count of numbers of nests present at one Otago colony should be made during the first half of November. All Otago colonies should be censused at 5-year intervals to determine trends in the numbers of birds using each colony site. Counts will need to be made from a boat at sea or from aerial photographs to reduce disturbance to nesting birds. A census of birds attending the breeding colonies should also be made by counting birds ashore at dawn or dusk. Annual nest counts at one or two colonies in Foveaux Strait should be made in November to monitor trends in this region.

L1.The entire national breeding population (number of nests and birds attending colonies) should be censused at 10-year intervals.

Research Priorities

H1.The population dynamics of all New Zealand pink-footed (*Leucocarbo*) shags are unknown.There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. Stewart Island shags may be one of the more accessible species to study long-term life history traits. Studies should consider either banding cohorts of chicks with a single colour-band for each year class or individually colour-banding chicks (or adults if they can be captured) so that on-going disturbance at the colony can be minimised.

H2. The social organisation of Stewart Island shags is little known. Work is especially needed to determine the impact of human disturbance on breeding success and fidelity to nesting sites.

L1. Very little is known about the breeding biology of Stewart Island shags. The timing of the breeding season (pairs displaying at nests, eggs or chicks present), laying dates (months of year that eggs are laid), descriptions of nests, eggs and nestlings, clutch size, incubation period and shifts, chick growth rates and nestling period, post fledgling dependence period etc. are poorly known or unstudied. Techniques to collect this information without causing undue disturbance of birds will need to be developed (remote video cameras, weighing platforms, and dataloggers etc. may need to used).

L2. The taxonomy of all the subantarctic shags and other pink-footed (*Leucocarbo*) shag species in New Zealand (e.g. king shag and Chatham Island shag) needs reviewing to determine relationships. Lalas (1993) has suggested that Stewart Island shags from the Otago region differ in size and plumage from those birds breeding in Southland. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice. In particular, the status of each plumage phase of Stewart Island shag needs attention.

L3. The behaviour (including vocalisations) of Stewart Island shags is virtually unknown and needs study.

Auckland Island Shag *Leucocarbo colensoi*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

The species breeds only at the Auckland Islands (including Enderby, Rose, Ewing, and Adams Islands). Birds disperse locally in bays and seas near the Auckland Islands.

Population

The total population is estimated as <1000 breeding pairs (Robertson & Bell 1984). A survey of the northern group of islands was carried out in February 1988. A minimum of 475 shag nests was found at 11 colonies on Enderby Island. The total breeding population on Enderby Island was estimated as at least 500 pairs (Taylor 1988). One colony of 62 nests was located on Rose Island. A very large colony with several hundred adults was found at the south-east end of Ewing Island (Taylor 1988). Moore & McClelland (1990) counted 306 nests on Ewing Island in 1989.

Threats

Feral cats and pigs may impact on nesting colonies or birds roosting on Auckland Island. Grazing by feral cattle and rabbits on Enderby and Rose Islands may have restricted colonies to sites on steep sea cliffs or ledges inaccessible to these species. Cattle also impacted on shags on Enderby Island by largely eliminating *Poa littorosa* tussock, a preferred nesting material. Both of these introduced mammals were eradicated in 1993. Fishing is not permitted within the species' natural range so there is no problem with fisheries bycatch. The main threat to the population would be a large oil spill near Enderby Island.

Previous Conservation Actions

1. Feral goats were eradicated from main Auckland Island in 1995.
2. Feral cattle and rabbits were eradicated from Enderby and Rose Islands in 1993.
3. Behavioural observations on Auckland Island shags were made by van Tets (1975).
4. The breeding colonies on Enderby, Rose and Ewing Islands were surveyed in 1988 and 1989 (Taylor 1988, Moore & McClelland 1990).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Auckland Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. Feral cats and pigs should be eradicated from main Auckland Island.

Future Survey and Monitoring Needs

H1. A thorough survey is needed of the entire Auckland Island coastline to locate all shag colonies and to count the number of nests at each site.

M1. A census of the entire adult shag population should be attempted once suitable methodology for counting breeding and non-breeding adults has been determined (possibly dawn or dusk counts of roosting birds).

L1. The breeding population at Enderby Island should be monitored every 10-20 years.

Research Priorities

M1. The population dynamics of all subantarctic shags are unknown. There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. The population at Enderby Island presents one of the few opportunities to study population dynamics of this group of shags because most Auckland Island birds nest in relatively accessible colonies or can be reached with suitable climbing gear. Non-breeding shags are tame and accessible at this site.

L1. The species is very poorly known. Further work is needed on social organisation and behaviour. The breeding biology of Auckland Island shags has not been studied in detail. The timing of breeding, laying dates, descriptions of nestlings, incubation shifts, chick growth rates and nestling period, post fledgling dependence period etc. are all unknown and need study.

L2. The taxonomy of all the subantarctic shags and other pink-footed (*Leucocarbo*) shag species in New Zealand (e.g. king shag, Chatham Island shag and Stewart Island shag) needs reviewing to determine relationships. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

Chatham Island Shag *Leucocarbo onslowi*

Conservation Status:	Endemic species
IUCN rank:	Endangered (B1 +2b,c,d)
Molloy and Davis rank:	Category B

Distribution

Breeds only at the Chatham Islands (Chatham, Rabbit Island, Star Keys). The species has not been recorded away from the Chatham Islands.

Population

Colony counts taken over the period 1937-1980 gave an estimate of 728-740 pairs, with birds nesting at 6-9 colony sites. Note that counts published for each site are inconsistent between Marchant & Higgins (1990) and Imber (1994). The first complete census of Chatham Island shag colonies located 842 breeding pairs at 10 sites in 1997 (M. Bell pers. comm. 1998).

Threats

The largest colonies occur at predator-free sites, but some colonies are still present on Chatham Island and are at risk from feral cats, weka, possums, pigs, sheep, cattle, dogs, and people. Disturbance by sheep, cattle, and people can lead to birds stampeding from nests with subsequent breakage of eggs or predation of nest contents by gulls. Fur seals also disturb birds nesting at the Star Keys and have occupied former colony sites there (M. Imber pers. comm. 1999). Occasionally, illegal shooting of shags is reported (M. Bell pers. comm. 1998). Fishing practises may potentially impact on this species, because birds are occasionally caught in crayfish pots (D. Bell pers. comm. 1998). The use of set nets, especially those placed close to breeding colonies, could be a future threat for this species. Oil spills from shipping accidents or oil exploration in the region are a potential but low risk threat in the near future.

Previous Conservation Actions

1. A census of all breeding pairs was completed in 1997 (M. Bell pers. comm. 1998).

Future Management Actions Needed

H1. Colonies on main Chatham Island should be protected from stock and feral pigs by fences if agreement is reached with local land-owners.

H2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the offshore island breeding colonies. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may have caused an introduction.

H3. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies.

M1.All nesting colonies should be given some form of legal protection (covenant, wildlife refuge) to limit disturbance by domestic stock and control visitor impacts.

Future Survey and Monitoring Needs

H1. The breeding population at one mainland colony (e.g. Matarakau or Motuhinahina Island) should be monitored annually to determine trends in the breeding population (number of breeding pairs).

H2. A census of the entire adult population (breeding and non-breeding birds) should be attempted once suitable methodology has been determined (possibly dawn or dusk counts of roosting birds).

M1. A comprehensive island-wide census is needed every 10 years.

Research Priorities

M1.The population dynamics of Chatham Island shags are unknown.There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. The Chatham Island shag population may be too small and sensitive to collect this information. Initially studies should be started on Stewart Island or Auckland Island shags. However, banding cohorts of Chatham Island shag chicks with a single colour-band for each year class and a colour-band for each colony site should be considered if disturbance can be minimised.

M2. The feeding ecology of this species is totally unknown. The diet needs studying and any food items regurgitated by adults or chicks, or pellets cast at roosts should be collected.The foraging behaviour could be studied to determine dive profiles and time spent foraging during breeding and non-breeding seasons.

L1. The biology of Chatham Island shags is very poorly known. Further work is needed on social organisation and behaviour and vocalisations. The breeding biology of Chatham Island shags has not been studied.The timing of the breeding season (pairs displaying at nests, eggs or chicks present), laying dates (months of year that eggs are laid), descriptions of nests, eggs and nestlings, clutch size, incubation period and shifts, chick growth rates and nestling period, post fledgling dependence period are all unknown and need study.

L2. The taxonomy of all the subantarctic shags and other pink-footed (*Leucocarbo*) shag species in New Zealand (e.g. king shag and Stewart Island shag) needs reviewing to determine relationships. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

Bounty Island Shag *Leucocarbo ranfurlyi*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds only at the Bounty Islands. Birds disperse locally over seas near the Bounty Islands.

However, two birds seen at Antipodes Island in 1950 were thought to be this species (Warham & Bell 1979).

Population

The total population is very small (569 breeding pairs in 1978). Colonies (expressed as breeding pairs) reported by Robertson & Van Tets (1982) were as follows: Proclamation, 20; Tunnel, 30; Depot, 11; Ranfurly, 66; Lion, 165; Spider, 12; Funnel, 64; Prion, 70; Coronet, 20; Molly Cap, 40; North Rock, 71). A total of 368 individual birds and 120 nests were counted on 13 islands in 1997/98 (Clark et al. 1998). It is not known whether the lower numbers of nests seen in 1997/98 were the result of different counting methods, differences in peak breeding times between years, or a real change in the numbers of birds at the Bounty Islands.

Threats

There are no current threats to Bounty Island shags other than the restricted breeding range. The Bounty Islands are free of introduced mammals and have no terrestrial vegetation. Fishing is not permitted within the species' natural range so there is no problem with fisheries bycatch. Potentially the main threat would be a large oil spill near the Bounty Islands but this seems unlikely in the near future unless oil prospecting commences in the region or there is a shipwreck.

Previous Conservation Actions

1. The distribution of colonies was surveyed in 1978 and a census was taken of breeding birds (Robertson & Van Tets 1982).
2. A count was made of shags roosting on islands and occupied nests were noted in 1997/98 from the yacht *Totorore* (Clark et al. 1998).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Bounty Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

Future Survey and Monitoring Needs

H1. The population should be monitored every 10 years including a census of nest sites and breeding pairs on all islands in the group.

Research Priorities

L1. The species is very poorly known. There has been very little study of social organisation, behaviour, and vocalisations. The breeding biology of Bounty Island shags has not been studied. The timing of breeding, laying dates, descriptions of eggs and nestlings, incubation period, incubation shifts, chick growth rates and nestling period, post fledgling dependence period are all unknown and need study.

L2. The taxonomy of all the subantarctic shags and other pink-footed (*Leucocarbo*) shag species in New Zealand (e.g. king shag, Chatham Island shag and Stewart Island shag) needs reviewing to determine relationships. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

L3. The population dynamics of all subantarctic shags are unknown. There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. This information would be nearly impossible to collect at the Bounty Islands owing to the difficulty in getting access to the islands and catching adult birds. A study is best undertaken on the closely related Stewart Island shag or on Auckland Island shags at Enderby Island.

Yellow-eyed penguin on nest, Campbell Island, 1986

The yellow-eyed penguin population has fluctuated markedly in recent years. The most serious mortality outbreak occurred during the summer of 1989/90, resulting in the deaths of at least 150 adult penguins at South Island colonies. Predation at nests by introduced mammals and changes in the marine environment are the main threats to this species. (See opposite.)

Yellow-eyed Penguin *Megadyptes antipodes*

Conservation Status: Endemic genus and species

IUCN rank: Vulnerable (B2c+B3d)

Molloy and Davis rank: Category B

Distribution

Breeds in eastern and southern South Island from Banks Peninsula to Bluff. Also breeds on Stewart Island and islands in Foveaux Strait, Whenua Hou, Auckland Islands (Enderby, Rose, Ewing, Ocean, Auckland, Adams) and Campbell Island. The species is confined to seas in the New Zealand region. Birds forage over the continental shelf. Yellow-eyed penguins occasionally disperse to the lower North Island and one bird has been resident at the Chatham Islands for at least 10 years (Imber 1994, G. Taylor pers. obs.).

Population

The yellow-eyed penguin population has fluctuated markedly in recent years (McKinlay 1998). Annual nest counts on the mainland began in 1981 and since that time, two significant mortality events have occurred (1986, 1990). The most serious mortality outbreak occurred during the summer of 1989/90, resulting in the deaths of at least 150 adult penguins at South Island colonies (Gill & Darby 1993). This was followed by a period of population growth at mainland colonies and the number of breeding pairs had recovered within 4 years (McKinlay 1998). A minor mortality event occurred in 1997. The mainland population has varied between 220 and 620 breeding pairs (Darby & Seddon 1990). The most recent estimate (from 1997) is 600-650 pairs (J. Darby in draft recovery plan). Moore (1992) estimated there were 470-600 breeding pairs in the Stewart Island/ Foveaux Strait region, 520-570 pairs on the Auckland Islands, and 490-600 pairs on Campbell Island. The estimates for Stewart Island and Auckland Islands are extrapolations whereas Campbell Island had an accurate census in 1988 (Moore and Moffat 1990b). Non-breeding birds make up about 40% of the total population (Richdale 1957). Moore (1992) estimated a total population of 5930 to 6970 birds in 1988/89.

Threats

Yellow-eyed penguins are susceptible to predation by introduced mammalian predators (Darby & Seddon 1990, Alterio et al. 1998, Ratz & Murphy 1999). Predation by feral cats and ferrets is the major cause of chick mortality at mainland colonies (Darby & Seddon 1990) and ferrets occasionally kill adult penguins at some mainland sites (B. McKinlay pers. comm. 1998). Stoats also kill chicks at mainland colonies (Alterio et al. 1998). Uncontrolled dogs have killed adults and chicks, and are an important threat at some mainland colonies. Feral pigs probably kill adults and chicks on Auckland Island and possibly at a few mainland colonies. Rats are not thought to be a problem because there was no evidence of egg or chick predation on Campbell Island in 1984/85 or 1987/88, a site where Norway rats are abundant (Taylor 1986, Moore & Moffat 1990b). There is no information on the effects of possums and hedgehogs though both are capable of taking eggs or small chicks. Weka may prey on eggs and chicks on a few colonies in Foveaux Strait and Stewart Island. Feral cattle, and to a lesser extent feral sheep, probably trampled a few nests on Enderby and Campbell Islands before these species were removed. Grazing of coastal margins by domestic cattle and sheep has removed much of the available penguin nesting habitat. Cattle also trample nests on the mainland, and in 1985, 29 of 41 nests were destroyed by cattle (J.T. Darby in Marchant & Higgins 1990). Fencing of habitats to exclude stock has been beneficial in removing the problem of trampling of nests but the subsequent growth of rank grass has increased predator densities around nest sites (Alterio et al. 1998, Ratz & Murphy 1999). Rabbits and rodents near mainland penguin colonies provide a year round food supply for mustelids and feral cats, increasing the risk of chick predation during the breeding season.

Fires are a potential hazard. A fire in coastal scrub at Te Rere Reserve in Southland in 1995 killed over 60 adult penguins (Sutherland 1999). The birds are at greatest risk during the moult (January to April) because they are unable to escape to sea. Yellow-eyed penguins are sensitive to human disturbance when landing at beaches and repeated visits to nest sites may cause some birds to abandon nest sites. Birds are particularly vulnerable to human disturbance during the moult phase.

The periodic adult deaths appear to be associated with periods of warmer than usual sea and land temperatures. The deaths were initially thought to be associated with temperature related changes such as shortage of prey species, biotoxins caused by algal blooms or increases in land-based viruses such as avian pox. Graczyk et al. (1995) examined the circumstances of these deaths and concluded that they were caused by an outbreak of avian malaria. Avian malaria antibodies were detected from all six yellow-eyed penguin populations from which blood samples were collected. The samples from birds that died had significantly higher absorbances than remaining samples and the circumstances of the deaths conformed with previous outbreaks of avian malaria that have occurred overseas (Graczyk et al. 1995).

At sea, yellow-eyed penguins have frequently been caught in near-shore set nets. Of 102 recaptures away from the colonies, 25% were taken from set nets (J.T. Darby in Marchant & Higgins 1990). The species forages over the continental shelf and may be at risk also from trawlers and purse-seiners. The species is unlikely to be captured by line-fishing techniques. Most prey items are taken from the sea floor (Moore et al. 1995, Moore in press b). There is no evidence that commercial or recreational fishing is impacting on prey availability. Little is known about the possible effects of pollutants such as plastics and chemical contaminants. However, these are unlikely to be much of a problem in the seas off southern New Zealand. An oil spill near the breeding colonies could have a major effect on this species. The sinking of the *Dong Won 529* off Stewart Island in October 1998 fortunately did not result in deaths of penguins (A. Cox pers. comm. 1998) but the risk of oil spills is clearly present.

Previous Conservation Actions

1. The breeding biology, population dynamics, social organisation, and behaviour of yellow-eyed penguins were studied by Richdale (1941a, 1945, 1946, 1947a,b, 1951, 1957).

2. Feral cattle and sheep were eradicated from Campbell Island by 1984 and 1991 respectively.

3. Weka and possums were eradicated from Whenua Hou (Codfish Island) in 1985 and 1987 respectively.

4. Feral cattle, rabbits, and mice were eradicated from Enderby Island in 1993.

5. Yellow-eyed penguins have been the object of a range of conservation management activities in the past 10-15 years. Much of this is summarised in the Yellow-eyed Penguin Species Conservation Strategy (Department of Conservation 1991). A review of research and monitoring studies during 1990-1991 was given by Moore (1991). Predator control is carried out annually at key breeding sites on the mainland (McKinlay et al. 1997). Habitat has been purchased or reserved for penguins on the Otago Peninsula, Catlins and in North Otago. Fencing and revegetation projects have also been carried out to restore nesting habitat. The Yellow-eyed Penguin Trust was formed in 1987 to raise public awareness of the plight of yellow-eyed penguins and to fund on-going conservation initiatives including reserve acquisition, land purchase, and creation of breeding habitat (McKinlay 1998).

6. A long-term study on population distribution, abundance, breeding success, and movements of yellow-eyed penguins has been carried out on the Otago Peninsula by J.T. Darby (Otago Museum) (Darby & Seddon 1990).

7. The breeding biology, social behaviour, dive depths, and diet of yellow-eyed penguins were studied in detail in the mid-1980s (Seddon 1988, 1989, van Heezik 1988, 1990, 1991, Seddon & van Heezik 1990, van Heezik & Davis 1990). Diet samples were obtained from adult and chick stomach contents from all major breeding sites.

8. The population genetics were examined by Triggs & Darby (1989) who found that each geographical grouping (South Island, Stewart Island, Auckland Islands, Campbell Island) was genetically discrete.

9. The distribution, abundance, breeding cycle, and breeding biology of this species were studied on Campbell Island (Moore & Moffat 1990b, Moore 1992, Amey & Moore 1995). Monitoring of numbers by beach counts at index sites continued from 1987-1997.

10. The distribution and population size of yellow-eyed penguins breeding at the Auckland Islands were surveyed in the late 1980s (Moore 1990, 1992).

11. The distribution and abundance of yellow-eyed penguins was surveyed on Banks Peninsula in 1988/89 (Dilks & Grindell 1990) and in later years.

12. A detailed assessment of foraging movements (range and activity), diving depths and profiles, diet and breeding success was carried out on the Otago

Peninsula and at the Catlins (Moore et al. 1991, 1995, Moore 1994, 1998, in press, Moore & Wakelin 1997).

13. A central database of all yellow-eyed penguin banding and breeding records was established and an analysis of banding recovery data was undertaken to determine population dynamics of birds in the 1980s and 1990s, including adult and juvenile survival, recruitment, and natal philopatry (Efford et al. 1994a, b, 1996, Efford & Spencer 1996).

14. Research on the effects of breeding habitat and predator guilds on survival and breeding success of yellow-eyed penguins has been carried out on Otago Peninsula (Alterio et al. 1998) and the Catlins (Ratz & Murphy 1999).

15. An experiment was conducted in 1992-94 to artificially reduce brood size to determine if this reduced reproductive costs and improved adult condition and post-breeding survival. This method may increase the ability of adults to survive post-breeding moult in years when food is in short supply (Edge 1996, Edge et al. 1999).

16. The influence of climatic events such as the El Nino weather pattern on the population dynamics of yellow-eyed penguins was investigated by Peacock (1995).

17. An updated recovery plan is currently being prepared by DOC Otago Conservancy (1998-99).

Future Management Actions Needed

E1. Habitat protection and restoration, fence maintenance and pest control should continue as prescribed in the draft recovery plan.

E2. An advocacy programme is needed to encourage set net users to adopt practices that will minimise seabird bycatch. Restrictions in the use of set nets near yellow-eyed penguin colonies may be necessary to protect this species.

H1. Controlled Dog Areas should be declared around all sites where yellow-eyed penguins breed. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies.

H2. Penguin colonies should be identified as sensitive areas in Tier 1 (site) and Tier 2 (regional) oil spill contingency plans. The plans should contain details of the location and size of all penguin colonies in the area and the appropriate wildlife response should be planned on this basis.

H3. Guidelines are needed to manage visitor access to mainland penguin colonies. Accessible sites could be protected as Wildlife Refuges.

M1. Feral pigs and cats should be eradicated from main Auckland Island.

M2. Norway rats should be eradicated from Campbell Island.

Future Survey and Monitoring Needs

H1. Monitoring of breeding pairs should continue annually on the Otago Peninsula and at Banks Peninsula. At remaining mainland sites, nest counts should be made at 5-year intervals. The numbers of birds landing at mainland beaches should be counted annually, using standardised techniques. An investigation is needed to examine the reliability of this counting method at mainland sites if it is to be used for future monitoring of population trends. Moore (1992) compared landing counts and nest numbers on Campbell Island. This study should be used as a model for similar comparative studies on the mainland.

H2. A survey is needed of yellow-eyed penguin landing beaches and nest sites on Stewart Island and adjacent islands in Foveaux Strait.

H3. A survey is needed of yellow-eyed penguins on main Auckland Island and Adams Island and an accurate estimate is needed of the breeding population at the Auckland Islands.

H4. Monitoring should continue at Campbell Island to detect changes in population abundance. Counts of birds landing at North-West Bay and South-East harbour beaches should be made over 3-4 consecutive years every decade using the techniques described by Moore & Moffat (1990b).

Research Priorities

H1. The study of yellow-eyed penguin population genetics needs to be completed to provide directions to managers on the importance of each sub-population.

H2. Publication of results from the long-term population study on Otago Peninsula and other South Island sites is needed to assist management of mainland populations. Some progress has been made by placing records in a computer database but further analysis is needed.

H3. A study is needed of the impact of fishing techniques, especially set-netting, on yellow-eyed penguin populations. In particular, the proportions of adults and juveniles killed in set-nets needs to be determined.

H4. The effects of introduced predators and marine perturbations on the breeding success of yellow-eyed penguins at Stewart Island and the Auckland Islands needs to be assessed.

M1. A study is needed of the impacts of supervised and unsupervised tourism on yellow-eyed penguin individuals and breeding populations.

M2. Investigate the factors that influence recruitment of immature penguins into breeding populations and investigate the factors that influence territory size and nest site selection.

M3. The breeding biology of yellow-eyed penguins has been studied in detail on the mainland and at Campbell Island. Information on the peak of laying, hatching, and fledgling is needed from pairs nesting at Stewart Island and Auckland Islands to find out if the breeding cycle varies throughout the geographic range of this species.

L1. A description of the calls of yellow-eyed penguins were published by Richdale (1957) and Marchant & Higgins (1990), but no studies have been made of sexual, individual, and geographic variation in calls.

Fulmar Prion *Pachyptila crassirostris crassirostris*

Conservation Status: Endemic subspecies

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category B

Distribution

Breeds at the Chatham Islands (The Pyramid, Forty-Fours), Snares Islands (Western Chain including Rima and Toru) and Bounty Islands (entire group). Birds disperse over sub-tropical and sub-antarctic seas but there are few records away from breeding colonies.

Population

Only a small population breeds at the Chatham Islands; estimated to be 1000-5000 pairs (Robertson & Bell 1984). At the Snares Western Chain there are an estimated 400-600 pairs (Miskelly 1984).The largest population of the subspecies is at the Bounty Islands where an estimated 76,000 pairs were present in 1978 (Robertson & van Tets 1982). A recent survey of Proclamation Island (Bounty Islands) in 1997 estimated 1235 pairs nesting on this island (Clark et al. 1998, A. Booth pers. comm. 1999).The total breeding population on the Bounty Islands in 1997 was estimated as 29,354 pairs (Booth & Schmechel, in prep.), based on an area of suitable breeding habitat of 139,780 m^2 and a nest density of 0.21 breeding pairs per m^2 (A. Booth pers. comm. 1999).

Threats

All known breeding islands are on barren rocky islands with sparse vegetation (Chathams, Snares Islands) or no vegetation (Bounty Islands). The birds nest in rock crevices, boulder screes, and in soil under albatross nests. All islands are free of introduced mammals. The introduction of rats is probably the main potential threat to these species, but the remoteness of the islands and the lack of vegetation make it unlikely that rats will reach or successfully colonise these islands. Large-scale harvesting of krill, oil pollution, contaminants, or plastics are possible threats facing the subspecies but are not considered a problem at present.

Previous Conservation Actions

1. The species has been virtually ignored in the past. A survey of the Bounty Islands in 1978 estimated the population at that site and made a few observations on breeding and habitat use (Robertson & van Tets 1982).

2. A recent survey (1997/98) on the Bounty Islands studied aspects of the breeding cycle and breeding biology of fulmar prions (egg laying period, egg and bird measurements, growth rates of young chicks, breeding success). A census of breeding pairs on Proclamation Island was completed during December (Clark et al. 1998).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the known breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting fulmar prions.

L1. Feral cats and weka should be removed from part or all of Pitt Island if suitable agreements are reached with the residents. Wild sheep, cattle, and pigs should be removed (by fencing?) from areas suitable for establishing seabird colonies.

L2. If safe colony sites are developed on Pitt Island, a tape playback system should be used to lure adult fulmar prions to a suitable colony site, e.g. Rangiauria. If necessary, chick translocations may be needed to establish the new colony.

Future Survey and Monitoring Needs

H1. Surveys are needed of small islands and stacks in the Chatham group not yet visited by seabird biologists to determine if fulmar prion colonies are present on these islands.

M1. Quantitative surveys are needed at each breeding site to confirm earlier estimates of the breeding populations at these locations.

Research Priorities

H1. A taxonomic revision is needed of fairy prion and fulmar prion populations. Confusion has arisen over separation of the species and subspecies in this group based on bill characters, plumage colour, and breeding ecology. In particular, the status of race *pyramidalis* needs investigation. This subspecies is used in the New Zealand checklist (Turbott 1990) but is discarded by Marchant & Higgins (1990). A modern analysis is needed using DNA techniques and examination of morphology, plumage, anatomy, vocalisations, and lice from each of the major geographic zones of both fairy prions and fulmar prions.

L1. Diet samples have been collected from a small number of individuals at the Chatham Islands. Information is needed on the diet of birds breeding at the Snares and Bounty Islands.

L2. The population dynamics of this subspecies are unknown. The remote breeding sites and extremely difficult access would make a long-term study impractical at these sites. A study of population dynamics could be carried out on race *eatoni* at the Auckland Islands or assume the species has a similar life history to fairy prions.

Lesser Fulmar Prion *Pachyptila crassirostris eatoni*

Conservation Status: Indigenous subspecies

IUCN rank: Data Deficient

Molloy and Davis rank: not listed

Distribution

Breeds at the Auckland Islands (Rose Island, and probably on Ocean and Ewing Islands). Elsewhere, breeds at Heard Island.

Population

The population at the Auckland Islands was estimated as 1000-5000 pairs (Robertson & Bell 1984). The population at Heard Island is estimated as 1000s of pairs (Marchant & Higgins 1990). Lesser fulmar prions are one of the least common petrel taxa breeding in New Zealand.

Threats

All breeding sites are free of introduced mammals although rabbits and cattle formerly occurred on Rose Island and sheep and goats on Ocean Island before 1945. These mammal species may have trampled nests that occurred in soil burrows. The chance introduction of rats is probably the main threat to this species. Large-scale harvesting of krill, oil pollution, contaminants, or plastics are possible threats facing the subspecies but are not considered a problem at present.

Previous Conservation Actions

1. No studies have been done on this subspecies in New Zealand. Birds were found on Rose and Ocean Island in the 1940s and some were spotlighted to ground at Ewing Island in February 1973. Breeding of this subspecies was suspected to occur amongst basalt rocks at the south-western point of Ewing Island (Bell 1975).
2. Rabbits were eradicated from Rose Island in 1993.

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Auckland Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures, in particular, are essential for protecting lesser fulmar prions.

M1. Feral cats and pigs should be eradicated from main Auckland Island.

Future Survey and Monitoring Needs

H1. Confirmation is needed that the subspecies still breeds at the Auckland Islands. Birds were last collected from nests in the 1940s. No birds have been found ashore on Ewing Island although it is listed as a breeding site. No lesser fulmar prions were seen on Ocean or Ewing Islands during night visits in February 1988 (Taylor 1988).

L1. A survey is needed of all predator-free islands in the Auckland Island group during November-January to locate further colonies of lesser fulmar prions. The subspecies may also breed in cliffs or caves on the main island that are inaccessible to feral cats and pigs.

L2. Estimates are needed of the breeding population of lesser fulmar prions at sites found in the above surveys.

Research Priorities

H1. A taxonomic revision is needed of fairy prion and fulmar prion populations. Confusion has arisen over separation of the species and subspecies in this group based on bill characters, plumage colour, and breeding ecology. A modern analysis is needed using DNA techniques and examination of morphology, plumage, anatomy, vocalisations, and lice from each of the major geographic zones of both fairy prions and fulmar prions.

L1. The breeding cycle and breeding biology of lesser fulmar prions are largely unknown. Information is needed on all aspects of breeding.

L2. Diet samples have been collected from a small number of individuals at Heard Island. Information is needed on the diet of birds breeding at the Auckland Islands.

L3. The population dynamics of this subspecies are unknown. The discovery of an accessible breeding population at the Auckland Islands, would provide the best opportunity to carry out a long-term study of fulmar prions. Otherwise, it will be necessary to assume that the species has a similar life history to fairy prions.

Kermadec Storm Petrel *Pelagodroma marina albiclunis*

Conservation Status: Endemic subspecies

IUCN rank: Data Deficient

Molloy and Davis rank: Category B

Distribution

The breeding grounds have not been discovered. The subspecies probably nests on cliffs on Macauley Island or on adjacent Haszard Islet in the Kermadec Islands group. Birds have been observed at sea off the Kermadec Islands, e.g. off Curtis Island, and possibly off Australia (Imber 1984b). The subspecies possibly bred in the past on Norfolk Island, but the sub-fossil white-faced storm petrel bones can not be separated to subspecies level.

Population

Unknown, probably very small (<100 pairs?). One was caught on Macauley Island in December 1988 (Tennyson et al. 1989) and several were seen at sea off Curtis Island in 1989 (Tennyson & Taylor 1990a). Four were captured at Sandy Bay, Macauley Island in August 1990 (L. Johnson pers. comm. 1990).

Threats

The subspecies probably formerly nested on Raoul and Norfolk Islands but presumably was extirpated from these sites by feral cats, Pacific rats (both islands), ship rats (Norfolk Island), and Norway rats (Raoul Island). Feral goats and Pacific rats probably pushed the subspecies off the plateau on Macauley Island. If birds are still present on Macauley, they will most likely be found nesting on cliff ledges where Pacific rats are absent. Competition for nest sites with the abundant and larger, more aggressive, black-winged petrel may also impact on the survival of this subspecies. Kermadec storm petrels are very vulnerable to any further introductions or the spread of mammalian predators to the islands in the Kermadec group. Fire is a threat to this subspecies if it occurs during the incubation period (likely to be mid-October to mid-December). Volcanic activity on Curtis Island may be a threat if the subspecies nests there or on nearby Cheeseman Island.

Kermadec storm petrel, Macauley Island, 1988

The breeding grounds of this subspecies of the white-faced storm petrel have not yet been discovered. The subspecies may nest on cliffs on Macauley Island or on adjacent Haszard Islet in the Kermadec Islands group.

Previous Conservation Actions

1. Feral goats were eradicated from Macauley Island by 1970.

2. The status of the subspecies has been controversial. Imber (1984b) and Marchant & Higgins (1990) considered that *albiclunis* might only be juveniles of the Australian subspecies of white-faced storm petrel which disperses into the north Tasman Sea in winter. However, the capture on Macauley Island in December 1988 of an adult bird with a white rump, bare brood patch and dirt on its bill (Tennyson et al. 1989) strongly indicates that white-faced storm petrels seen with white rumps near the Kermadec Islands belong to a distinct subspecies.

3. Surveys were carried out on Macauley Island in September and November/December 1988 and Curtis Island in October/November 1989 in an attempt to discover the breeding grounds (Taylor & Tennyson 1988, Tennyson et al. 1989, Tennyson & Taylor 1990a). No nest sites were found although one adult bird was attracted to a light on Macauley Island in 1988 and several were seen at sea off Curtis Island in 1989 (see above).

4. In August 1990, four birds were attracted to a light and captured in Sandy Bay, Macauley Island (L. Johnson pers. comm. 1990).

Future Management Actions Needed

E1. Pacific rats should be eradicated from Macauley Island.

E2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the southern Kermadec Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may have caused an introduction. Rodent quarantine measures are essential for protecting Kermadec storm petrels.

M1. Norway and Pacific rats, and feral cats should be eradicated from Raoul Island.

M2. A new colony of Kermadec storm petrels should be established on Raoul Island once predators have been removed. While Macauley Island may appear to be the logical place to try and establish this subspecies, intense burrow competition with larger species is quite likely to prevent the subspecies re-establishing on the plateau of this island. Storm petrels are very easily lured to tape recordings of their own calls. A tape playback unit should be used to lure adults to a new colony site on Raoul Island, probably on flat open ground near the eastern coast.

Future Survey and Monitoring Needs

H1. A survey is needed to determine the breeding grounds of this subspecies. The most promising sites to check in priority order are: Haszard Islet, Macauley Island cliffs, Cheeseman Island, Meyer Islets, and other islets/stacks in the Herald group. Also worth checking again are L'Esperance Rock, Curtis Island, and Raoul Island cliffs. Surveys may be worthwhile on the stacks and islands off Norfolk Island.

The best time to search for this subspecies is from mid-August to February. Searches carried out from mid-August to mid-October will avoid interference from the vast numbers of black-winged petrels which breed in the Kermadec group.

H2.Techniques used to capture Kermadec storm petrels include spotlighting and using halogen lamps or Tilley lanterns to attract birds. Loud tape playback of white-faced storm petrel calls is also worth trying. If Kermadec storm petrels are captured, miniature transmitters (1 g) should be attached to the birds and radio-telemetry used to see if nest sites can be located.

H3. If breeding grounds are discovered, then a survey is needed to estimate how many pairs of Kermadec storm petrels are present in the group. Call response to tape playback is probably the best technique to survey nesting birds.

H4. Surveys should be conducted at sea near the Kermadec Islands to estimate the size of the population (using standard at sea transect techniques to estimate seabird abundance). Surveys are also needed to determine if the distribution of white-faced storm petrel subspecies is disjunct or continuous in the north Tasman Sea and northern New Zealand region during the spring and summer.

H5. All islands in the Kermadec group should be inspected every 3-5 years to ensure that rodents and other introduced mammals have not colonised these islands.

Research Priorities

H1. Taxonomy of the white-faced storm petrel group (*P. marina* subspecies) needs further resolving to determine the extent of divergence of the populations breeding in Australia, Kermadec Islands, northern and southern New Zealand, Chatham Islands, and Auckland Islands. If samples are available, the races breeding on Tristan da Cunha, Salvages and Cape Verde Islands in the Atlantic Ocean should also be included in this analysis.The comparison should preferably use DNA techniques, but a reappraisal of external morphological and skeletal characteristics is also needed. If subspecific characters are revealed by DNA analysis, then samples of the storm petrel bones from Norfolk Island should be tested to determine which subspecies they belong to.

M1. If a breeding population is discovered in the Kermadec Islands, then a basic breeding timetable is needed (months that birds visit the colony, time of laying, hatching and fledging).

L1. Studies of population dynamics and diet are probably best undertaken on the closely related *maoriana* subspecies.

Pied Shag *Phalacrocorax varius varius*

Conservation Status:	Endemic subspecies
IUCN rank:	Vulnerable (C2a)
Molloy and Davis rank:	not listed

Distribution

Breeds coastally around North, South, and Stewart Islands including numerous close inshore islands. Also breeds at the Three Kings Islands according to Turbott (1990). There are 51 breeding sites listed by Marchant & Higgins (1990). A few colonies are found on freshwater lakes near the sea (Muriwai, Western Springs, and Lake Pupuke, (Auckland); Lake Rotorua, (near Kaikoura); and Masons Bay, Stewart Island). The species is largely absent from the southern halves of both North Island and South Island. Birds disperse locally over inshore waters feeding mostly in bays, harbours, and estuaries but also in the open sea. Stragglers have reached The Snares. Another subspecies breeds in Australia.

Population

Robertson & Bell (1984) estimated that there were 5000-10,000 pairs of pied shags in New Zealand. Counts at some of the colonies listed in Marchant & Higgins (1990) gives a minimum estimate of 652 pairs. Millener (1972) found that colonies in the Auckland area averaged 17-18 pairs during the period 1969-1971. The subspecies has apparently declined in the last 100 years (possibly owing to human persecution) because Buller (1888) recorded populations of some thousands of birds at Matata and 300-400 at the Rurima Rocks; today there are very few pied shags at these sites.

Threats

Pied shags are still persecuted by humans, because birds with gunshot wounds are occasionally found dead on northern beaches (G. Taylor pers. obs.). The species nests in tall trees, on cliff ledges, or on offshore islands and is probably not at risk from feral cats, dogs, or pigs. Mustelids, rats, and possums may have some impact on mainland colonies but no information is available. The species is sensitive to disturbance by humans but nest sites are usually in safe locations. There is very little risk to this species from fishing techniques such as hand-lines and trawling because the birds are generally shy of people and boats. A few pied shags may be caught by inshore long-line fisheries. Bottom-feeding shag species are sometimes caught in crayfish pots and this may be a slight risk for this species. However, set-netting, especially in estuaries, harbours, or small bays presents a continuing high risk throughout the year. The impact of over-fishing has not been assessed for this species. The risk of oil spills affecting this species is moderately high because the majority of the population occurs in coastal inshore bays and estuaries in the Bay of Plenty, Auckland, Northland, and Nelson/Cook Strait regions. Shipping activity is more intense in these regions.

Previous Conservation Actions

1. The foraging behaviour of pied shags was studied by Stonehouse (1967).
2. Millener (1972) studied social organisation and behaviour, vocalisations, plumages, morphology, diet, and breeding biology. Additional notes on the breeding cycle were presented by Lalas (1979b).
3. A colony of pied shags nesting in Nelson City was successfully transferred to adjacent Haulashore Island by shifting nest sites and discouraging birds at the original colony site (Hawkins & Heinekamp 1992).
4. Establishment of a new colony in southern North Island was monitored by Reese et al. 1996.

Future Management Actions Needed

E1. New Zealand pied shags are a publicly notifiable species under the Wildlife Act. That is, they may be killed subject to conditions set by the Minister of Conservation in a gazette notice. In view of the recent assessment of their conservation status, pied shags should be upgraded to a totally protected species in future amendments of the Wildlife Act.

E2. An advocacy programme is needed to encourage set net users to adopt practices that will minimise seabird bycatch. For example, nets should not be left unattended in estuaries and harbours.

Future Survey and Monitoring Needs

H1. A national pied shag census is needed to estimate the total population of this subspecies. This is best done by counts at dawn or dusk at known roost sites and breeding colonies.

H2. Population monitoring is needed at a sample of breeding sites in the North and South Islands to determine if the species is currently in decline. Accessible colonies occur in Auckland, Bay of Plenty, and Nelson regions.

L1. Surveys are needed to locate all breeding colonies of this species. All colony locations need to be recorded in the National Seabird Colony Register and estimates made of number of nests at each site.

Research Priorities

M1. The population dynamics of pied shags are unknown. There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity. Studies should consider either banding cohorts of chicks with a single colour-band for each year class or individually colour-banding chicks (or adults if they can be captured) so that on-going disturbance at the colony can be minimised.

M2. The movements and patterns of dispersal of pied shags in New Zealand needs research. Colour-banded cohorts of chicks need to be marked at the larger colonies to indicate how far birds move from each site and if birds disperse between the three main islands.

L1.The breeding biology of pied shags is reasonably well known in New Zealand. Further work is needed on the breeding cycle. This includes following marked birds to see if they can successfully nest twice a year, and determining breeding success at a range of colony sites, especially in the South Island.

Light-mantled albatross and chick, Campbell Island, 1987

Light-mantled albatross are occasionally caught on southern bluefin tuna long-lines in New Zealand and Australian regions, but Japanese scientists report that the species is frequently caught on the high seas.The population trends of the New Zealand populations are unknown. (See overleaf.)

Light-mantled Albatross *Phoebetria palpebrata*

Conservation Status: Indigenous species

IUCN rank: Data Deficient

Molloy and Davis rank: not listed

Distribution

Breeds at the Auckland Islands (Adams, Disappointment, Auckland, Enderby, Rose), Campbell Islands (Campbell, Dent, Jacquemart, Folly, Monowai, and other inshore stacks) and Antipodes Islands (Antipodes, Bollons, Archway, Leeward). Elsewhere breeds on Macquarie, Heard, Kerguelen, Crozet, Prince Edward, Marion and South Georgia Islands. The species disperses over cold Antarctic waters in summer as far south as the pack ice (Weimerskirch & Robertson 1994) but ranges north into temperate and sub-tropical seas in winter. Circumpolar in the Southern Ocean.

Population

The size of the breeding populations in New Zealand is still very poorly known. A survey on Campbell Island in 1995 (Moore 1996) found 401 nests on the south-west peninsula, offshore islands and a few inland locations. He estimated that about 1600 pairs per annum may nest on Campbell Island. This figure was higher than the previous guess of >1000 pairs (Sorensen 1950b), but is probably also an underestimate, based on further surveys in 1996 in higher density areas on the south coast (P. Moore pers. comm. 1999). The Auckland Islands population was estimated to be c. 5000 breeding pairs per annum (Bell 1975). Antipodes Island was considered to have fewer than 1000 breeding pairs in 1969 (Warham & Bell 1979). A count of nesting birds in 1995 found 95 occupied nests and the population was thought to be no more than 200-300 breeding pairs (A. Tennyson & G. Taylor unpub.). The total world population has been estimated at c.21,600 pairs per annum, equivalent to 140,000 individuals (Gales 1998). The population trend is unknown at all locations except at Possession Island (Crozet Islands). There the population has declined by 13% since 1980 (Weimerskirch & Jouventin 1998).

Threats

Feral pigs and cats may take a few eggs or kill chicks on Auckland Island although most birds nest on cliff ledges and are isolated from these predators. Formerly feral sheep on Campbell Island disturbed some nesting birds and may have increased the level of brown skua predation on eggs and chicks (G. Taylor pers. obs.). Studies on Campbell Island in 1984 showed that Norway rats had no effect on eggs and chicks of small albatross species (Taylor 1986). Formerly, feral cats may have taken a few young chicks on Campbell Island, especially at inland sites. Cats were scarce on Campbell Island (Dilks 1979, Taylor 1986) and may have died out since the mid-1980s (Moore 1997). The most important predator on land is probably the brown skua. They are seen cruising the nesting areas and have been observed swooping and frightening adults from their nests, and are quick to take any unattended eggs, and possibly target birds during change-over at the nest (P. Moore pers. comm. 1998). Brown skuas have also been observed killing unguarded chicks (G.Taylor. pers. obs.). Disturbance by human visitors has some impact because the species is quite sensitive to disturbance during courtship and some birds will abandon nests if handled during early incubation (Moore 1996). However, few people visit the breeding colonies on the New Zealand islands. Fires at Campbell and Auckland Islands present a slight potential risk to this species although the climate is usually wet at these locations. Fire is more of a potential risk at the drier Antipodes Island but would be unlikely to have much impact on this species because the albatrosses are surface nesters and nest sites are very dispersed around the coastal margins of Antipodes Island. Ticks are common on birds at some sites. Ticks, Norway rats on Campbell Island, and mice on Antipodes and Auckland Island may be potential vectors for diseases such as avian cholera which has killed rockhopper penguins at Campbell Island or for other diseases such as avian pox or avian malaria. Malarial antibodies have been recorded from yellow-eyed penguins on Campbell Island (Graczyk et al. 1995).

At sea, the main threat is from commercial long-line fishing (Gales 1993, 1998). Until recently, very few light-mantled albatross were reported caught on southern bluefin tuna long-lines in the New Zealand EEZ (Murray et al. 1993). However, over 30 birds were caught by vessels fishing east of New Zealand in 1997. The species formed 6% of the total seabird catch from tuna long-liners of those birds landed and returned for identification between 1988 and 1997 (Baird et al. 1998). Small numbers of light-mantled albatross have been caught on tuna longlines in the Australian EEZ (Gales et al. 1998) but Japanese scientists report that the species is frequently caught on the high seas (Uozumi 1998). There are no reports of light-mantled albatross being killed or injured in trawl fisheries (DOC observer programme unpub.). During the breeding season, the birds commute from the breeding colonies to cold Antarctic waters (Weimerskirch & Robertson 1994). Other species at Campbell Island (rockhopper penguins, elephant seals) have declined since the 1940s. These declines have been attributed to changes in food availability as a result of ocean warming since the 1950s (Cunningham & Moors 1994, Taylor & Taylor 1989). This same factor may have had an impact on light-mantled albatross populations. Little is known about the possible effects of pollutants such as plastics, chemical contaminants and oil spills. One recent study at Marion Island found no evidence of plastics in stomach contents (Cooper & Klages 1995).

Previous Conservation Actions

1. The breeding biology of this species on Campbell Island was studied by Sorensen (1950b).
2. Cattle were eradicated from Campbell Island in 1984, and sheep were removed from parts of the island in 1970 and 1984, and finally eradicated by 1991.
3. Feral cattle, rabbits, and mice were eradicated from Enderby Island in 1993.
4. Feral goats were eradicated from main Auckland Island by 1995.

5. The distribution of light-mantled albatross breeding areas on Campbell Island was mapped in 1984/85 (Taylor 1986).

6. A pilot census was carried out on part of Campbell Island in 1995 to establish techniques suitable for an island-wide census. Several repeatable viewpoint counts were established at the western end of the island, in a similar manner to those used on Macquarie Island. Breeding pairs were banded and breeding success was monitored at a sample of nests at two inland areas (Moore 1996). This work was continued and expanded to an area on the south coast (for breeding pairs and coastal survey) in 1996 but only a reduced census of viewpoint index sites was repeated in 1997 (P. Moore pers. comm.).

7. The distribution of breeding pairs was mapped on Antipodes Island in 1995 (A. Tennyson & G. Taylor unpub.).

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

H1. Increased observer coverage is needed on long-lining vessels working in the open seas to determine if light-mantled albatrosses are being caught in the Tasman Sea or South Pacific Ocean.

H2. Feral pigs and cats should be eradicated from Auckland Island.

H3. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the subantarctic islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may have caused an introduction.

M1. Norway rats should be eradicated from Campbell Island.

Future Survey and Monitoring Needs

H1. A baseline census is needed of the total breeding population on Campbell Island using techniques developed by Moore (1996). The census should be carried out in 2-4 consecutive years because the species is a biennial breeder, and the breeding frequency is lower than most other albatrosses.

H2. Monitoring is needed of a section of Campbell Island to determine long-term trends in the breeding population. The western coastal area, and associated inshore islands (esp. Folly Island) surveyed in 1995-97 by Moore (1996) and the southern area in 1996 and 1997 (P. Moore pers. comm. 1998) should be monitored for 5 consecutive years every decade. The main emphasis should be on the repeatable viewpoint counts. Additionally, an estimate should also be made of breeding success by checking the nest sites on Folly Island in February.

H3. A baseline census is needed of the breeding populations on the Auckland Islands and Antipodes Island. The Auckland Island survey should census Adams

Island as a priority site, then Auckland Island, and finally Disappointment Island. Each island census needs to be done in 2 consecutive years (as a minimum) to overcome some of the variation caused by biennial breeding patterns.

Research Priorities

H1. The population dynamics of this species still needs further research. Some studies have been conducted on populations in the Indian Ocean, but research is needed on birds in the Pacific Ocean sector. This should either be conducted at Campbell Island or Macquarie Island (to take advantage of previous banding projects on these islands). In particular, information is needed on breeding frequency, adult survival rates, fledgling survival rates and recruitment of juveniles to the breeding population, natal philopatry, and species longevity. The small amount of banding and breeding data that has been collected sporadically on Campbell Island should be collated and analysed.

H2. The movements and dispersal patterns of adults and fledglings should be studied using satellite telemetry. In particular, information is needed on adult movements outside of the breeding season (June to September) to see if birds are foraging in zones used by long-liners fishing in the high seas.

M1. The diet of light-mantled albatrosses has not received detailed study in the New Zealand region. More work is needed on the diet of birds at each of the three New Zealand breeding grounds. Seasonal variation in types of foods fed to chicks needs to be determined. More work is also needed to correlate diet with foraging zones (using satellite telemetry) and to determine if there are sexual differences in the type of food items consumed.

L1. The development of adult plumage and bill characters needs investigation. It is not yet known when adult bill characters and plumage are developed and this would be useful to determine the ages of birds killed on long-lines. Also, juveniles of light-mantled albatrosses and sooty albatrosses (*Phoebetria fusca*) are apparently inseparable. The age class of birds found dead on New Zealand beaches needs to be determined to see if adult birds regularly occur at sea off northern New Zealand. The moult patterns of beach-cast birds also need examination because moult is apparently suspended by breeders during the breeding season.

White-chinned Petrel *Procellaria aequinoctialis aequinoctialis*

Conservation Status: Indigenous subspecies

IUCN rank: Vulnerable (A1b,c,d,e;A2b,c,d,e)

Molloy and Davis rank: not listed

Distribution

Breeds at the Auckland Islands (Auckland, Adams, Disappointment, Ewing), Campbell Islands (Dent, Jacquemart, Monowai, Cossack Rock) and Antipodes Islands (Antipodes, Bollons). Formerly bred on Campbell Island (Bailey & Sorensen 1962). Elsewhere breeds at Kerguelen, Crozet, Prince Edward, Marion, South Georgia, and Falklands Islands. Birds disperse widely in the Southern Ocean between the tropics and Antarctica (Weimerskirch et al. 1999).

Population

The breeding population in New Zealand is poorly known and estimates of the breeding populations made at some sites are largely intuitive guesses. Robertson & Bell (1984) considered there were between 10,000 and 50,000 pairs in New Zealand. More recently, Taylor (1988) estimated there were at least 100,000 pairs on Disappointment Island. The population on the Antipodes Islands is also thought to be at least 100,000 pairs (G. Taylor & A. Tennyson unpub.). Monowai Island, off Campbell Island, was estimated to have 10,000 pairs in 1985 (G. Taylor unpub.). There are considered to be hundreds of thousands of pairs at the Kerguelen Islands, tens of thousands of pairs at the Crozet and Prince Edward Islands, and 2 million pairs at South Georgia (Marchant & Higgins 1990). However, recent studies on Bird Island (South Georgia) indicate that white-chinned petrels have declined substantially (by 28%) in the past 20 years (J. Croxall pers. comm. 2000).

Threats

Although white-chinned petrels are the largest burrowing petrel species, they are still vulnerable to predators at the egg and chick stage. Brown skuas attack and kill adult white-chinned petrels at Antipodes and Campbell Islands (Moors 1980, G. Taylor pers. obs.). The species formerly bred on Campbell Island (Bailey & Sorensen 1962), but predation by Norway rats and feral cats destroyed that population (Taylor 1986). Trampling by cattle and sheep might have impacted on the Campbell Island population in earlier years. White-chinned petrels have been recorded breeding on Auckland Island (Bell 1975). This population is likely to suffer severe predation from feral cats, and feral pigs are also likely to kill these birds by digging out burrows and eating the adults. Similarly, feral goats on Auckland Island, cattle and rabbits on Enderby Island, and rabbits on Rose Island may have contributed to the demise of populations on these islands in earlier years. The major land-based threat to this species is the introduction of rats and other predators to the current breeding islands. Mice are present on Antipodes Island and Auckland Island but appear to have no effect on the breeding success of this large seabird. Fire is a slight threat because the species nests in dense tussock and fern at Antipodes Island. However, the birds fly over colonies during the day so they are more likely than small petrel species to abandon nests in the event of a fire. The burrows are often dug in wet peat and this makes them prone to collapse by humans (G. Taylor pers. obs.).

White-chinned petrels are vulnerable to fisheries impacts, especially from long-lining fisheries, because they are very adept at diving deeply to retrieve baits cast by long-liners. The species is able to forage for baits both by day and night. Consequently, large numbers of birds have been caught around the Southern Ocean in past decades. White-chinned petrels are the second commonest petrel species caught on tuna long-lines in both the Australian and New Zealand EEZs (Brothers et al. 1998, Baird et al. 1998). Japanese tuna long-lines set in the high seas also kill large numbers of this species (Uozumi 1998). The impact of these incidental drownings on the total population of white-chinned petrels in our region is unknown. Recently, Ryan & Boix-Hinzen (1999) found that white-chinned petrels formed the highest proportion of seabirds killed in the Patagonian toothfish long-line fishery in the Prince Edward Island EEZ. Of particular concern was the high proportion of males killed (83%). Virtually all birds killed were breeding adults. These losses appear to be having a severe impact on the large South Georgia population. White-chinned petrels also scavenge food behind trawlers and small numbers get entangled in warps and nets during trawler hauls (Bartle 1991, DOC fisheries observer programme unpub.). The species may have been killed by netsonde monitor cables used on Russian squid trawlers before these devices were banned from the New Zealand EEZ in 1992 (Anon 1997).

Previous Conservation Actions

1. Feral cattle and sheep were eradicated from Campbell Island by 1984 and 1991 respectively. Feral goats were eradicated from Auckland Island by 1995. Feral cattle and rabbits were eradicated from Enderby and Rose Islands in 1993.

2. Breeding observations, measurements of adult birds and eggs, and behavioural observations were made at Antipodes Island in 1969 and 1978 (Warham & Bell 1979, Imber 1983).

3. Vocalisations were studied at Antipodes Island by Warham (1988).

4. Coarse estimates were made of populations breeding on Monowai Island in 1985 (G. Taylor unpub.), Disappointment Island in 1988 (Taylor 1988), and on Antipodes Island in 1995 (G. Taylor, & A. Tennyson unpub.).

5. The breeding biology of white-chinned petrels was studied at the Crozet Islands by Mougin (1970, 1971 - references in Warham 1990), Jouventin et al. (1985) and at South Georgia by Hall (1987). Another study of this species has begun recently at South Georgia (P. Prince pers. comm. 1997). Movements and foraging range of white-chinned petrels in the South Atlantic and Indian Oceans has been studied recently by Weimerskirch et al. (1999).

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

E2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the subantarctic islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting white-chinned petrels.

H1. Feral cats and pigs should be eradicated from Auckland Island.

M1. Norway rats should be eradicated from Campbell Island.

L1. A tape-playback system should be used on Campbell Island to lure birds back to the main island once Norway rats are eradicated. The most suitable sites to position this unit would be Mt Paris (prospecting birds recorded here previously), Mt Eboule (colony would be associated with the remnant grey petrel colony), and Cattle Bay, opposite Dent Island (where the last known breeding site on the main island occurred in 1943) (Bailey & Sorensen 1962). All these sites are very close to extant colonies on offshore islands.

Future Survey and Monitoring Needs

H1. The larger islands with breeding colonies of white-chinned petrels (Adams, Antipodes, Disappointment, Dent) should be checked every 5 years to ensure rodents and other introduced mammals have not colonised these islands.

M1. Population monitoring is needed at one or two accessible sites. Possible sites include a basin on Adams Island, section of North Plains on Antipodes Island, and the small colony on Ewing Island. Burrow density should be determined or a count of all burrows made in a defined area. These counts should be repeated at 5-year intervals to determine trends in the New Zealand population.

L1. The distribution of white-chinned petrel breeding colonies is still not completely known in the New Zealand region. Surveys are needed in priority order on the offshore islands and stacks off Campbell Island, Adams Island, Auckland Island, islands and stacks off Auckland Island, and the small stacks and islands off Antipodes Island. These surveys could be undertaken by observing islands and stacks in the evening from the adjacent main island, from a boat, or from day visits to each site (the species has distinctive large breeding burrows).

L2. Accurate estimates are needed of the size of the breeding populations on the larger colonies (in priority order): Antipodes, Disappointment, Adams, Dent, Jacquemart, and Monowai Islands.

Research Priorities

H1. Satellite tracking is needed to determine foraging range and potential overlap with fisheries in the New Zealand region. Tracking is needed of breeding birds (incubation, chick rearing), to determine adult activity during the non-breeding season, and fledged chicks. These studies should be carried out at both Auckland and Antipodes Islands.

M1. The population dynamics of this species have not been studied anywhere. Most aspects (e.g. age of first return, age of breeding, longevity etc.) can probably be obtained from other subantarctic islands with permanent bases. However, information is needed from New Zealand colonies on adult and juvenile survival rates to assess potential impacts from fisheries interactions. These rates may vary around the Southern Ocean if each population is affected by different regional fishing practises. Potential study colonies are on Ewing Island (small isolated colony which will assist collection of juvenile survival data) and/or on Antipodes and Adams Islands to determine adult survival rates.

M2. The diet has been studied at most breeding sites but only to a limited extent in the New Zealand region. Food samples should be taken from birds carrying satellite transmitters to correlate diet with foraging zone.

L1. The breeding cycle and breeding biology of white-chinned petrels has been studied at the Crozet Islands and South Georgia. Timing of the breeding cycle in New Zealand is still poorly known. Information is needed on spread of laying dates, and peak dates of laying, hatching, and fledgling at both Antipodes and Auckland Islands. Breeding biology is well known in this species, but no information is available from New Zealand colonies on breeding success rates.

White-chinned petrel, Campbell Island, 1985

White-chinned petrels are vulnerable to fisheries' impacts, especially from long-lining fisheries, because they are very adept at diving deeply to retrieve baits cast by long-liners. The species is able to forage for baits both by day and night. Consequently, large numbers of birds have been caught around the Southern Ocean in past decades.

Grey Petrel *Procellaria cinerea*

Conservation Status: Indigenous species

IUCN rank: Data Deficient

Molloy and Davis rank: Category O

Distribution

Breeds at the Campbell Islands (Campbell, Dent and probably Jacquemart) and Antipodes Islands (Antipodes, Bollons). Elsewhere breeds at Kerguelen, Amsterdam, Crozet, Prince Edward, Tristan da Cunha and Gough Islands. Formerly bred at Macquarie and Marion Islands. The species disperses over subantarctic and sub-tropical waters between 32°-58° S.

Population

This winter-breeding species is poorly known in New Zealand. Birds are apparently common when they return to Antipodes Island in autumn (G. Elliott pers. comm. 1997). The population size at the Campbell Islands has not been estimated previously. Possibly up to 100 pairs nest on the main island and an unknown (but probably small number) of pairs (hundreds?) nest on small islands off Campbell Island. Robertson & Bell (1984) estimated 10,000 - 50,000 pairs in New Zealand. No expedition has been undertaken to assess seabird populations on Antipodes Island in autumn/winter. The population at Gough Island is apparently 100,000s, but elsewhere populations number only 1000s of birds (Marchant & Higgins 1990).

Threats

Although grey petrels are large burrowing petrels, they are still vulnerable to predators at the egg and chick stage. A small breeding population persists on Campbell Island but predation by Norway rats wipes out most breeding attempts (Bailey and Sorensen 1962, Taylor 1986). Feral cats may have contributed to past population declines on Campbell Island. Cats may have died out on Campbell Island because there have been no sightings since the mid-1980s (Moore 1997). Trampling by cattle and sheep may also have impacted on the Campbell Island population in the past. A major threat to this species is the introduction of rats and other mammalian predators to Antipodes Island and the small islands off Campbell Island. Mice are present on Antipodes Island but appear to have no effect on the breeding success of this large seabird. Brown skuas are a significant predator of fledgling chicks at Antipodes Island (Moors 1980). Fire is a slight threat at Antipodes Island because the species nests in dense tussock and fern. However, as grey petrels fly over colonies during the day (Warham & Bell 1979) they are more likely than small petrel species to abandon nests in the event of a fire. Petrel burrows are easily collapsed by people walking through colonies. Visitor access to breeding colonies should be strictly controlled.

The key threat to grey petrels is from commercial long-lining for tuna (Bartle 1990). Grey petrels are capable divers and have been observed diving deeply to retrieve baits cast by commercial long-liners, especially those vessels fishing for tuna and ling. Grey petrels form the largest percentage of seabirds killed by tuna long-liners in the New Zealand EEZ. Between 1988 and 1997, 27% of birds landed on ships and returned for identification were grey petrels (Baird et al. 1998). Incidental bycatch kills proportionately more breeding females than males, but the impact on the breeding population is currently unknown (Bartle 1990, Murray et al. 1993). The species is also hooked and killed on tuna long-lines set in the Australian EEZ and in the high seas (Gales et al. 1998, Uozumi 1998). Grey petrels regularly feed behind trawlers (Petyt 1996). However there are very few reports of grey petrels getting entangled in cables and nets during trawls (Bartle 1991, DOC observer programme unpub.).

Previous Conservation Actions

1. Feral cattle were eradicated from Campbell Island in 1984 and feral sheep were eradicated between 1984 and 1991.
2. Breeding pairs were located on Campbell Island in 1984 (Taylor 1986) and 1990-93 (J. Amey pers. comm. 1994). Some nests were protected by laying rat poison around the burrows. Breeding attempts at these sites were monitored and chicks were successfully reared following rat control (J. Amey pers. comm. 1994).

Future Management Actions Needed

E1. Action is needed to ensure that improved fishing practises are adopted that minimise the numbers of grey petrels caught behind ships. These actions include the use of tori lines and/or underwater setting devices on long-lining vessels and encouraging night-setting of lines.

E2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the subantarctic islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting grey petrels.

H1. Norway rats should be eradicated from Campbell Island.

M1. A tape play-back system could be used on Campbell Island to lure birds back to the main island from offshore colonies once Norway rats have been eradicated. The most suitable sites to position this unit would be Mt Eboule (to boost the remnant grey petrel colony) and Mt Paris. Tapes of calls should be played from February to September.

Future Survey and Monitoring Needs

H1. Population monitoring is needed at Antipodes Island. Possible sites include hilltops near North Plains or the western cliffs. Burrow density should be determined in quadrats or active burrows should be counted in a defined area. These burrow counts should be repeated over 4 years because the species may nest biennially. Burrow counts in study areas should then be repeated at 10-year intervals to determine trends in the New Zealand population. The birds are most conspicuous from mid-February to late March during the courtship period.

H2. The two main islands in New Zealand with breeding colonies of grey petrels (Antipodes, Dent) should be checked every 5 years to ensure rodents and other introduced mammals have not colonised these islands.

M1. The distribution of grey petrel breeding colonies is still not completely known in the New Zealand region. Surveys are needed on all the islands and stacks off Campbell Island and Antipodes Island. These surveys could be undertaken by observing islands and stacks in the evening from the adjacent main island or from a boat, or from day visits to each site (between mid-February and June).

M2. An accurate estimate is needed of grey petrel population size in New Zealand. Surveys should be undertaken on Antipodes, Dent, and Jacquemart Islands in February-March to map burrow locations and in April-May to estimate density of breeding pairs.

L1. Grey petrels have not been recorded from the Auckland Islands but could potentially breed there because the species nests (or formerly nested) on all other subantarctic islands (south of 48º) in the New Zealand region. The most likely places the species could occur are Disappointment Island and the south slopes of Adams Island. These islands should be visited between late February and July, and specific searches carried out for grey petrels.

Research Priorities

H1. The population dynamics of grey petrels have not been studied at any colony. Most aspects can probably be obtained from other subantarctic islands with permanent bases, e.g. age of first return, age of breeding, longevity etc. However information is needed from New Zealand colonies on adult and juvenile survival rates to assess potential impacts from fisheries interactions. These rates may vary around the Southern Ocean if each population is affected by different regional fishing practises. Adult survival (and breeding success) information could be collected from a study colony on Antipodes Island but the large size of this island will make collection of juvenile survival and recruitment data technically difficult to obtain.

H2. Satellite tracking is needed to determine foraging range and potential overlap with fisheries in the New Zealand region. Tracking is needed of breeding birds during the incubation and chick-rearing stages. These studies should be carried out at Antipodes Islands.

M1. The diet of grey petrels is very poorly known at all breeding sites. Food samples should be taken from birds carrying satellite transmitters to correlate diet with foraging zone.

M2. The movements of grey petrels outside the breeding season are poorly known. The species may be migratory, leaving New Zealand seas and moulting off South America. Satellite transmitters should be attached to breeders feeding nearly fledged chicks in September or October and also to several fledglings to establish where they go during October to February.

L1. The breeding biology and breeding cycle has been partly studied at the Crozet and Tristan da Cunha Islands. Information is still needed on most breeding stages including incubation period, incubation shifts, chick growth rates, feeding frequency, and nestling period. This could be collected at other subantarctic islands with permanent bases. Information needed from New Zealand is timing of breeding cycle (return to colony, spread of laying dates, peak laying, hatching and fledging) and breeding success. This information is best collected at Antipodes Island.

L2. The behaviour of grey petrels is poorly known. Studies are needed of social organisation, courtship displays, and use of vocalisations. This research could be undertaken on subantarctic islands outside the New Zealand region.

Grey petrel chick, Antipodes Island, 1995

This winter-breeding species is poorly known in New Zealand. A small breeding population persists on Campbell Island, but predation by Norway rats wipes out most breeding attempts. Grey petrels are capable divers and have been observed diving deeply to retrieve baits cast by commercial long-liners. This species forms the largest percentage of seabirds killed by tuna long-liners in the New Zealand EEZ.

Black Petrel *Procellaria parkinsoni*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category B

Distribution

Breeding is only confirmed from Little Barrier and Great Barrier Islands. Black petrels were formerly widespread on the mountains and hills (300+ m asl.) of North and South Islands (Oliver 1955) but most colonies were lost before the 1950s (Oliver 1955). The species still bred in the Kaitake Ranges near New Plymouth until at least 1958 (Mead & Medway 1960). A few pairs may continue to nest on the mainland because there are occasional reports of petrel burrows and petrel droppings from high points especially in the Auckland region (McFadden 1993). At sea, the species forages mainly off the eastern North Island although some occur in the Tasman Sea westwards to the Australian coast. Black petrels migrate after breeding to the eastern tropical Pacific, with birds frequently seen off the coast between southern Mexico and northern Peru, and westwards to the Galapagos Islands (Pitman & Balance 1992).

Population

The Great Barrier Island population was thought to be about 500-1000 breeding pairs (Imber 1987), but recent surveys suggest the population is probably more than 2500 pairs (E. Bell pers. comm. 1998). About 100 breeding pairs are present on Little Barrier Island (M. Imber pers. comm. 1998). The total world population is likely to be about 10,000 birds.

Threats

Feral cats previously killed large numbers of chicks and adult black petrels on Little Barrier Island (Imber 1987). Feral cats are present on Great Barrier Island but appear to have little impact on the survival of black petrels on this island (Imber 1987). Stray dogs and feral pigs may also be a threat to nesting petrels on Great Barrier Island. Although black petrels are large burrowing petrels, they are still vulnerable to rodent predation at the egg and chick stage. Ship rats are present in the Great Barrier Island breeding colonies and may take some eggs and chicks. Pacific rats are found on both Little Barrier and Great Barrier Islands but rarely prey on eggs or chicks (Imber 1987). A potential threat to this species is the risk of introduction of Norway rats, mustelids, and possums to Great Barrier Island. If these species established on this large island, they would be very difficult to eradicate. Mice are also present on Great Barrier Island but appear to have no effect on the breeding success of this large seabird. Fire is likely to be a lesser threat because the species nests mainly in damp forest on the summits of the two islands. A few chicks have been afflicted with avian pox virus, causing some deaths (M. Imber & G. Taylor pers. obs.). Black petrels were formerly harvested by iwi, but there is no evidence that birds are currently taken.

Black petrels frequently scavenge behind fishing boats and are one of the problem species that dives deeply to retrieve baits cast by long-liners. Four black petrels were killed on tuna long-lines in the New Zealand EEZ and returned for autopsy between 1988 and 1997 (Baird et al. 1998). A further 11 birds (7 males, 4 females) were caught on tuna long-lines during an experimental daytime fishing programme (testing line setting devices) in April-May 1998 (G. Taylor pers. obs.). This high capture rate (all caught on just one fishing vessel) revealed how at risk the species might be in areas where fishing practises are unrestricted. All these birds were caught in northern New Zealand seas. The species might also be caught by long-line fisheries operating closer to shore in New Zealand (e.g. snapper fisheries). There are numerous anecdotal observations of black petrels taking baits in these fisheries but there has been no observer coverage to document capture rates. However, banded black petrels have been caught by recreational line fishers. Black petrels may also be at risk from fisheries interactions in the eastern tropical Pacific. Birds have been seen associating with fishing boats in this region (R. Pitman pers. comm. to M. Imber 1999).

Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. This species, however, forages widely in the Pacific Ocean so it may be at greater risk from pollutants than some other New Zealand breeding species. The heavy volume of shipping near the Panama Canal and chance of an oil spill occurring in this area is a moderate threat to this species especially during the period May to October. The two main breeding colonies also occur near areas with active shipping (Whangarei, Auckland, Tauranga), and both colonies are near the Marsden Point oil refinery. An oil spill near the breeding islands between October and April could impact on this species.

Black petrel chick, Great Barrier Island, 1988

Black petrels were almost wiped out by feral cats on Little Barrier Island. A successful cat eradication operation was completed in 1980. Two hundred and forty-nine black petrel chicks were transferred from Great Barrier Island to Little Barrier Island between 1986 and 1990 in an attempt to boost the Little Barrier population.

Previous Conservation Actions

1. Feral cats were eradicated from Little Barrier Island by 1980.
2. The breeding cycle, breeding biology, and diet of black petrels were studied in detail on Little Barrier Island (Imber 1976, 1987).
3. Vocalisations of black petrels were described by Warham (1988).
4. Two hundred and forty-nine black petrel chicks were transferred from Great Barrier Island to Little Barrier Island between 1986 and 1990 (McHalick 1999) in an attempt to boost the Little Barrier population which had been devastated by cat predation up to 1980. Follow-up visits to both islands have shown a mixed success for this project (M. Imber pers. comm. 1999).
5. The foraging movements and diet of black petrels were studied on Great Barrier Island by attaching radio transmitters to adults and collecting food samples from returning adults and chicks (however foods were not analysed) (Scofield 1989).
6. The distribution and foraging ecology of black petrels in the eastern tropical Pacific was studied by Pitman & Ballance (1992).
7. A study was started on Great Barrier Island in 1996 to locate black petrel burrows, monitor population trends, band adults and chicks, measure breeding success, and determine the basic population dynamics of this species (Bell & Sim 1998a, b).

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises. Increased observer coverage is needed on long-liners in the inshore fisheries and tuna fishing boats off northern and eastern North Island to determine the extent of black petrel bycatch.

E2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the known breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting black petrel.

H1. Information is needed about the nature and extent of black petrel interactions with fisheries in the eastern tropical Pacific Ocean during the austral winter. Liaison with fisheries observer programmes and officials in central and South American countries is needed to learn more about this potential threat to black petrel populations.

H2. If evidence is gained from the current Great Barrier Island study that feral cats or rats are causing too high a loss of eggs and chicks for the species to sustain population growth, then a trapping and poisoning programme should be initiated at the colonies.

M1. Pacific rats should be eradicated from Little Barrier Island.

Future Survey and Monitoring Needs

H1. The size of breeding populations on both Great Barrier and Little Barrier Islands needs to be accurately determined. Colony locations should be mapped and counts made of occupied burrows. Banding of chicks and adults should continue at both islands.

H2. The permanent monitoring plots on Great Barrier Island should be checked annually to determine trends in the number of breeding pairs. All new burrows should be tagged and mapped within these monitoring sites. Breeding success should be assessed annually to detect evidence of predation.

L1. Reports of mainland breeding sites of black petrels should be followed up and site inspections undertaken between December and February.

Research Priorities

H1. Satellite tracking (maximum transmitter weight 25 g) is needed to determine foraging range and potential overlap with fisheries in the New Zealand region. Satellite tracking should be carried out initially on breeding birds during incubation and chick rearing. Tracking is also needed of adults during the non-breeding season and on fledged chicks to determine migration routes and foraging zones off central America.

L1. Further information is needed on some aspects of the breeding cycle. Chick growth rates, frequency of adult feeds, and meal size all need further study. A larger sample of egg measurements is needed. More weights of adults are needed to determine weight variation throughout the breeding cycle.

L2. The vocalisations of black petrels needs further study to determine if sexual and individual differences occur and to describe how the calls function in courtship and nest defence.

Westland Petrel *Procellaria westlandica*

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (D2)
Molloy and Davis rank:	Category B

Distribution

Breeds inland in forest near Punakaiki, Westland, South Island. At sea, Westland petrels forage over the continental shelf and into pelagic waters east and west of the North and South Islands, mainly about and just north of the sub-tropical convergence (Freeman & Wilson 1997, Bartle 1985). Birds disperse to the South Pacific Ocean and possibly the west coast of South America after breeding (Marchant & Higgins 1990).

Population

Numbers of Westland petrels increased between the 1960s and 1982 possibly owing to the extra availability of food from trawler discards (Bartle 1985). The total population peaked in 1982 at 20,000 (± 5000 birds) and the population has remained steady in recent years. There are an estimated 2000 pairs breeding annually (J.A. Bartle in Adams 1998). Recent modelling of population data collected between 1970 and 1991 suggests that the species may begin to decline, primarily owing to poor female survival rates (J. A. Bartle in Adams 1998). Productivity rates were also low but appear to have recovered in the 1990s. If a population decline is confirmed, the species' IUCN status should be revised to critically endangered.

Threats

Introduced mammals are an important land-based threat to this species. Predation by feral cats, stoats, and possibly rats impact on the breeding success of Westland petrels. Occasionally dogs attack adults and chicks.The native weka is a natural predator of Westland petrel but with a shortage of other prey items available, petrel chicks are especially vulnerable to weka predation. Burrows are sometimes trampled by cattle, goats, and humans. Browsing by possums and goats increases the likelihood of slips occurring at the colonies and may have contributed to the slip in the Rowe colony in 1994. Habitat destruction by past and current human activity such as mining, forestry, and agriculture has reduced the available habitat for Westland petrels. The birds also occasionally strike powerlines when flying to and from the colony. Birds could potentially be attracted to lights and noisy machinery if mining or other developments occurred near the colonies. Fires are only a slight threat because the colony is usually damp during the winter breeding season. Ecotourism is currently closely monitored and carefully run to minimise impacts on the breeding birds. Avian pox virus causes chick deaths in the closely related black petrel and may also be a threat to Westland petrels.

At sea, a small number of Westland petrels have been caught on southern bluefin tuna long-lines in the New Zealand and Australian EEZs (Murray et al. 1993, Baird et al. 1998, Brothers et al. 1998). The species regularly scavenges behind trawlers (Bartle 1985, Freeman 1997, 1998) and a few birds may be injured or killed when the nets are hauled. Although there are no confirmed deaths caused by trawling (Bartle 1991, DOC fisheries observer programme unpub.), losses are expected because the closely related white-chinned petrel has been killed behind trawlers (Bartle 1991). The total impact of incidental bycatch versus benefits from scavenging fisheries wastes is currently unknown. Westland petrels regularly exploit fisheries waste from the hoki fishing fleet, comprising 63% of the total diet during the chick rearing stage (Freeman 1998). Birds are thought to be able to switch to more natural prey or scavenge a wider variety of waste when the hoki fishing season is finished (Freeman 1998). Little is also known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. However, because this species may forage as far a field as South America in the non-breeding season, it may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. The distribution and abundance of breeding colonies of Westland petrels were surveyed in the 1950s by Jackson (1958) and in the 1970s by Best & Owen (1974, 1976).
2. The breeding cycle of Westland petrels was studied by Baker & Coleman (1977).
3. The diet of Westland petrels was examined by Imber (1976).
4. A major long-term project has been carried out on the social organisation, behaviour, breeding biology and population dynamics of Westland petrels from 1969 to present by J.A. Bartle (Te Papa, Museum of New Zealand).
5. The Dick Jackson Memorial Reserve (which contains 20% of the known burrows) was gifted to the Royal Forest and Bird Protection Society by Fletcher Challenge Ltd in 1989.
6. DOC staff have been carrying out predator and browser control in the main breeding colonies since 1990. Breeding success has been monitored annually at the Bartle study burrows (Adams 1998).
7. Amanda Freeman (Lincoln University) has recently carried out a PhD study on the diet of Westland petrels during the breeding season and also examined foraging ecology using satellite transmitters (Freeman 1997, 1998, Freeman & Wilson 1997, Freeman et al 1997).
8. The colonies within the Paparoa National Park were protected in a "Westland Petrel Special Area", gazetted in 1999. This designation will restrict public access to the colonies and help to minimise damage to burrows.
9. A draft Westland petrel recovery plan was prepared in 1996 and revised in 1998 (Adams 1998).

Future Management Actions Needed

E1. Predator control should continue around the main colonies to prevent predation of adults and minimise the impacts of these predators on breeding success. Regular monitoring of nests is needed to detect evidence of predation and to respond accordingly.

E2. Fencing of boundaries is required to prevent grazing animals (particularly cattle) from encroaching on the colonies.

H1. Sustained control is needed of browsing mammals, especially feral goats and possums.

H2. Efforts should be made in consultation with landowners to purchase or gain formal protection for parts of the colony outside the National Park.

M1. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies.

M2. Hazards to birds flying to and from the colony need to be identified and minimised if possible. These include overhead powerlines, noise, and lights especially at mining operations.

Future Survey and Monitoring Needs

E1. Monitoring should continue of the study burrows prepared by J. Bartle and A. Freeman at Scotchmans Creek to sample annual breeding success. To continue monitoring long-term trends in the population, all burrows within the sample of sub-colonies should be mapped and tagged and the study sites checked annually. Breeding adults and chicks should be banded in these study colonies.

H1. A census of all Westland petrel burrows should be attempted every 10 years to provide an accurate estimate of the total breeding population. Counts should be separated into discrete subcolonies to assist those monitoring the species in the future.

Research Priorities

E1. Results of the studies undertaken by J.A. Bartle on breeding biology and population changes needs to be published.

E2. More intensive research is needed on Westland petrel population dynamics, especially determination of adult survival and chick recruitment rates, and to measure the extent of immigration and emigration between neighbouring study colonies. Further population modelling is needed to assess annual mortality and survival rates (to discover whether the apparent high female mortality rate is real and continuing) and to help identify possible management options.

H1. Satellite tracking (maximum transmitter weight 35 g) is needed to determine in more detail the foraging behaviour and movements of adults during both the breeding and non-breeding seasons. In particular, research is needed to examine the differences in foraging strategy (distance travelled, locations visited, time spent in fishing zones etc.) between males and females to see if this contributes to apparent differences in mortality rates between the sexes. Fledged chicks should also be studied to determine migration routes and foraging zones off South America.

H2. Research is needed to determine causes of nest failure at the breeding colonies. Video surveillance and regular inspections of nests using a burrowscope may help to determine if predation is an important factor.Tracking paper tunnels, scat searches and trapping may also provide information on background population levels of predators both within the colony and in similar habitats nearby which lack petrels.

L1. Research is still needed on some aspects of the breeding biology including incubation period, incubation shifts, nestling period, and chick growth rates and measurements.

Chatham petrel, Rangatira Island, 1991

Chatham petrels only breed on Rangatira Island in the Chatham Islands group.The main threat to the breeding population is intense competition for nest sites with the extremely abundant broad-billed prion. Control of broad-billed prions in and adjacent to Chatham petrel burrows is now carried out annually to minimise impacts on breeding Chatham petrels. (See overleaf.)

Chatham Petrel *Pterodroma axillaris*

Conservation Status: Endemic species

IUCN rank: Critically endangered (A1e, B1+B2e)

Molloy and Davis rank: Category A

Distribution

Breeds only on Rangatira Island in the Chatham Islands group. Sub-fossil remains have been found on main Chatham, Pitt, and Mangere Islands (Tennyson & Millener 1994, A. Tennyson pers. comm. 1998). The distribution at sea is still poorly known. Birds are occasionally seen near Rangatira Island, and one was recorded 120 km south of the island (West 1994). The species is assumed to migrate to the North Pacific Ocean in the non-breeding season (as do all its close relatives) although there are no records from the Northern Hemisphere.

Population

Previously thought to number only 50 birds, these estimates were later revised to 200-400 birds (Marchant & Higgins 1990, West 1994). However, recent research has indicated a population of about 800-1000 birds and this estimate is supported by the banding of over 400 individuals since 1990 (G.Taylor unpub.).The species has apparently declined in the past 60 years, or is very capricious in its breeding sites, because occupied burrows and surface birds are now sparse or absent from areas commonly used in the 1930s (Fleming 1939) and even as late as the 1980s (e.g. Summit Track, Woolshed Bush) (West 1990). Prior to recent management, breeding success was as low as 10-30% per annum (E. Kennedy & G. Taylor unpub.). Breeding success since 1997 has reached 71-78% (Bancroft 1998, 1999).

Threats

There are no introduced mammals on Rangatira Island. Formerly the island was farmed and sheep, cattle, and goats were present (West 1994). Chatham petrels were lost from other islands in the group and feral cats and pigs were probably the main culprits although Norway rats, ship rats, kiore, weka, feral sheep, and cattle would have contributed to the declines. The introduction of mammalian predators to Rangatira Island is a key threat to the species and is managed by strict controls on visitor access to the island. The burrows are also extremely fragile and occur in very friable soils.These are easily crushed by people working on Rangatira Island. Fire is also a high risk because Rangatira is very dry in summer. Illegal visits by people harvesting muttonbirds each autumn are a potential hazard to Chatham petrels. Currently the main threat to the breeding population is intense competition for nest sites with the extremely abundant broad-billed prion.These birds prevent Chatham petrels from reclaiming burrows when they return in spring, break eggs and kill chicks in late summer, and fight with and possibly fatally injure some adult Chatham petrels (E. Kennedy, G.Taylor & P. Gardner unpub., Bancroft 1998, 1999). The habitat on Rangatira is regenerating after farming and this may also have an effect on breeding distribution of petrels on the island (West 1994).

Previous Conservation Actions

These are fully documented in the draft recovery plan. Important actions include:

1. Sheep, cattle, and goats were removed from Rangatira Island in 1961.

2. The species was studied by J. West and R. Nilsson in the late 1980s. New burrows were found and observations were made on the timing of the breeding cycle and nesting habitat used by Chatham petrels (West 1994).

3. Research was carried out by G. Taylor, E. Kennedy, and S. Phillipson between 1991 and 1998. Over 300 new birds were banded and up to 60 new breeding burrows were located (although not all were used in one season). Observations were made on breeding habitat, vocalisations, and breeding biology (Taylor 1991). Annual assessments of breeding success were started and estimates made of the total population size. The impact of broad-billed prion competition was identified and actions taken to protect breeding pairs. These included the construction of artificial nests sites and blocking off burrows from July to late October to prevent them being used by breeding broad-billed prions.

4. Recent research and management by P. Gardner, K-J. Wilson, M. Bell and F. Bancroft has located further breeding burrows (using transmitters to track birds to breeding burrows), banded new birds, monitored pair bond stability and breeding success, studied chick development and growth, determined the timing and impact of prion attacks on Chatham petrels, and evaluated the effectiveness of the burrow blockading experiment.

5. Plywood boards placed on the feet of people working on Rangatira Island has greatly reduced damage to burrows, especially when moving around off the marked tracks.

6. Control of broad-billed prions in and adjacent to Chatham petrel burrows is now carried out annually to minimise impacts on breeding Chatham petrels (Bancroft 1998, 1999).

7. Trials are being undertaken to develop burrow entrance covers and electromagnetic control devices to restrict movements of prions into active Chatham petrel burrows (P. Gardner, W. Sullivan, K.J. Wilson unpub.)

8. A draft recovery plan for Chatham petrels was prepared by Euan Kennedy and revised in 1999 by Wellington Conservancy.

Future Management Actions Needed

E1. Access restrictions to Rangatira Island need to be maintained to minimise the risk of fires occurring during the breeding season and to prevent rodents or other predators establishing on the island.

E2. Artificial nest sites will need to be maintained annually and further techniques developed to protect birds nesting in these sites. The location and protection of new Chatham petrel nests will need to continue until populations are established elsewhere in the Chatham Islands or it is found that the species is increasing on

Rangatira Island. These actions include the exclusion and elimination of broad-billed prions occupying Chatham petrel breeding burrows.

E3. A new safe colony site needs to be established elsewhere in the Chatham Islands. The best potential sites are on Pitt Island or Chatham Island. These will need to be protected from stock, feral pigs, feral cats, possums, and weka by a predator-proof fence. A fenced site proposed for seabird restoration at the proposed Sweetwater Conservation Covenant (SW Chatham Island) will require additional rat control once birds start prospecting at the colony site. An advantage of colony sites on Chatham Island is that prospecting by broad-billed prions is less active here than on Pitt Island. (Note that Mangere Island is considered unsuitable because broad-billed prions are already abundant there (see Tennyson 1991).) The new colony will need to be established by chick translocations and/or the use of tape playback of calls.

H1. Ideally, feral cats and weka should be removed from part or all of Pitt Island if suitable agreements are reached with the residents. Wild sheep, cattle, and pigs should be removed (by fencing?) from areas suitable for establishing seabird breeding colonies.

Future Survey and Monitoring Needs

E1. All breeding burrows of Chatham petrels on Rangatira Island need annual monitoring. This includes identification of breeding pairs and determination of breeding success. All chicks reared in these burrows need to be banded.

E2. Additional breeding burrows need to be located using a variety of techniques (e.g. affixing transmitters to birds caught on the surface or spotlighting at the swamp site, war-whooping to induce calling, night searches, and daytime burrow checks).

H1. Further estimates of the size of the total population should be assessed by spotlighting and recapturing birds both in flight and on the surface at night.

M1. Further sampling of sub-fossil bone deposits is needed to determine the former distribution and abundance of Chatham petrels on islands in the Chatham group.

Research Priorities

Research needs are highlighted in the draft recovery plan. They include:

E1. Development of techniques to exclude/discourage broad-billed prions from entering known Chatham petrel burrows.

E2. Development of sustainable techniques to ensure long-term survival of Chatham petrels on Rangatira Island.

E3. Study of Chatham petrel chick development and growth, feeding frequencies by adults, meal size, and to find out whether adults abandon chicks prior to fledging.

E4. Development and improvement of translocation methodology using analogous species to refine techniques for establishing *Pterodroma* petrels at new colony sites.

H1. Identification of site and habitat features that are suitable for nesting Chatham petrels. This will help explain the potential impact of forest regeneration patterns on Chatham petrel breeding areas and also help to identify suitable colony locations on other islands.

H2. Data collection on Chatham petrel population dynamics (age of first breeding, adult survival rates, breeding frequency, chick survival and recruitment, and natal philopatry).

H3. Research on the breeding biology and behaviour of broad-billed prions to help understand the process by which prions select burrows, establish pair bonds, and retain burrow ownership.

L1. Diet samples should be collected whenever the opportunity arises for analysis to determine the composition and frequency of food items consumed.

L2.When available, satellite transmitters (weighing no more than 5-8 g), should be attached to breeding birds to determine where the birds forage during incubation period and when feeding chicks.Transmitters should also be attached to adults feeding nearly fledged chicks in late April or May to determine the migration flight path and foraging zone during the non-breeding season.

White-naped petrel, Macauley Island, 1988

The species mainly breeds at Macauley Island (50,000 pairs estimated in 1988), but a few pairs also nest on Philip Island at the Norfolk Islands group.The species formerly nested on Raoul Island but was wiped out by feral cats and Norway rats. (See overleaf.)

White-naped Petrel *Pterodroma cervicalis cervicalis*

Conservation Status: Indigenous species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds at the Kermadec Islands (Macauley Island) and also Norfolk Islands (Philip Island). The species formerly nested on Raoul Island (Merton 1970). Birds disperse widely over sub-tropical and tropical seas and migrate each winter to the North Pacific Ocean.

Population

The population on Macauley Island was estimated as 50,000 breeding pairs in 1988 (Tennyson et al. 1989). Recently, a few pairs have been discovered breeding on Philip Island (O. Evans in Moore 1999). These birds nest on the surface whereas the birds at Macauley Island all nest in burrows.

Threats

There were less than 500 pairs nesting on Raoul Island in 1908, but the species has not been recorded there subsequently (Oliver 1955, Merton 1970). This population was probably extirpated by feral cats and Norway rats. Pacific rats may have had some impact on the species on Raoul Island, but these rats do not appear to have an impact on the species on Macauley Island. Feral goats formerly trampled burrows on both Raoul and Macauley Islands. Rabbits were present on Philip Island and intense browsing of vegetation caused extensive erosion on this island. The introduction of new mammalian predators or browsers to Macauley Island would pose the greatest potential risk to the species. Fire is another potential risk because the surface of Macauley Island is covered in sedges and grass. A fire between November and March would cause the greatest loss to the breeding population. The nesting colonies on Macauley Island are in extremely friable soil and birds nest extensively in all the main access gullies to the island's summit plateau. The species is very vulnerable to trampling of burrows by visitors. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. This species, however, forages in the North Pacific Ocean in winter so it may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. Feral goats were eradicated from Macauley Island in 1970 and Raoul Island in 1984.
2. The species was first discovered breeding on Macauley Island in 1970 (Bell 1970).

3. Rabbits were eradicated from Philip Island about 1985 and subsequently 4 white-naped petrels were found ashore in 1992 (including a nesting pair) (O. Evans in Moore 1999).
4. White-naped petrels were surveyed on Macauley Island in 1988 and an estimate made of the breeding population (Tennyson et al. 1989). Birds were banded, measured and weighed (Marchant & Higgins 1990), vocalisations recorded and behaviour noted (Tennyson & Taylor 1990a).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching Macauley Island. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may have caused an introduction. Rodent quarantine measures are essential for protecting white-naped petrels.

H2. Access to Macauley Island should be strictly controlled to minimise damage to breeding burrows.

M1. Pacific rats should be eradicated from Macauley Island.

M2. Norway and Pacific rats and feral cats should be eradicated from Raoul Island.

M3. A new colony should be established on Raoul Island once predators are removed. This will require the transfer of chicks from Macauley Island to Raoul Island and the use of a tape playback system to lure birds back to the colony site. Formerly white-naped petrels were only known to breed on the summit ridges of Raoul Island. However, they nest from sea-level to the summit on Macauley Island. This suggests that the breeding colonies found on Raoul Island in 1908 were already relict colonies and that predators had destroyed low-altitude colonies. The new colony site should be situated near the coast to maximise the chance of non-breeding adults hearing the tape playback unit when flying past Raoul Island.

Future Survey and Monitoring Needs

H1. Macauley Island should be visited every 5 years to ensure that new species of introduced mammals have not colonised the island.

H2. The permanent marked quadrats and photopoints on Macauley Island should be monitored every 10 years to assess changes in the distribution and abundance of the seabird populations on the island. In particular, the process of vegetation recovery following the removal of goats in 1970 needs to be monitored for decades to quantify any negative impacts that different regeneration stages might have on the population of white-naped petrels.

M1. White-naped petrel colonies on Macauley Island should be mapped and a quantitative assessment made to confirm the accuracy of the 1988 population estimate.

M2. The study area at Sandy Bay (Macauley Island) should be visited between October and December to retrap adults banded in both 1970 and 1988, to obtain estimates of annual survival and longevity. These visits should be made at 5-year intervals.

Research Priorities

M1. The behaviour and social interactions of this species are poorly known. Studies on vocalisations, courtship, and habitat use should be obtained prior to shifting birds to Raoul Island.

M2. The population dynamics of this species are unknown. Age of first breeding, longevity, and survival of adults and chicks are unknown. No chicks have been banded in this species. A long-term project will be logistically difficult to carry out. The birds banded at Sandy Bay should be retrapped over the next 10 years to determine long-term trends in adult survival and longevity. Recruitment research will require a separate study and trips to the island in May to band cohorts of chicks.

L1. The breeding biology of this species has not been studied. Information is needed on the basic breeding timetable (when birds return from the North Pacific, laying period, peak of laying, hatching period, peak of hatching, fledging period and peak of fledging). There are also no data on incubation period or shifts, chick rearing, and breeding success. The species will need to be studied on Macauley Island.

L2. The taxonomy of this species is still controversial (formerly considered by taxonomists to be a race of the Juan Fernandez petrel *Pterodroma externa* whereas Imber (1985b) places these two taxa in different sub-genera.). Further studies are needed to determine the relationship with Juan Fernandez, Barau's (*Pterodroma baraui*), Galapagos (*Pterodroma phaeopygia*) and dark-rumped petrels (*Pterodroma sandwichensis*). This should include DNA analysis and a reappraisal of morphology, anatomy, lice, and vocalisations. Additionally the population on Philip Island should be checked to determine if the birds are the same race as those breeding at Macauley Island. (Are the differences in choice of breeding sites an adjustment to local habitats or the result of evolutionary divergence?)

L3. The diet of this species is unknown. Samples should be collected whenever the opportunity arises.

L4. When available, satellite transmitters (weighing 12-18 g) should be attached to adults feeding chicks in May to determine migration routes and foraging zones in winter (non-breeding season). Research could also be undertaken in association with a diet sampling study to determine the foraging range during the breeding season.

Cook’s Petrel *Pterodroma cookii*

Conservation Status: Endemic species

IUCN rank: Endangered (A1e, B1+B2b,d)

Molloy and Davis rank: Category C

Distribution

Breeds only on Little Barrier Island, Great Barrier Island, and Whenua Hou (Codfish Island). Formerly bred on the North and South Island mainland (Bartle et al. 1993). During the breeding season, birds disperse widely in the Tasman Sea and south-west Pacific Ocean over warm sub-tropical and cool temperate waters. The species migrates in the non-breeding season to the eastern Pacific Ocean between California and Chile (Marchant & Higgins 1990). Birds are also regularly reported from the subarctic front in the North Pacific Ocean (Bartle et al. 1993).

Population

The main population is on Little Barrier Island where there are perhaps 50,000 breeding pairs (Imber 1985a). The species is very rare on Great Barrier Island. Only four burrows have been found in recent years and the population is declining towards extinction on the island (Scofield 1990b). There were an estimated 20,000 breeding pairs on Whenua Hou in 1934 but weka predation reduced this population to about 100 pairs by 1984 (Bartle et al. 1993). The species is apparently increasing on both Little Barrier and Whenua Hou following the removal of feral cats and weka. However, predation of eggs and chicks by Pacific rats appears to have slowed population recovery (Imber 1984a, M. Imber pers. comm. 1999). Even so, there are evidently many more pairs on Whenua Hou in the 1990s than were present in the 1980s (M. Imber unpub.).

Threats

Feral cats formerly killed large numbers of Cook’s petrels on Little Barrier Island. Pacific rats eat both eggs and chicks (Imber 1984a, 1985a). The impact of these predators on breeding success on Little Barrier Island has not been quantified but is expected to be severe in some seasons (M. Imber pers. comm. 1999). Feral cats, ship rats and Pacific rats are the species responsible for the decline on Great Barrier Island. Feral pigs and goats may also have had some past impact. Weka killed large numbers of Cook’s petrels on Whenua Hou before weka were eradicated in 1985 (West 1990). Possums may also have impacted on a few nesting pairs. Pacific rats were present on Whenua Hou until 1998 and apparently took eggs and chicks although the effects of rat predation on breeding success was not quantified. The introduction of new mammalian predators (especially Norway rats and stoats) would have a major impact on this species. Fire is unlikely to be much of a risk to this species because the pairs nest mainly in damp forest (Imber 1985a). Burrows are usually long and deep amongst tree roots and are not easily collapsed by visitors. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. This species, however, forages off Central and North America so it may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. Feral cats were eradicated from Little Barrier Island by 1980.
2. Weka and possums were eradicated from Whenua Hou in 1985 and 1987 respectively.
3. The breeding biology of Cook's petrels was studied on Little Barrier from 1971 to 1979 (Imber 1985a). Information was also collected on the diet of this species (Imber 1996).
4. The status of Cook's petrels on Great Barrier Island was assessed by Scofield (1990b). The response of Cook's petrels to war-whoop calls was also noted (Scofield 1990a)
5. The breeding success of Cook's petrel on Whenua Hou has been monitored in study burrows since 1983 (West 1990, W. Cooper unpub.). Between 1997 and 1999, breeding pairs were banded to obtain information on adult survival rates and pair bonding. All accessible chicks have been banded annually in these study burrows to obtain information on recruitment rates of juveniles and age of first breeding (W. Cooper pers. comm. 1999). Information has been obtained on dates of laying and hatching, breeding frequency, and egg measurements (W. Cooper, M. Imber unpub.).
6. Pacific rats were poisoned on Whenua Hou in 1998. The success or otherwise of this operation will be known 2 years after the poison operation.
7. Plots were set up on Whenua Hou in December 1998 to monitor the recovery of Cook's petrels on the island (M. Imber pers. comm. 1999).

Future Management Actions Needed

E1. Pacific rats should be eradicated from Little Barrier Island.

E2. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the known breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting Cook's petrel.

H1. If a colony (more than 5 burrows) of Cook's petrel is located on Great Barrier Island, appropriate pest control should be instigated to prevent the species from becoming extinct there.

L1. Consideration should be given to re-establishing a colony on the North Island mainland. Potential sites for an inland colony would be Mokoia Island in Lake Rotorua or Mototaiko Island in Lake Taupo. Chicks would need to be transferred to these sites from Little Barrier Island and tape playback used to lure returning birds back to the colony.

Future Survey and Monitoring Needs

E1. The status of Cook's petrel on Great Barrier Island should be monitored by:

a) collecting all dead birds and noting locations where found,

b) permanently tagging and mapping any active burrows found on the island,

c) recording locations where birds regularly display in flight and estimating the number of birds active in these display areas.

H1. The recovery of the Cook's petrel population on Whenua Hou should be monitored by:

a) checking breeding success in the permanent study burrows,

b) counting and/or mapping all burrow sites in the long-term study plots at 5-year intervals,

c) confirming that previously banded chicks have recruited to the breeding population (none had been recorded breeding by 1998/99).

H2. Further surveys are needed on Whenua Hou to locate new breeding burrows and colonies. A specially trained seabird dog could be used to locate isolated burrows.

H3. Permanent plots with mapped and tagged burrows are needed on Little Barrier Island to monitor recovery of Cook's petrel. These should be checked every 5 years.

M1. An accurate estimate of the size of the breeding population on Little Barrier Island could be attempted. This would need to be sampled by transects and/or quadrats to determine the number of breeding burrows per unit area. The survey should also produce a map showing the distribution of breeding colonies and the types of habitats occupied (aspect, altitude, and forest types).

Research Priorities

H1. The taxonomy of Cook's petrels should be reviewed to determine if the populations on each island are distinct races. For example, Bartle et al. (1993) claimed that the Great Barrier Island population is separable on measurements. The Whenua Hou birds have a different breeding timetable to the northern populations and may not interbreed. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

M1. The population dynamics of Cook's petrel are still unknown. Information is needed on age of first return to colonies, age of first breeding, longevity, survival and mortality of adults and juveniles, recruitment of chicks, and natal philopatry. Separate studies are needed of both the Little Barrier and Whenua Hou populations because the populations may differ.

M2. Information is needed from the Little Barrier Island population on the timing of return to breeding colonies, incubation period, nestling period, chick growth rates, feeding frequency, and meal sizes. Studies are also needed to document the impact of Pacific rats on breeding success and to determine at what stages of the breeding cycle predation occurs.

L1. The ecology of the Cook's petrel on Whenua Hou is still fairly poorly known. Information is needed on the breeding cycle to determine incubation and fledgling periods, chick growth rates, frequency of feeds, and meal size delivered by adults.

L2. The diet of Cook's petrels at Whenua Hou is unknown. Food samples should be collected from birds whenever the opportunity arises.

L3. The social behaviour and social organisation of this species is poorly known. Research is needed on vocalisations to determine if sexual differences are present in the calls and the extent of individual variation and recognition of calls. Courtship behaviour and displays need description.

L4. When available, satellite transmitters (weighing no more than 4-8 g) should be attached to breeding birds to determine where the birds forage during the incubation and chick feeding periods. Transmitters should also be attached to adults feeding nearly fledged chicks to determine the migration flight path and foraging zone during the non-breeding season. Separate studies are needed on both Little Barrier and Whenua Hou populations.

Chatham Island taiko chick, Tuku Valley, 1996

Chatham Island taiko are one of the most endangered seabird species in the world. Rediscovered in 1978, there are an estimated 100-150 birds. Only 17 Chatham Island taiko chicks have fledged from known breeding burrows between 1987 and 1999. Chicks in nests are vulnerable to predation by cats, rats, possums, weka, and feral pigs. Intensive pest control has increased breeding success to nearly 100% in recent years, but the survival of this species remains precarious. (See opposite.)

Chatham Island Taiko *Pterodroma magentae*

Conservation Status:	Endemic species
IUCN rank:	Critically endangered (A1e, B1+B2e, C1, C2a, D1)
Molloy and Davis rank:	Category A

Distribution

Breeds only on Chatham Island, inland near the Tuku-a-tamatea River. At sea, the species forages south and east of the Chatham Islands during spring to autumn, over cool subantarctic waters (Imber et al. 1994a). The distribution at sea during the non-breeding season is unknown, but birds may disperse eastwards into the temperate South Pacific Ocean (where the type specimen was shot at sea last century) (Crockett 1994).

Population

There have been 92 taiko banded between 1978 and December 1999. These include 12 adults and 13 chicks first captured in or near the known burrows and 67 birds first caught by spotlighting in the lower Tuku Valley. The total world population has been estimated previously as either 50 or 120 birds (Imber et al. 1994b, Crockett 1994). The proportion of banded to unbanded birds captured by spotlighting or found at burrow sites newly discovered in 1999 suggests that the current population is about 100-150 birds. The species formerly nested in great abundance on main Chatham Island (based on sub-fossil deposits) and has declined steeply in the past 100 years. Possible sightings of Magenta petrels (which could be Chatham Island taiko) off Chile leave open the possibility that another undiscovered population (or very similar species) breeds in South America (Howell et al. 1996).

Threats

Taiko are one of New Zealand's most threatened birds. All known breeding burrows (six located by 1998) are found on Chatham Island and in some years all chicks have been lost to predators. Feral cats, pigs, ship rats, Pacific rats, mice, possums, feral cattle, feral sheep, and the introduced buff weka all occur in the vicinity of the breeding colonies. Feral cats have probably been the main contributor to the decline of taiko by killing large numbers of adults over the past century. Feral pigs can dig up burrows and eat birds. Occasionally stray pig-hunting dogs pass near the colonies and may dig up burrows or attack adults. Possums compete for burrows, and rats and weka prey on eggs and chicks. All known burrows are widely dispersed and most are in wet sites near valley floors. Damp ground and flooding of chambers has probably contributed to nest failures in some seasons. Some burrows are protected in the Tuku Nature Reserve but others are on private land (fortunately currently owned by supportive and interested landowners). Human disturbance of the burrows is not a threat at present although pig-hunting with dogs near the burrows may be a risk. Avian disease has not been identified as a problem but could be devastating with such a small population. The risks to taiko at sea are poorly known. However, the closely related grey-faced petrel does occasionally follow ships, and birds are killed in fishing operations, especially on long-lines. Taiko may also be vulnerable to fishing interactions.

Previous Conservation Actions

1. Chatham Island taiko were rediscovered in 1978 by David Crockett and colleagues following 10 years of intensive ground searching and nights spent spotlighting for birds in the south-west of Chatham Island (Crockett 1994).
2. In 1983, Manuel and Evelyn Tuanui gifted 1238 ha of the Tuku Valley as a Nature Reserve to protect the breeding grounds of Chatham Island taiko.
3. From 1978 to 1987, intensive burrow searches were conducted inland from the Tuku River mouth and also on all outlying islands in the Chatham group. Further birds were captured by spotlighting at the site near “Taiko Base Camp”. Transmitters were attached to birds in 1987 and these were tracked inland to reveal the first three breeding burrows (Imber et al. 1994a, Crockett 1994).
4. After discovery of the first burrows, DOC staff began an intensive burrow protection operation including traplines to remove cats and possums and poisoning to remove rats near the breeding sites (Imber et al. 1994b). The intensity of these operations has increased each year as rodent control grids have been extended around known burrows. The level of pest control increased in 1996/97 to include removal of wekas which were suspected of taking one or more chicks in the 1995/96 season (Imber 1997). Whereas a number of chicks have been lost in some seasons, only 2 dead adult taiko have been found in the past 20 years (Imber et al. 1998).
5. The basic breeding cycle and aspects of the breeding biology have been studied between 1990 and 1998 (Taylor 1991, Imber et al. 1994b, G.Taylor & M.Imber unpub.).
6. Further telemetry operations were undertaken in 1988, 1993 (leading to the discovery of two additional breeding burrows), 1996, 1997 (two new sites located) and 1999 (at least 25 new burrows located). Further spotlighting has also occurred at other times in an attempt to catch pre-breeding taiko banded at the burrows plus new adult birds.
7. In 1992, eight people carried out a 2-week ground search of suitable habitat in the upper Tuku Valley and near known burrows. This thorough search did not locate any further breeding burrows.
8. Egg and chick rearing trials on grey-faced petrels were conducted in 1995 and 1996 at the National Wildlife Centre, Mt Bruce, to develop techniques for artificial rearing of petrels in captivity should this be required as a management tool for taiko. The diet of grey-faced petrel chicks was analysed in 1997/98 by Massey University to create a model diet to feed any orphaned taiko chicks (Hendriks et al. 2000).
9. A permanent conservation officer was appointed in 1996 to manage the taiko nest protection programme.

10. A draft recovery plan has been produced to guide taiko research and management (Grant 1994). This plan was revised by Wellington Conservancy in 1999.

11. Blood samples were collected from 36 taiko by November 1999 for DNA analysis of sex and genetic relationships (C. Millar & D. Lambert pers comm. 1999, G. Taylor unpub.).

Future Management Actions Needed

E1. Continuation of predator and herbivore control will be needed annually in perpetuity or until most remaining taiko are secured in a safe colony site. Rat control is essential around each breeding burrow between November and March. Weka should be controlled from January to May.

E2. A safe colony site should be developed near the Tuku Valley (e.g. proposed Sweetwater Conservation Covenant) or other suitable sites using a predator-proof fence to exclude feral cats, weka, possums, and pigs. Some nearly fledged chicks from the known breeding colonies could be transferred to this site to provide a safe location for birds to fledge. Tape playback of taiko calls should be used to lure non-breeding birds and returning chicks back to the safe colony site.

E3. Light-weight transmitters should be attached to all fledgling taiko just prior to departure to ensure that chicks safely depart from the nesting sites.

H1. Study holes should be excavated, if possible, to all active nest chambers to allow active intervention if chicks are abandoned or under-nourished, and for chick transfers to a secure site before fledging.

H2. Blood samples should be collected from all newly captured taiko to collect information on sex and genetic relationships of all birds in the population.

Future Survey and Monitoring Needs

E1. IR nest cameras should be set up at each active burrow to monitor taiko activity including visits to burrows by taiko and identification of predators at burrow entrances. The status of all breeding burrows (and tagged holes) needs to monitored each breeding season.

E2. Ground searches should be carried out annually within 100 m of all existing burrows to locate and map any newly established burrows. Handling of birds at known burrow sites should to be kept to a minimum and only for approved projects.

E3. Telemetry operations should be carried out about every 2-3 years to locate new breeding sites and to enable protection of all nests. Current evidence suggest only non-breeding taiko are caught at the lights site and fitting transmitters to these birds will enable newly excavated burrows to be found. Taiko located on the ground at night should not be handled or disturbed; subsequently in daytime (after a test transmitter has been left at the site where the bird was found) the site should be properly marked, carefully searched for burrows, and a temporary track made to the site.

H1. A ground search of all breeding areas and other suitable habitat should be carried out by a trained dog and handler to see if more burrows can be found.

Research Priorities

E1. The vocalisations of taiko need further study to determine if sexual and individual differences occur and to describe how the calls function in courtship and nest defence. Information is also needed from closely related species (grey-faced petrels, white-headed petrels) to determine which vocalisations are important in attracting those species to the ground. This information will help efforts to attract taiko to the safe colony site.

H1. Translocation experiments should be conducted on closely related species to establish techniques for future taiko management. These include artificial rearing of eggs and chicks of species such as grey-faced petrels, and subsequent transfer and release of these chicks into the wild. Studies are also needed to identify the optimum timing of chick translocations to determine when chicks develop natal site attachment.

H2. Diet samples should be collected whenever birds regurgitate during handling. These should be given to Dr Mike Imber (DOC, Wellington) or other diet experts for analysis.

M1. The breeding biology of taiko has received some study. Extreme care is needed because so few pairs exist. Incubation period, incubation shifts, and chick feeding frequency could be determined by attaching transponders or transmitters to birds or recording activity with dataloggers, or by monitoring with IR nest cameras. Weighing platforms could possibly be placed in one or two nests to collect information on meal sizes.

M2. Satellite tracking (maximum transmitter weight 15 g) is needed to determine foraging range during the breeding season. Satellite tracking should be carried out initially on breeding birds during incubation and chick rearing. Tracking is also needed of adults during the non-breeding season and on fledged chicks to determine where they disperse to in the winter.

Pycroft's Petrel *Pterodroma pycrofti*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: not listed

Distribution

Breeds on 11 offshore islands off eastern North Island including Ririwha (also known as Stephenson), Poor Knights group (Aorangi), Hen, Lady Alice, Coppermine, Whatupuke, Mauitaha, Red Mercury, Double, Stanley, and Korapuki. Formerly bred on Norfolk Island. Recently, Pycroft's petrels were heard in flight over the Three Kings group (Great Island) (R. Pierce pers. comm. 1997). The distribution at sea is poorly known, but the species is assumed to migrate to the North Pacific Ocean between April and October.

Population

J. Bartle (in Marchant & Higgins 1990) estimated that the total population was less than 300 breeding pairs in the 1960-70s. Currently, the largest population is on Red Mercury Island where an estimated 2000-3000 pairs were present in 1998 (G. Taylor unpub.). Previous surveys (1989-91) estimated 1000-2000 breeding pairs on Red Mercury. The population on Red Mercury appears to be rapidly increasing following rodent eradication in 1992. There are several hundred pairs on the other islands in the Mercury group (G. Taylor unpub.). The population at the Hen and Chickens group is smaller and may be fewer than 500 pairs (R. Pierce pers. comm. 1997). Less than 10 pairs were estimated on both Aorangi and Ririwha Islands (Bartle 1968). Collar et al. (1994) estimated that there were 2000 breeding pairs in New Zealand, with a total population of 10,000 individual birds, based on OSNZ and DOC population surveys from 1987-1993. The 1998 DOC survey on Red Mercury Island now indicates a total breeding population of 2500-4000 pairs and an overall population of 10,000 to 20,000 individuals.

Threats

Pacific rats have been shown to have a significant impact on breeding success (Pierce 1998a,b). Fortunately Pacific rats have been eradicated from most Pycroft's petrel breeding colonies and only remain on Ririwha, Hen, and Mauitaha Islands. Rabbits may have had some impact on Korapuki and Stanley Island in the past by digging up the smaller Pycroft's petrel burrows. The accidental introduction of mammalian predators to islands with Pycroft's petrels is a key potential threat to the species and is managed by strict controls on visitor access to most of these breeding islands. The burrows are fragile and often occur in very friable soils. These are easily crushed by people visiting or working on these islands. Fire is also a key potential threat to this species because nesting occurs in summer and all breeding grounds are very dry between December and March. Competition for nest sites with tuatara and little shearwaters had minimal effect on breeding productivity (Pierce 1998b) but burrow competition with petrel species (especially little shearwaters) may increase in the future (R. Pierce pers.

Pycroft's petrel, Double Island, 1988

Pacific rats have a significant impact on breeding success. Fortunately, Pacific rats have been eradicated from most Pycroft's petrel breeding colonies and only remain on three breeding islands. The largest colony of Pycroft's petrel is on Red Mercury Island where an estimated 2000-3000 pairs were present in 1998.

comm. 1998). Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. This species, however, migrates to the North Pacific Ocean, so it may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. Pacific rats were eradicated from Korapuki, Double, Stanley, Red Mercury, Lady Alice and Whatupuke Islands between 1987 and 1997. Pacific rats were poisoned on Coppermine Island in 1997. The success or otherwise of this operation will be known 2 years after the poison operation.

2. Rabbits were eradicated from Korapuki and Stanley Islands in 1988 and 1992 respectively.

3. Aspects of the breeding biology, breeding habitat, and calls were studied on Aorangi Island (Bartle 1968).

4. Aspects of the breeding cycle and breeding biology were studied on Lady Alice Island in 1982/83 (Dunnet 1985).

5. Population surveys were undertaken on the Mercury Islands between 1987 and 1998 (G. Taylor unpub.). Both adults and chicks were banded and estimates made of the breeding populations. Permanent seabird burrow monitoring plots were set up and mapped on Stanley Island in 1993 and remeasured in 1998. Large numbers of Pycroft's petrels were banded on Red Mercury, Stanley, and Double Islands during this period. A sample of breeding burrows were mapped and permanently tagged on Red Mercury and Stanley Islands in 1998 (G. Taylor unpub.).

6. The populations on the Chickens Island group have been studied since 1992. Research includes location of new breeding colonies (Tennyson & Pierce

1995), monitoring marked burrows, and assessment of breeding success on islands with and without Pacific rats (Pierce 1998a, b).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the known breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting Pycroft's petrel.

H2. Pacific rats should be eradicated from Mauitaha and Hen Islands.

M1. Consideration should be given to establishing colonies on other northern offshore islands. Suitable islands include Burgess Island (Mokohinau group), Cuvier Island and possibly more inshore islands such as Motuora or Tiritiri Matangi. Chicks would need to be transferred to those sites (probably from Red Mercury Island) and tape playback used to lure returning birds back to the colony. These trials can be used as an analogous experiment for work on the critically endangered Chatham petrel.

M2. Pacific rats should be eradicated from Ririwha Island if the owners agree, and the island should be given appropriate reserve status (e.g. conservation covenant).

Future Survey and Monitoring Needs

H1. All islands with populations of Pycroft's petrels should be checked preferably every 2 years and at least every 5 years to ensure that introduced predators (especially rodents) have not established.

H2. The current status of Pycroft's petrel is poorly known on Ririwha and Aorangi Islands. Surveys are needed to confirm breeding still occurs on these islands and to estimate the size of populations.

M1. Monitoring of marked study burrows should continue on Lady Alice Island. Permanent plots with mapped burrows should be established to monitor changes in petrel breeding density. The effects of burrow competition should also be monitored to determine how this impacts on Pycroft's petrel breeding success.

L1. Accurate estimates of the breeding populations are needed on all islands. These should include ground surveys locating burrows by war-whooping and standard transect and quadrats to determine density of breeding burrows. Priorities are Red Mercury, Stanley, and Lady Alice Islands.

L2. Surveys are needed on Fanal, Three Kings, and Ohinau Islands to determine if new Pycroft's petrel colonies are present on these islands. Surveys are best done between mid-October and January.

Research Priorities

M1. The population dynamics of this species are still unknown. Information is needed on age of first return to colonies, age of first breeding, longevity, survival and mortality of adults and juveniles, recruitment of chicks and natal philopatry. Research is best done on Lady Alice, Stanley, or Red Mercury Islands.

M2. The social behaviour and social organisation of this species is poorly known. Research is needed on vocalisations to determine if sexual differences are present in the calls and the extent of individual variation and recognition of calls. Courtship behaviour and displays need description.

L1. The diet of Pycroft's petrel is unknown. Food samples should be collected from birds whenever the opportunity arises. Studies are needed to see whether the populations at Mercury Islands have a similar diet to birds at the Hen and Chickens Islands and whether there are differences in food items delivered to chicks by males or females.

L2. Research is needed on aspects of the breeding cycle at the Mercury Islands to compare with studies at the Chickens Islands. Information needed includes dates of first return; the spread of laying, hatching, and fledgling; peaks of laying, hatching, and fledgling; egg measurements; incubation period; chick growth rates; frequency of feeds and meal size delivered by adults; nestling period; and breeding success and breeding frequency.

L3. When available, satellite transmitters (weighing no more than 3-6 g) should be attached to breeding birds to determine where the birds forage during the incubation and chick feeding periods. Transmitters should also be attached to adults feeding nearly fledged chicks to determine the migration flight path and foraging zone during the non-breeding season.

Kermadec Little Shearwater *Puffinus assimilis kermadecensis*

Conservation Status: Endemic subspecies

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: not listed

Distribution

Breeds only at the Kermadec Islands (islets off Raoul Island, Macauley, Curtis, Cheeseman, and probably Haszard Islet). Birds disperse locally in the Tasman Sea and south-west Pacific, occasionally reaching North Island, New Zealand.

Population

There were an estimated 100,000 pairs breeding on Curtis Island in 1989 (Tennyson & Taylor 1990a). Several thousand pairs breed on other islands in the group (Merton 1970, Bell 1970, Taylor & Tennyson 1988).

Threats

Populations on Raoul Island were extirpated by introduced Norway and Pacific rats, and feral cats. Pacific rats apparently restrict the little shearwater population on Macauley Island to nesting on cliff faces and coastal ledges where these rats are scarce or absent (Taylor & Tennyson 1988). The introduction of new mammalian predators could wipe out little shearwater populations on the breeding islands. However the chance of introduced predators reaching these islands is quite low because most have rocky volcanic shorelines that limit the opportunities for boats to anchor close inshore and make it very difficult for people to land. Fires may cause temporary losses in the populations, especially if these occurred during incubation (June-August). Volcanic activity on Curtis Island could potentially wipe out the major breeding colony there and on Cheeseman Islet. The nesting colonies on Curtis Island are in extremely friable soil and are easily collapsed by people walking through the colonies. Visitor access to these sites needs to be strictly limited to protect the birds especially during the breeding season (May to November).

Previous Conservation Actions

1. Feral goats were eradicated from Macauley Island by 1970.
2. A survey was undertaken on Macauley Island in 1988 (Taylor &Tennyson 1988).
3. A survey was undertaken on the distribution and size of the population nesting on Curtis Island in 1989 (Tennyson & Taylor 1990a). Adults and chicks were banded in one study area and fledging dates were obtained (G Taylor & A Tennyson unpub.).

4. Measurements and weights were obtained from adults and chicks on Macauley and Curtis Islands (Marchant & Higgins 1990, G Taylor & A Tennyson unpub.)

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Kermadec Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting Kermadec little shearwaters.

H2. Pacific rats should be eradicated from Macauley Island.

M1. Norway and Pacific rats and feral cats should be eradicated from Raoul Island.

M2. A new colony on Raoul Island should be established once predators are removed. This will probably require the transfer of chicks (from Meyer Islets as first preference but from Curtis Island if necessary) and the use of a tape playback system to lure adult birds. The colony should be established under forest on a headland opposite the Meyer islets.

Future Survey and Monitoring Needs

H1. All islands in the Kermadec group should be inspected every 5 years to ensure that rodents and other introduced mammals have not colonised these islands.

M1. The study area on Curtis Island (where birds were banded in 1989) should be sampled in a visit between August and October to retrap adults and to obtain estimates of survival of adults and recruitment of chicks. This should be done at 5-10 year intervals.

L1. A population survey and census is needed to estimate the size of the populations nesting on the rodent-free islands off Raoul Island and on Haszard and Cheeseman Islets.

(Note that accurate counts of breeding burrows will not be possible with this subspecies because the birds nest in extremely friable soils and colonies are highly prone to damage.)

Research Priorities

M1. Taxonomy of the little shearwater group (*P. assimilis* subspecies) needs further resolving to determine the extent of divergence of the populations breeding on the Kermadec Islands, Norfolk and Lord Howe Islands, islands off Australia, and islands off New Zealand. This research should include DNA analysis and a detailed study of morphology, anatomy, and vocalisations.

L1. Information is needed on the basic breeding timetable (months birds visit the colony, laying period and peak of laying, hatching period and peak of hatching, fledging period and peak of fledging) and breeding productivity. This research could best be done on the Meyer Islets using a small sample (c30) of selected burrows along a marked access track. The productivity study should be carried out over 3-5 seasons to determine average productivity for this subspecies.

L2. Studies of population dynamics (age of first breeding, longevity, survival, and mortality of adults and fledglings) are probably best undertaken on the *haurakiensis* subspecies.

L3. Research on diet and at sea distribution/movements is a low priority for the Kermadec little shearwater. Any future studies would need to be done so as not to risk damage to the colonies or compromise existing monitoring projects.

Kermadec little shearwater, Curtis Island, 1989

There were an estimated 100,000 pairs breeding on rat-free Curtis Island in 1989. However, on nearby Macauley Island, Pacific rats apparently restrict the little shearwater population to nest sites on cliff faces and coastal ledges where these rats are scarce or absent.

North Island Little Shearwater *Puffinus assimilis haurakiensis*

Conservation Status: Endemic subspecies

IUCN rank: Vulnerable (A1e, D2)

Molloy and Davis rank: not listed

Distribution

Breeds on islands in the Hauraki Gulf and Bay of Plenty. Populations occur at the Cavalli Islands (Motuharakeke), Poor Knights (Aorangi, Tawhiti Rahi), Hen, Chickens Islands (Coppermine, Lady Alice, Whatupuke, Muriwhenua and probably Mauitaha), Mokohinau Islands (Lizard, Stack H), Mercury Islands (Red Mercury, Stanley, Double, Korapuki, Middle), Aldermen Islands (Ruamahuanui, Ruamahuaiti, Hongiora), Penguin and Rabbit Islands. Birds disperse locally in seas off North Island, New Zealand.

Population

Perhaps 10,000 pairs with the largest populations on Hongiora Island (c.3000 pairs), Ruamahuanui Island (c.1200 pairs), and Red Mercury Island (c.1000 pairs) (G. Taylor & A. Tennyson unpub.). Populations of 100s of pairs occur on Lizard Islet, Motuharakeke, Tawhiti Rahi, Middle, and Stanley Islands.

Threats

Pacific rats have been shown to take eggs and chicks of this species and have a significant impact on breeding success (Booth 1995, 1996, Booth et al. 1996, Pierce 1998a,b). The subspecies is absent from islands where Norway rats, ship rats, feral cats, and stoats occur or formerly occurred. The introduction of new mammalian predators could wipe out little shearwater populations on the current breeding islands. Most of the breeding islands are remote and predators are only likely to reach the islands via boats. Access restrictions and the difficulty of landing on these islands will help to minimise this threat. Fires may cause temporary losses in the populations, especially if fires occurred during the incubation period (July-September). The nesting colonies on the small islands, which have always lacked rodents, typically have very friable soils and burrows are easily collapsed by people moving about on these colonies. Visitor access to these sites needs to be strictly limited to protect adult birds especially during the courtship and incubation periods (April to September).

Previous conservation actions

1. Pacific rats have been eradicated from the following islands with little shearwater breeding colonies: Korapuki (18 ha), Double (33 ha), Stanley (100 ha), Red Mercury (225 ha), Burgess (52 ha) and other small islands in the Mokohinau group, Lady Alice (155 ha), and Whatupuke Island (102 ha). Pacific rats were poisoned on Coppermine Island in 1997. The success or otherwise of this operation will be known 2 years after the poison operation.

North Island little shearwater (left) and Pycroft's petrel, Double Island, 1988

Pacific rats take eggs and chicks of both these species, and the rats have a significant impact on breeding success. Following rat eradication, the species have begun competing for available nest sites at the Chickens Islands.

2. A study has been undertaken of the effects of Pacific rats on little shearwater breeding success (Booth 1995, Pierce 1998a,b). Infra-red time lapse video monitors have been used to reveal how Pacific rats prey on eggs of little shearwaters (Booth 1996, Booth et al. 1996)
3. Aspects of the breeding cycle were studied on Lady Alice Island, especially timing of egg laying, adult foraging shifts, and chick growth rates (Booth 1996, Booth et al. in press).
4. Surveys have been undertaken to determine the size of little shearwater populations in the Chickens, Mokohinau, Mercury, and Aldermen Islands (R. Pierce, T. Greene, G. Taylor & A. Tennyson unpub.).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting North Island little shearwaters.

H2. Pacific rats should be eradicated from the remaining islands where breeding populations are present: Mauitaha, Hen, Penguin, and Rabbit.

L1. New colonies should be established on islands which were presumably used by this subspecies in the past. Priority for restoration are Cuvier Island and Middle Chain Island (Aldermen group). Other possibilities include predator-free sites such as Motuora and Tiritiri Matangi Island in the inner Hauraki Gulf. Establishment on all islands will require the use of tape playback systems to lure adults and probably the transfer of chicks from the nearest colony with >500 breeding pairs.

Future Survey and Monitoring Needs

H1. All islands with little shearwater populations should be inspected every 5 years to ensure that rodents and other introduced mammals have not colonised these islands.

M1. Colonies on Lady Alice, Stanley, and Ruamahuanui Islands should continue to be monitored to assess future changes and trends in the little shearwater populations at these sites.

L1. Accurate surveys of the distribution and number of breeding pairs on each island should be encouraged using volunteers such as students or OSNZ groups.

L2. Surveys are needed of islands in northern New Zealand which may have undetected populations of little shearwaters, e.g. Three Kings, The Noises, Channel, Ohinau, and Castle.

Research Priorities

M1. Taxonomy of the little shearwater group (*P. assimilis* subspecies) needs further resolving to determine the extent of divergence of the populations breeding on the Kermadec Islands, Norfolk and Lord Howe Islands, islands off Australia and islands off New Zealand. Research should include DNA analysis and a detailed study of morphology, anatomy, and vocalisations.

M2. The *haurakiensis* subspecies is best suited for a long-term study of population dynamics (age of first breeding, longevity, survival and mortality of adults and fledglings). This should be undertaken on either Lady Alice or Stanley Island where reasonable numbers of adults and chicks have been banded during the past 10-20 years.

L1. Research is needed on the diet of little shearwaters. When available, satellite tracking should be undertaken to determine foraging range and at sea distribution. (Maximum transmitter weight no greater than 5-7 g for this subspecies.)

Buller's Shearwater *Puffinus bulleri*

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (D2)
Molloy and Davis rank:	Category B

Distribution

Breeds only at the Poor Knights Islands although 1 bird was found in a burrow with a chick at the Simmonds Islands in 1990 (Taylor & Parrish 1991).The species forages north of the sub-tropical convergence during the breeding season. Buller's shearwaters generally stay over the continental shelf, but the species is also found in the mid-Tasman Sea and off eastern Australia (Jenkins 1974, 1988). Buller's shearwaters migrate to the North Pacific Ocean in winter and disperse widely from Japan and Alaska east to California. A few turn up annually off Peru and Chile (Marchant & Higgins 1990).

Population

By 1936, the population on Aorangi had been decimated by feral pigs and only about 100 burrows remained on an inaccessible cliff ledge. The breeding population on Aorangi rapidly increased following the removal of feral pigs in 1936. Fortunately, pigs were absent on Tawhiti Rahi, and about half a million birds were believed to be there in 1940.The total population in 1981 was estimated as 2.5 million birds with c.200,000 pairs nesting on Aorangi Island (Harper 1983, 1986). There have been no recent estimates made of population size, and it is uncertain if the population is continuing to increase.

Threats

Buller's shearwaters are largely confined to one group of islands. There are no introduced mammals on the Poor Knights or Simmonds Islands. Feral pigs were eradicated on Aorangi Island. The introduction of mammalian predators is a key threat to this species but current pest eradication techniques would probably eliminate predators before they had too much impact on the population. Competition for burrows with other species of petrels may have a slight impact. Buller's shearwaters appear to be the dominant species when competing for burrows (Harper 1983).The Poor Knights are very dry in summer and fires could cause temporary losses in the populations, especially during the incubation period (November to January). Burrows are easily collapsed by people moving about on colonies because the soil is very friable. Visitor access needs to be strictly limited to protect birds especially during the courtship and incubation periods (September to January).

At sea, Buller's shearwaters scavenge food behind trawlers and occasionally around recreational fishing boats (Langlands 1991). A few birds may be caught accidentally in trawl nets and on hand and reel-lines.The species does not appear to be caught on tuna long-lines or inshore long-lines (Baird et al. 1998).There is a slight risk of this species being caught in set nets in New Zealand because Buller's shearwaters were previously killed in drift-nets set in the high seas of the

North Pacific Ocean (Gould et al. 1998). Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. This species, however, forages in the North Pacific Ocean during the austral winter, so it may be at greater risk from pollutants than some other New Zealand breeding species. In summer, the main breeding colony is situated near active shipping lanes (Whangarei, Auckland) and the main New Zealand oil refinery is at Marsden Point (near the Poor Knights Islands). An oil spill could have an impact on this species if it occurred between September-February.

Previous Conservation Actions

1. Feral pigs were eradicated from Aorangi Island in 1936.
2. Aspects of the breeding cycle and breeding biology were studied by Harper (1983, 1986). Estimates were also made of population size and status, and diet and feeding behaviour were noted (Harper 1983).
3. The seasonal distribution and feeding habits of Buller's shearwaters at sea in the New Zealand region was described by Jenkins (1974, 1988).
4. The diet of Buller's shearwater in the North Pacific Ocean was studied by Gould et al. (1988).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Poor Knights Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction. Rodent quarantine measures are essential for protecting Buller's shearwater.

M1. Consideration should be given to establishing colonies on other northern offshore islands. The nearest islands to the Poor Knights Islands (Chickens, Mokohinau group) would probably not be suitable for establishing Buller's shearwater because they already have nationally important populations of grey-faced petrels, Pycroft's petrels, and flesh-footed shearwaters. Suitable options include inshore islands such as Motuora and Tiritiri Matangi. Cuvier Island may also be a suitable site for this species. Chicks would need to be transferred to these sites, and tape playback used to lure returning birds to the colony.

Future Survey and Monitoring Needs

H1. The current status of Buller's shearwaters on the Simmonds Islands needs to be assessed.

H2. Monitoring plots should be set up on both Aorangi and Tawhiti Rahi Islands on the boundaries of existing colonies to determine the population growth rate and pattern of expansion of the species on these islands.

H3. An accurate estimate is needed of the breeding population on both islands. This should be carried out using standard transect and quadrat techniques and examination of burrows during the incubation period (December-January).

L1. People carrying out bird surveys on the Three Kings Islands and Chickens Islands in September-October or December-January should watch for this species to see if birds are prospecting or breeding at these island groups.

Research Priorities

H1. The population dynamics of this species are still unknown. Information is needed on age of first return to colonies, age of first breeding, longevity, survival and mortality of adults and juveniles, recruitment of chicks, and natal philopatry. Potential problems include burrows being in soft friable soils and difficulty of relocating returning juveniles in the large colonies. A discrete and accessible sub-colony should be used to band all adults and chicks to assist in recapturing birds.

L1. Aspects of the breeding cycle and breeding biology have been studied by Harper (1983). Further work is needed on the spread of laying, hatching and fledging dates, incubation and nestling periods, incubation shifts, chick growth rates, frequency of feeds and meal size delivered by adults, breeding success and breeding frequency. Note that the species is reported to be very sensitive to human disturbance during incubation. A study using transponder implants may be needed to collect the above information.

L2. The diet and foraging ecology of Buller's shearwaters in the New Zealand region needs further research. Food samples should be collected from birds during different stages of the breeding cycle. Dive depths and dive profiles also need to be determined.

L3. Satellite transmitters (weighing no more than 10-15 g) should be attached to breeding birds to determine where the birds forage during the incubation period and when feeding chicks. Transmitters should also be attached to adults feeding nearly fledged chicks in late-April to determine the migration flight path and foraging zone during the non-breeding season.

L4. Further work is needed on social behaviour and social organisation in Buller's shearwaters. Research is also needed on vocalisations. The types of calls are poorly known and need description. Studies are also needed to determine if sexual differences are present in the calls and the extent of individual variation and recognition of calls. Courtship behaviour and displays need description.

Hutton's Shearwater *Puffinus huttoni*

Conservation Status: Endemic species

IUCN rank: Endangered (B1 + B2b,c,d)

Molloy and Davis rank: Category B

Distribution

Only breeds in two valleys in the Seaward Kaikoura Range, South Island (Harrow 1965, 1976). The species formerly bred throughout the Seaward Kaikoura and possibly Inland Kaikoura Range (Harrow 1976, Wragg 1985), and there are subfossil deposits recorded from inland North Canterbury (Holdaway & Worthy 1994) and possibly elsewhere in the eastern South Island (Worthy 1999). The species forages over the continental shelf mainly east of the South Island and north of the sub-tropical convergence. The entire population migrates to Australian seas between April and August (Warham 1981). Most birds reach the Indian Ocean north-west of Western Australia but some stay in the Tasman Sea and off South Australia (Halse & Halse 1988).

Population

Sherley (1992) estimated there were at most 134,400 breeding pairs. This figure was based on an aerial survey of colony distribution, plotting of colony size from aerial photographs, and a sample of 22 plots (10x10 m) in sub-colonies of different density in the Kowhai River colony. However, Sherley (1992) had no data available to determine the proportion of burrows that are not used by breeding pairs. R. Cuthbert (pers. comm. 1998) found that 70% of suitable burrows are occupied by breeding pairs. If this correction factor is added to Sherley's estimate then the breeding population is about 94,000 pairs. Hutton's shearwater colonies found by Geoff Harrow elsewhere in the Seaward Kaikoura Ranges in the 1960s (Harrow 1976) had disappeared by the early 1980s (Wragg 1985). There have been contractions of colony margins at lower altitude sites in the Kowhai Stream colony since 1983 (G. Taylor pers. obs.). Possibly shearwaters have been excluded from these formerly open sites by vegetation recovery rather than population declines (R. Cuthbert pers. comm. 1998). Regeneration of shrubby vegetation following removal of browsing mammals has covered areas of rank grassland near the "Harrow colony" site in the upper Kowhai River. The results of population modelling carried out by R. Cuthbert (Otago University) using data collected since 1989 suggest there has been no population decline in the past 10 years.

Threats

All Hutton's shearwater colonies are on the mainland and therefore are potentially vulnerable to the full suite of mammalian predators and browsers. Stoats are known to kill adults and chicks and also take eggs, yet recent studies suggest they only have a limited impact on the shearwater population (R. Cuthbert pers. comm. 1999). Mice are present in the colonies. They appear to have no direct impact on the shearwaters, however, do provide an alternate food supply for stoats. Occasional ferrets and possums reach the Kowhai Stream colony. Currently there is no evidence that Norway, ship, or Pacific rats are present in the colonies. Feral cats and pigs are normally absent from the upper valleys where the colonies occur but are present in the river catchment below the shearwater colonies. These two species are potentially the greatest threat to the shearwater colonies. High altitude (1200-1700 m asl.), winter snow cover, and inhospitable terrain appear to be the only reasons that they are scarce or absent in the colonies. Deer and chamois occasionally browse vegetation and trample burrows but have been uncommon in recent years owing to sustained control programmes. New Zealand falcons and Australasian harriers capture and kill small numbers of adults, and kea have been observed digging out Hutton's shearwater chicks from short or shallow burrows, then eating the fat deposits on these chicks.

Hutton's shearwater killed by stoat, Seaward Kaikoura Range, 1995

Hutton's shearwaters only breed high up in the Seaward Kaikoura Range, South Island. Geoff Harrow first discovered the breeding colonies in 1965. Heavy snowfalls and predation by stoats are two major threats to this species.

Fire is a possible threat because the colonies can be very dry in late summer. The Kowhai Stream colony is protected as a Nature Reserve and human disturbance is minimal. Nevertheless the burrows are extremely fragile and easily crushed by people. Care is needed when studying this species because adults are sensitive to handling during incubation. The high altitude location creates its own problems. In some seasons burrows are covered in snow till very late and this delays or prevents breeding. Heavy snow-falls can also crush burrows. Avalanches occur in some seasons and parts of colonies are frequently eroded by slips or damaged by rock falls. The ground can remain very damp in spring and high rainfall plus unseasonal cold temperatures are likely to increase egg failure or chick mortality as occurs in other petrel species (Warham 1990). Spring snowfalls may entomb adults and late summer snow may trap chicks or prevent adults from feeding them. Avian diseases have not been recorded at the colony, but if they occur could increase chick mortality.

At sea the birds are sometimes caught in set nets (Tarburton 1981), and the species may be at risk from inshore long-lines. There is no evidence that birds are injured directly by trawling or purse-seining fishing techniques. However, the long-term impact of over-harvesting of inshore fish species such as kahawai has not been assessed but could have serious consequences for Hutton's shearwaters which often feed in association with these fish species. Natural fluctuations in food supply could also impact on shearwater breeding success. Warm water incursions are reported to affect the availability of krill in some seasons (Sherley 1992). An oil spill centred off Kaikoura Peninsula or near Wellington between September and March could have an impact on this species.

Previous Conservation Actions

1. The breeding grounds in the Seaward Kaikoura Ranges were first discovered in 1965 (Harrow 1965). Subsequent trips to the colonies in the following years provided information on the breeding cycle, distribution of colonies, descriptions of the habitat and threats to the colonies (Harrow 1976). Birds were banded at the "Harrow colony" site in the upper Kowhai River.
2. The comparative biology and taxonomy of fluttering shearwaters and Hutton's shearwaters was studied by Wragg (1985). Blood samples were collected and measurements of adults were taken. Burrow densities were determined by transects and plots.
3. The distribution and density of breeding colonies was surveyed between 1986 and 1989 by Sherley (1992). Estimates were made of the size of the breeding population. Permanent plots for monitoring population trends were established and photopoints set up. Some assessment was also made of breeding success.
4. Opportunistic control of chamois and deer is undertaken by DOC staff in the Kowhai Valley to protect Hutton's shearwater colonies. Feral pig populations are also controlled when they are observed in the upper Kowhai Valley.
5. A long-term monitoring project was initiated by A. Davis and B. Paton in 1989 to sample breeding success in three different habitat types and to help understand the threats to the species' survival. The project has involved annual monitoring of 40-60 occupied study burrows and banding adults and chicks in these study burrows.
6. This project has been continued in 1996 as part of a PhD study by R. Cuthbert (Otago University) who is investigating the causes of the Hutton's shearwater decline, in particular the role of predators. Information is also being collected on the breeding cycle and breeding biology. Birds are also being banded as part of the long-term study of population dynamics, co-ordinated by Nelson/ Marlborough Conservancy, DOC.
7. A draft recovery plan for Hutton's shearwater was prepared in 1996.

Future Management Actions Needed

E1. Annual control of feral pigs is needed in the central and upper valley to reduce the risk of pigs reaching the shearwater colonies. On-going control of deer and chamois are needed to prevent burrows being crushed and loss of vegetation cover caused by these browsing animals.

M1. Consultation is needed with the landowners of Shearwater Stream colony to legally protect this site either through a conservation covenant or through land purchase. The colony should then be gazetted as a Nature Reserve.

M2. A study of fisheries impacts on Hutton's shearwater is needed in the Kaikoura region (see research needs). If this study demonstrates that some fishing techniques or harvest levels are affecting the population viability of Hutton's shearwaters then DOC should advocate the establishment of an inshore Marine

Protection Zone (size of the zone and the limitation on fishing techniques to be recommended from the research findings). The main fish stock which may need local protection is kahawai which is an important species in the foraging ecology of Hutton's shearwaters.

M3. Attempts could be made to re-establish breeding colonies at former breeding sites at lower altitude (e.g. Mt Fyfe) or possibly on the Kaikoura Peninsula. These new sites will need to be fenced to exclude predators, especially feral cats, stoats, and pigs, and ideally rodents. Chicks may need to be transferred to some of these sites and tape playback used to lure returning birds to the colony. Hutton's shearwaters may have some physiological adaptations to nesting at high altitude that may limit their potential to establish a colony near sea level (R. Cuthbert pers. comm. 1998).

Future Survey and Monitoring Needs

H1. Study burrows in the Kowhai River colony should be monitored annually to measure adult survival rates using mark/recapture of banded breeding pairs. Breeding success should continue to be assessed annually to correlate chick production against variable seasonal factors such as rainfall and snowfall levels in the Seaward Kaikoura Ranges and natural sea temperature fluctuations in the marine environment.

H2. Permanent burrow plots and photopoints should be monitored at 5-year intervals to observe changes in burrow density and to detect colony contractions or expansions.

M1. Transects should be used to sample burrow density in each sub-colony. A sample of burrows in each sub-colony should be checked with a burrowscope to measure burrow length, presence of multiple chambers or entrances and to confirm the presence of incubating birds. These samples should provide a calculation of the ratio of occupied to unoccupied burrows for comparison with the census by Sherley (1992).

L1. An independent assessment of the size of the total Hutton's shearwater population would provide a useful comparison with population estimates based on burrow counts. One possible technique would be to colour-dye a sample of 0.5-1% of the estimated shearwater population (i.e. a sample of 2000-4000 birds) and count ratios of dyed to undyed birds at sea to calculate the total population size. If successful, this technique could be repeated every 10 years to monitor long-term trends in the total population.

Research Priorities

H1. The research project by Richard Cuthbert on Hutton's shearwater breeding biology, breeding success, and causes of mortality is close to completion (1999/2000). This will help to identify and model those land-based factors which may contribute to any population declines.

H2. The population dynamics of Hutton's shearwater are still unknown but are being investigated by Richard Cuthbert. Further work will be needed to gather information on age of first return to colonies, age of first breeding, longevity,

Hutton's shearwater colony, Upper Kowhai Stream, Seaward Kaikoura Range, 1995

survival and mortality of adults and juveniles, recruitment of chicks, natal philopatry, and breeding frequency. Information is also needed on the extent of bird movements between sub-colonies.

H3. Research is needed to examine the interactions between fishing operations (methods of fishing and harvest levels) and the foraging behaviour and diet of Hutton's shearwater. Food samples should be collected from birds whenever the opportunity arises. Radio transmitters should be placed on breeding birds to monitor movements at sea during pre-laying, incubation, and chick rearing periods. Tracking of birds should reveal the distance birds feed offshore and how far they move from the Kaikoura Peninsula. Observations are needed on the importance of shoaling fish in the foraging strategy of Hutton's shearwater. Diet samples should be collected from radio-tagged birds for analysis and comparison with observed foraging zones and techniques. Dive depths and dive profiles are also needed from this species. This research will help to quantify the risks to Hutton's shearwater from fishing operations in the Kaikoura region.

M1. The flight paths used by Hutton's shearwaters to reach and depart from the breeding colonies need to be determined to help assess suitable locations for establishing new lower altitude breeding colony sites.

M2. The social behaviour and social organisation of this species needs further research. Vocalisations should be studied to determine if sexual differences are present in the calls and the extent of individual variation and recognition of calls. Courtship behaviour and displays need description. The response of Hutton's shearwater to tape playback of calls also needs research.

L1. When available satellite transmitters (weighing no more than 10 g) should be attached to breeding birds in early March and nearly fledged chicks to determine the migration flight path and foraging zone during the non-breeding season.

Black-fronted Tern *Sterna albostriata*

Conservation Status: Endemic species

IUCN rank: Endangered (A1b,c,e)

Molloy and Davis rank: Category B

Distribution

Black-fronted terns breed only in the South Island, mainly on riverbeds in the eastern South Island from Marlborough to Southland but a few occasionally nest on rivers in Westland. Birds disperse after breeding to coastal and inshore seas from Stewart Island to southern North Island with a few reaching Hawkes Bay, Bay of Plenty, and Kaipara Harbour. The species has not been recorded outside of New Zealand. Formerly, black-fronted terns may have nested on the Volcanic Plateau, North Island.

Population

Robertson & Bell (1984) estimated that there may be as few as 1000-5000 pairs of black-fronted terns. No national census of breeding colonies has been attempted for this species. However, counts of birds using Marlborough, Canterbury, Otago, and Southland rivers occurred in the 1970s and 1980s (O'Donnell & Moore 1983, Robertson et al. 1983, 1984, O'Donnell 1992, W. Cooper pers. comm 1999). Counts were also conducted in the upper Waitaki catchment during the 1960s and 1990s (Maloney et al. 1997, Maloney 1999). The largest populations in the 1980s were observed on the Ahuriri and Ashburton Rivers (O'Donnell & Moore 1983, Robertson et al. 1983). Most other rivers in lowland Canterbury supported less than 300 terns and Otago rivers had populations of less than 150 birds (O'Donnell 1992). Recently, 3302 black-fronted terns were counted in a census of the upper Waitaki catchment between 1991 and 1994 (Maloney et al. 1997).

Black-fronted terns have declined in numbers throughout their breeding range (O'Donnell 1992). Counts at some winter localities in the early 1990s (e.g. Farewell Spit) were only 25% of those recorded in the early 1980s (Higgins & Davies 1996). The population on the Ashburton River (the second largest population of this species in the 1980s) declined from over 750 birds in 1981 to less than 200 birds by 1990 (O'Donnell 1992). Similar declines have probably occurred on other lowland river systems. The population in Southland is probably less than 1000 birds and declining (W. Cooper pers. comm. 1999). Some of the best remaining habitat for black-fronted terns is likely to be in the upper Waitaki catchment (perhaps 50% of the total breeding habitat). Even here, the population on four rivers declined between the 1960s and 1990s (Maloney 1999).

Threats

Introduced predators are a key threat. Mustelids (especially ferrets) and feral cats take eggs, chicks, and occasionally adults at breeding colonies. Hedgehogs are an important egg predator in the upper Waitaki Basin and probably elsewhere (Sanders 1997). Other possible introduced predators include possums and

Norway rats. Australian magpies have been recorded killing chicks of black-fronted terns (Marchant & Higgins 1990). Australasian harriers may be a threat to chicks once they leave the nest.

Flooding of nests by storms and swollen rivers are natural hazards but availability of suitable nesting habitat has been restricted by the infestation of braided riverbeds by weeds, especially willows and Russell lupins (Maloney et al. 1997, 1999). Weed encroachment is a major threat, especially in lowland Canterbury rivers (O'Donnell 1992, R. Maloney pers. comm. 1999). Human disturbance of nesting colonies is increasing as industrial and recreational use of rivers increases. The extraction of gravel from riverbeds is a significant threat in Southland. Aside from the loss of nesting habitat, the consequent lowering of the riverbed increases the risk of flooding of nest sites (W. Cooper pers. comm. 1999). Vehicles on riverbeds may disturb nesting birds and sometimes destroy nest sites. In particular, 4WD vehicles are being used increasingly to access remote areas on rivers (K. Brown pers. comm. 1999). People walking, fishing, hunting, swimming or picnicking near black-fronted tern nests can also cause nest failure or abandonment if people spend too much time near the nests. Uncontrolled dogs accompanying people using the rivers are a threat to eggs and chicks. Sheep and cattle grazing riverbeds during spring and summer may occasionally cause disruption in nesting colonies. Future hydro scheme developments on braided rivers or water extraction for irrigation are also important potential threats to this species.

Previous Conservation Actions

1. The diet, foraging behaviour, social organisation, vocalisations, seasonal movements, and aspects of the breeding biology of black-fronted terns were studied by Lalas (1977, 1979a).

2. A series of riverbed surveys in the 1970s and 1980s mapped the distribution and numbers of black-fronted terns in Marlborough, Canterbury, and Southland (O'Donnell & Moore 1983, Robertson et al. 1983, 1984, W. Cooper pers. comm. 1999). Bird populations in the Upper Waitaki catchment were surveyed in the 1960s and 1990s (Maloney et al. 1997, Maloney 1999). Annual population counts were made on the Ashburton River between 1981 and 1990 (O'Donnell 1992).

3. The plumage development, moults, and winter movements of black-fronted terns were studied by Lalas & Heather (1980) and Latham (1981).

4. OSNZ carried out a national survey of black-fronted terns between 1981 and 1984. The aim was to investigate winter movements, plumage variation, age composition of flocks, roosting sites, and feeding behaviour. Birds were colour-banded in some seasons to study winter movement patterns and age-related plumage changes (Sagar & Heather 1981, 1982). Some findings of this study were reported by Heather & Sagar (1982).

5. The habitat of black-fronted terns in the Mackenzie Basin is being protected as part of Project River Recovery (Hughey & Warren 1997). Willows are being removed to maintain and restore breeding habitat (Maloney et al. 1999).

Project River Recovery is also carrying out predator research (establishing causes of nest losses, and studying hedgehog home range and diet) and is conducting a public awareness campaign to minimise the impacts of recreational users on riverbed fauna (K. Brown pers. comm. 1999).

6. A Ph.D. project by Rachel Keedwell (Massey University) began in September 1998 and is investigating the population dynamics, breeding biology, and natural history of black-fronted terns. Project River Recovery is also placing video cameras at nests of black-fronted terns in association with Rachel's research. The project will be completed by December 2001.

Future Management Actions Needed

E1. Further loss of braided river habitat will have a detrimental impact on black-fronted tern populations. Any proposals to establish further hydro-dams, remove gravel from riverbeds, or remove water for irrigation should be closely examined to see how they might impact on black-fronted tern populations using that river.

H1. Nest protection may be needed around key colonies, especially if the current research projects reveal that breeding success is adversely affected by introduced predators. In particular, nest protection may be needed in sites where rabbit populations have been reduced because predator pressure on the birds is likely to increase.

H2. Spraying or mechanical extraction of weeds on riverbeds may be required at sites outside of the upper Waitaki Basin if suitable nesting habitat continues to be lost to weed infestation.

M1. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting bird colonies.

M2. Off-road users must be made aware of the potential impacts of taking 4WD vehicles and motorbikes on riverbeds during the breeding season of terns and other bird species.

Future Survey and Monitoring Needs

E1. There is an urgent need to accurately census the size of the black-fronted tern population in New Zealand, especially following the recent release of Rabbit Haemorrhagic Disease (RHD) (formerly known as RCD) in the South Island. A survey of all South Island braided riverbeds should be undertaken between October and December. The location of all colonies should be mapped and breeding pairs counted. A joint survey by DOC staff and OSNZ volunteers may be needed, or contract staff employed to carry out this survey. Co-ordination of counts in the same region will be necessary, especially if breeding colonies fail and birds shift to nearby river systems.

H1. Accessible colonies in Marlborough, Canterbury, and Southland should be monitored annually. Ideally, one or two rivers should be checked each year, colonies mapped and all tern nests counted.

M1. Winter counts of black-fronted tern flocks are needed to help monitor trends in the population. These should be carried out in the same localities in the same month each year.

Research Priorities

Some aspects of the following research needs are being examined in the current Ph.D. study by Rachel Keedwell (Massey University).

E1. Research is needed on the movements of black-fronted tern populations within and between braided river systems to determine the fidelity of individuals to breeding sites and river systems. Do birds stay together as colonial groups even if they change breeding sites? Adults need to be individually marked to assess the extent of local movements.

H1. The breeding biology of black-fronted terns is poorly known. Breeding success has not been quantified and needs study. For example, are two chicks ever raised at the same nest? Is predation by mammalian predators affecting breeding success and nestling survival after leaving the colony?

H2. The population dynamics of black-fronted terns is unknown. Information is needed on age of first breeding, adult survival rates, juvenile recruitment and survival, natal site fidelity, pair bond fidelity, and longevity. In particular, research is needed on the possible impacts of mammalian predators on adult survival rates at breeding colonies and recruitment of juveniles.

H3. The presumed benefits of predator control need to be studied by comparing breeding success and survivorship at black-fronted tern colonies protected by predator control with nearby sites with no pest control. This research will also help to assess the medium-term impacts of the recent release of RHD on river nesting bird species. RHD is predicted to bring about changes in rabbit population density on and adjacent to riverbeds, and this is likely to result in predators switching to black-fonted tern populations.

M1. The movements of black-fronted terns after breeding need more detailed study. Birds need to be individually marked to determine if flocks from the same colony stay together after breeding, and find out if birds go to the same winter quarters each year and do juveniles remain with adults over the winter?

M2. The breeding cycle needs study to determine when birds return to rivers and establish colonies. Egg measurements and descriptions are needed. More information is needed on clutch size, incubation period, chick growth rates, nestling period, and extent of parental care after fledgling.

New Zealand Sooty Tern *Sterna fuscata kermadeci*

Conservation Status: Endemic subspecies

IUCN rank: Vulnerable (A1c,e + D2)

Molloy and Davis rank: not listed

Distribution

Breeds only at the Kermadec Islands (Raoul, North Meyer, South Meyer, Dayrell, Macauley, Curtis, Cheeseman). Elsewhere, other subspecies breed throughout the tropical and sub-tropical Pacific, Indian, and Atlantic Oceans. Birds disperse widely over tropical and sub-tropical seas. A sooty tern banded as a chick at Raoul Island in the 1960s was recently found breeding on the Seychelles (Indian Ocean) (Cossee 1995).

Population

Formerly, a very large population bred at Raoul Island (80,000 pairs in 1966/67) (Merton 1970) but only a few thousand pairs were present in 1993 (C. R. Veitch pers. comm. 1996). Predation of adults and chicks by feral cats and rats has been the cause of this dramatic decline (Taylor, R.H. 1979). In 1966/67, there were an estimated 2500 breeding birds on North Meyer, >4000 on South Meyer and c.3000 on Dayrell (Merton 1970). Bell (1970) found c50 pairs of sooty terns on Macauley Island in 1970. Birds possibly began to re-colonise the island after the removal of goats in 1970. By 1988, there were 10,000 pairs breeding on Macauley Island (Tennyson et al. 1989). However, the number of pairs on Curtis Island apparently declined during this same period. Bell (1970) found 10,000 nests in 1970 but by 1989, only 5500 pairs were recorded on Curtis Island (Tennyson & Taylor 1990a). The population on Cheeseman Island was estimated at 5000+ pairs in 1970 (Bell 1970). Elsewhere, there are some huge populations of other subspecies including up to a million breeding pairs at Lord Howe Island and 40,000-70,000 pairs on Norfolk Island and outliers. The total world population of sooty terns probably exceeds 25 million pairs (del Hoyo et al. 1996).

Threats

Feral cats are having a significant impact on the population at Raoul Island. They kill both adult birds and chicks. Norway rats are also important predators taking both eggs and young chicks (Taylor, R.H. 1979). Pacific rats have been observed chewing eggs under incubating adults at Macauley Island (G. Taylor unpub.) and presumably take eggs also at Raoul Island. The introduction of new mammalian predators would have a significant impact on the breeding populations, especially on islands which are currently predator-free. Feral goats formerly had an impact on populations breeding on Macauley and Raoul Island because they trampled nests and frequently disturbed the colonies. Fires may cause temporary losses in the populations but as the birds are surface nesters, fires are unlikely to cause losses of adult birds. Volcanic activity at Curtis or Raoul Island could potentially have a major impact on these breeding populations. The rapid regeneration of Macauley Island, following the removal of goats, may eventually lead to the loss of breeding habitat on the plateau although the colonies will probably shift to coastal slopes or behind beaches. The birds are easily disturbed by people wandering through or near colonies and disturbance is especially a problem when chicks are being reared. Visitor access to the breeding colonies needs to be strictly limited to protect the birds especially between November and March.

Previous Conservation Actions

1. Feral goats were eradicated from Macauley Island in 1970 and Raoul Island in 1984.
2. The populations on Cheeseman, Curtis, and Macauley Islands were surveyed in 1970 (Bell 1970).
3. The populations on Raoul Island and adjacent offshore islands were censused in 1966/67 (Merton 1970). The Denham Bay colony was censused again in 1978 (Taylor, R H 1979).
4. The populations on Macauley Island and Curtis Island were censused in 1988 and 1989 respectively (Tennyson et al. 1989, Tennyson & Taylor 1990a).
5. Large numbers of sooty tern chicks have been banded on Raoul Island since the 1960s (Merton 1970).

Future Management Actions Needed

H1. Norway and Pacific rats and feral cats should be eradicated from Raoul Island.

H2. Pacific rats should be eradicated from Macauley Island.

H3. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Kermadec Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

Future Survey and Monitoring Needs

H1. All islands in the Kermadec Islands should be inspected every 5 years to ensure that rodents and other introduced mammals have not colonised these islands.

M1. The sooty tern colony on Raoul Island should be censused annually in February to determine the number of chicks fledging from Denham Bay colony. A count of nesting adults should be carried out prior to the eradication of cats and rats and thereafter at 5-year intervals.

M2. The status of the Hutchinson Bluff colony on Raoul Island needs clarification. Up to 40,000 pairs were reported at this site in 1966/67, but there was no evidence of a breeding colony at this site in 1978.

M3. A survey is needed on the Meyer Islets and Napier Islet to determine the number of pairs nesting on these islands.

L1. The populations breeding on Macauley, Curtis, and Cheeseman Islands should be monitored every 10 years, including an accurate count of breeding pairs at each site.

L2. L'Esperance Rock should be surveyed between November and February to establish if sooty terns nest on this island.

Research Priorities

M1. The impact of Norway rats, Pacific rats, and feral cats could be studied on Raoul Island to determine the importance of each predator in the decline of sooty terns there. In particular, rodents could be trapped at the Denham Bay colony to isolate the impact of feral cats. Then, when this project is concluded, a poison operation can proceed on Raoul Island to eradicate all rodents.

L1. The taxonomy of sooty tern subspecies is weak and needs revision. The Kermadec Islands subspecies *kermadeci* (Mathews 1916 cited by Turbott 1990) was separated from other taxa on bill dimensions. However, the type specimen was described from Sydney, Australia, and was only assumed to come from the Kermadec Islands. Recent comparison of Kermadec Island birds with Norfolk Island and Lord Howe Island birds (Higgins & Davies 1996) throws doubt about the validity of this taxon. Males from these three island groups have significantly deeper and longer bills than males from tropical Australia. Some weights of birds sampled at the Kermadec Islands were heavier than any weights collected previously in Australian breeding colonies. One bird banded as a chick at Raoul Island in the 1960s was recently found breeding on the Seychelles (Indian Ocean) (Cossee 1995). This indicates that gene flow probably occurs between populations in the Pacific and Indian Oceans. A full revision using modern DNA techniques and comparison of morphology, plumage, feather lice, and vocalisations is needed.

L2. The ecology and breeding biology of this species has received little study in the Tasman Sea populations but is well known from research conducted at Christmas Island (Pacific Ocean) and Ascension Island (South Atlantic Ocean) (Higgins & Davies 1996). Detailed long-term studies are not recommended at the Kermadec Islands owing to the adverse impact on other seabirds breeding in the group and the potential adverse impact on sooty tern breeding success.

New Zealand Fairy Tern *Sterna nereis davisae*

Conservation Status:	Endemic subspecies
IUCN rank:	Critically Endangered (A1c,e + D1)
Molloy and Davis rank:	Category A

Distribution

Breeds only in Northland at Papakanui Spit (South Kaipara Head), Mangawhai and Waipu Estuaries. The species flocks in winter at Kaipara Harbour (Parrish & Pulham 1995b). Fairy terns formerly bred throughout the North Island and eastern South Island (Oliver 1955).

Population

The total New Zealand population in 1997-99 is about 25-30 birds (8-10 breeding pairs). The population declined by at least 50% since the 1970s but is currently stable or slightly increasing as a result of intensive management (Parrish & Pulham 1995b, Parrish & Honnor 1997).

Threats

The preferred nesting habitat of fairy terns is currently on open sand dunes although last century birds nested on braided riverbeds (Oliver 1955). Mobile sand dunes presumably provide some protection from natural and introduced predators. Mustelids and feral cats are likely to be key predators and can take eggs, chicks, and adults. Rats may also take eggs and chicks. Other possible introduced predators include hedgehogs and possums although the latter are unlikely to be common in open dunelands. Natural predators include black-backed gulls, harriers, and variable oystercatchers. Uncontrolled dogs are a major threat to eggs and chicks. People walking dogs on beaches may be a key reason why the species has declined in recent years at popular Northland beaches. Direct human disturbance is also a primary cause of nest failure. People driving motorbikes and 4WD vehicles on dunes disturb nesting birds and could potentially destroy nests. Recreational beach activities are greatly increasing on Northland beaches. People walking, fishing, sunbathing, swimming, or picnicking near fairy tern nests can also cause nest failure or abandonment if they spend too much time near the nests. Flooding of nests by spring tides and storms are natural hazards but the availability of suitable nesting habitat may have been restricted by the planting of marram or pine plantations on dunes and development of seaside resorts on sandspits.

Previous Conservation Actions

1. The New Zealand Wildlife Service initiated nest protection programmes around fairy tern nests in 1983. Nest sites were fenced and wardens employed to protect the birds from human disturbance. This programme has continued to the present and currently is managed by DOC in Northland and Auckland (Parrish & Honnor 1997, Pulham 1997).

2. Wardens, DOC staff, and members of OSNZ have carried out detailed monitoring of fairy tern breeding biology and breeding success. Chicks have been colour-banded and nest manipulations undertaken to enhance productivity. These manipulations include swapping eggs between nests to replace infertile clutches and artificial incubation of eggs in captivity. Intensive post-breeding surveys have also been undertaken and have located the winter flocking sites in the Kaipara Harbour. An accurate census of the total population is carried out each autumn (Parrish & Honnor 1997, Pulham & Dowding 1996, Honnor 1997).

3. The breeding biology of fairy terns has been studied in detail (Parrish & Pulham 1995a). Population dynamics are also being studied by DOC. Each chick is colour-banded to allow information to be collected on age of first breeding, longevity, natal site fidelity, and movements (Parrish & Honnor 1997).

4. Since the 1995 breeding season, some fairy tern nests have been monitored with IR time-lapse video cameras to determine cause of nest failures. Predator trapping has also been undertaken at some sites (Parrish & Honnor 1997).

5. A fairy tern recovery plan was approved in 1997 (Parrish & Honnor 1997).

6. The molecular systematics of New Zealand fairy terns was studied by Victoria University researchers (Chambers & Coddington 1998).

7. A study of fairy tern breeding biology and sex determination by DNA techniques was initiated by Massey University in 1998 (Treadgold 1998).

8. Captive rearing of fairy tern eggs and chicks has been carried out by Auckland Zoo in recent years both as a cross-fostering technique to allow eggs or chicks to be returned to fairy tern pairs with infertile eggs or as part of attempts to captive rear chicks for release into the wild.

Future Management Actions Needed

E1. On-going nest protection and employment of wardens will be needed for the foreseeable future to enhance breeding success and to continue recovery of the subspecies. Wardens are needed at each fairy tern nesting locality. Further nest surveillance is needed to identify predators and causes of nest failure.

E2. Trapping of potential predators should continue at each nesting locality.

E3. Nest manipulations should continue to maximise productivity. Infertile eggs should be removed to encourage re-nesting. Intra-specific cross fostering should also be used to enhance breeding success.

E4. Public education and advocacy is essential for fairy terns. This species nests in areas popular with the general public and support is needed from the public to enable access restrictions to continue on beaches to protect nest sites. Dog owners must be informed and educated about the risks dogs impose on ground-nesting seabird colonies.

H1. All flocking and nesting sites should be legally protected as wildlife refuges or wildlife management areas to help reduce human impacts on fairy terns.

Controlled Dog Areas should also be designated at all fairy tern breeding colonies and favoured roost sites.

Future Survey and Monitoring Needs

E1. Breeding success and breeding activity needs to monitored at each fairy tern nest each summer.

H1. The autumn flocks need to be censused annually to determine the size of the fairy tern population and to check for colour-banded birds.

H2. Surveys are needed to establish whether or not fairy tern juveniles remain in New Zealand during the winter. Checks are needed at both breeding sites and flock sites used by adults in winter.

H3. New nesting localities should be surveyed annually. Sites where the species formerly bred are probably the best locations to initially check for new pairs.

Research Priorities

H1. The sex and genetic relationships of all fairy terns in New Zealand need to be determined to assess any sex imbalance in the population and to determine the extent of relatedness of birds in the population. Blood samples should be collected from all chicks in the future and adults should be captured and have blood collected if practical. Research on this aspect is being undertaken by S. Treadgold (Massey University).

H2. Techniques for captive rearing of fairy tern chicks need to be developed. Further work is needed on helping captive-reared chicks to become independent in the wild without support of parent birds or zoo staff.

M1. The taxonomy of the New Zealand fairy tern needs further assessment to confirm the distinctiveness of the New Zealand population from those in Australia and New Caledonia. Research is currently being undertaken by Victoria University taxonomists.

M2. The habitat needs of fairy terns needs further investigation. Information is needed on how the birds' partition feeding areas and claim nest sites. Research may reveal if habitat is limiting the spread of fairy terns in New Zealand.

New Zealand White-fronted Tern *Sterna striata striata*

Conservation Status:	Endemic subspecies
IUCN rank:	Vulnerable (A1c,e)
Molloy and Davis rank:	Category C

Distribution

Breeds around the coasts and offshore islands of North, South, and Stewart Islands. A few colonies occur inland on riverbeds in the South Island. Other subspecies breed at the Auckland and Chatham Islands and on islands in Bass Strait, Tasmania. The New Zealand subspecies disperses over coastal waters and the continental shelf. Juveniles and possibly some adults migrate to southern and eastern Australia each winter.

Population

The New Zealand breeding population was estimated by Robertson & Bell (1984) to be between 100,000 and 1 million breeding pairs. This however appears to have been a vast overestimate of the population size or alternatively there has been a major population decline since the 1970s. A national census of white-fronted tern colonies carried out by OSNZ members between 1995 and 1997 found 4800 nests in 1995, 8800 nests in 1996, and 11,500 nests in 1997 (Powlesland 1998). The total breeding population is therefore likely to be between 12,000 and 15,000 pairs. The main breeding sites (>250 pairs) are Walker Island, Black Rocks, Papakanui Spit, Big Sand Island, Miranda, Waiaua Estuary, Portland Island, Waitangi Estuary (Hawkes Bay), Nelson Boulder Bank, Oparara Estuary, Waitaki River, Tiwai Spit, and Waiau Bar (Southland) (Powlesland 1998). There is evidence from counts in Northland that the species is declining, with fewer colonies and nests present in the 1990s than the 1970s (R. Pierce pers. comm. 1996).

Threats

White-fronted terns nest on the mainland at sites such as rocky headlands, beaches, sandspits, shellbanks, and braided riverbeds. Many colonies occur on predator-free offshore islands and stacks. Introduced predators are a key threat at mainland colonies. Mustelids (especially stoats and ferrets) and feral cats take eggs, chicks, and adults. Norway rats may also take eggs and chicks. Other possible introduced predators include hedgehogs and possums. Uncontrolled dogs are a major threat to eggs and chicks. Human disturbance is a primary cause of nest failure on the mainland. People driving motorbikes and 4WD vehicles on dunes disturb nesting birds and sometimes destroy nest sites. Recreational activities are greatly increasing on beaches and riverbeds. People walking, fishing, sunbathing, swimming, or picnicking near white-fronted tern nests can also cause nest failure or abandonment if people spend too much time near the nests. The species is apparently sensitive early in the nesting period. Flooding of nests by spring tides, storms, and swollen rivers are natural hazards but availability of suitable nesting habitat may have been restricted by the planting of marram or pine plantations on dunes, development of seaside resorts on sandspits, and the infestation of braided riverbeds by weeds.

White-fronted terns regularly catch small fish in association with schools of predatory fish such as kahawai or kingfish. Commercial fishing, especially long-lining of predatory fish and purse-seining of shoaling fish may be detrimental to white-fronted terns by reducing available fish stocks or by disrupting the relationship between terns and predatory fish. White-fronted terns are occasionally caught on fishing lines, especially when recreational fishers are trolling through schools of kahawai.

Previous Conservation Actions

1. The breeding biology, local movements, and aspects of the social organisation and population dynamics were studied at Kaikoura by Mills & Shaw (1980).
2. White-fronted terns were colour-banded by OSNZ members at the Nelson Boulder bank in the 1980s to determine their movements within New Zealand after the breeding season.
3. The employment of wardens in Northland, Auckland, and Bay of Plenty (Matakana Island) to protect shorebirds, especially fairy terns and New Zealand dotterels has had a beneficial influence on nesting white-fronted tern colonies in the same regions.
4. OSNZ carried out three consecutive national surveys of white-fronted tern nesting colonies and breeding pairs between 1995 and 1997 (Powlesland 1998).

Future Management Actions Needed

H1. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies. Controlled Dog Areas should be designated at all regionally significant mainland breeding colonies (>250 pairs).

M1. All large white-fronted tern colonies on the mainland (more than 250 pairs) should be protected by nest fences and signs displayed during the breeding season. Wardens should be employed to protect shorebirds at the larger publicly accessible colonies, especially during November-January.

Future Survey and Monitoring Needs

H1. White-fronted tern populations in Northland, Auckland, and Bay of Plenty (Matakana Island), which are protected by wardens, should be counted each year and an estimate made of the number of chicks reared at these sites.

M1.The national census of white-fronted tern colonies should be repeated over 3 consecutive years at 10-20 year intervals.

Research Priorities

H1. The diet of white-fronted terns has not been studied. Food samples should be collected from adults whenever the opportunity arises. A detailed study of food fed to chicks is needed to compare the diet in different years and geographical regions.

H2. Research is needed on the potential impacts (negative or positive) of fisheries activities on the food supply of white-fronted terns. Does harvest of predatory fish such as kahawai affect the availability for terns of small shoaling fish stocks? Observations on foraging behaviour need to be correlated with diet to assess whether or not fishing activities might influence the population status of this species.

M1. The population dynamics of white-fronted terns has been partially studied by Mills & Shaw (1980). Further detailed study is needed to determine adult survival rates, recruitment of chicks and survival to breeding age, longevity, fidelity of birds to pair bonds, and nesting colonies.

L1. Aspects of the breeding cycle and breeding biology need further study. The status of birds laying two eggs needs to be determined (early or late layers?, older birds?), re-laying ability needs to be confirmed, incubation shifts and incubation period need determination, and study is needed of chick growth rates, nestling period and extent of parental care following fledging. Breeding success also needs to be studied to determine variations between years, laying dates, and sites.

L2. The movements of white-fronted terns within New Zealand and also patterns of migration to Australia need further research. Chicks should be colour-banded with regional colours and year cohort markers to determine if winter flocks are composed of birds from the same region or from widely scattered colonies. Recruitment of chicks into natal colonies or geographic zones also needs study: in particular, are birds from the Auckland and Chatham Islands subspecies physically and/or genetically isolated from mainland populations?

L3. The social organisation, behaviour, and vocalisations of white-fronted terns needs more detailed study.

L4. The measurements and weights of birds from the Auckland Islands are significantly larger and heavier than mainland birds (Higgins & Davies 1996). This population was described by Mathews in 1929 as a separate subspecies. The Chatham Island population has also been included in this subspecies. A review of white-fronted tern taxonomy is needed using modern DNA techniques and a comparison of plumage, bare part colours, anatomy, body measurements, vocalisations, and body lice. Comparisons are needed of birds from Auckland, Chatham, Stewart, South, and North Islands and also birds in Australia which are described as a separate subspecies *incerta*.

Southern White-fronted Tern *Sterna striata aucklandorna*

Conservation Status: Endemic subspecies

IUCN rank: Vulnerable (C2a, D1)

Molloy and Davis rank: Category C

Distribution

Breeds only at the Auckland and Chatham Island groups. Breeding has been confirmed on Chatham, Rangatira, Mangere, Star Keys, Middle Sister, Murumurus, The Pyramid, and Houruakopara Islands. The subspecies disperses over coastal waters and the continental shelf near the breeding islands. Sightings of white-fronted terns at Campbell and Macquarie Islands are likely to be this subspecies. A colour-flagged tern banded as a chick on Chatham Islands was later sighted in Australia (Bell 1997).

Population

The size of the population nesting at the Auckland and Chatham Island groups is unknown but there are likely to be hundreds of pairs at each group. There were 100 pairs on Houruakopara Island in 1979, 120 chicks banded on Rangatira Island in 1977 (Imber 1994), and 150 chicks banded at the Chatham Islands in 1996 (Bell & Bell 1997) .

Threats

Southern white-fronted terns nest mainly on predator-free offshore islands and stacks although some nest on rock ledges or cliffs on the main islands. Introduced predators are a key threat in these latter sites. Feral cats and possibly feral pigs may take eggs, chicks, and adults on Chatham, Pitt and Auckland Islands. Norway rats may also take eggs and chicks on Chatham Island. Other possible introduced predators include weka, hedgehogs, and possums on Chatham Island. Uncontrolled dogs on Chatham Island are a possible threat to eggs and chicks. Human disturbance may cause nest losses at a few of the more accessible colonies.

Previous Conservation Actions

1. Sheep and cattle were removed from Rangatira Island in 1961 and sheep were removed from Mangere Island in 1968.

2. Feral goats were eradicated from main Auckland Island in 1995.

3. Rabbits, feral cattle, and mice were eradicated from Enderby Island in 1993, and rabbits were eradicated from Rose Island in 1993.

4. Birds were colour-flagged at the Chatham Islands in 1996 to determine movements of terns after the breeding season (Bell & Bell 1997, Bell 1997).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching offshore islands and the subantarctic islands.A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. Dog owners need to be informed and educated about the risks dogs impose on ground-nesting seabird colonies.

M2. Feral cats and pigs should be eradicated from main Auckland Island.

Future Survey and Monitoring Needs

H1. A survey is needed to locate breeding colonies of white-fronted terns at the Auckland Islands.An accurate count of breeding pairs is needed to assess the size of the population.

H2. A survey is needed of all breeding colonies on the Chatham Islands and counts are needed of the number of breeding pairs.

M1. The populations of white-fronted terns on Rangatira and Mangere Islands should be monitored annually and accurate counts made of the number of breeding pairs.

Research Priorities

H1. The measurements and weights of birds from the Auckland Islands are significantly larger and heavier than mainland birds (Higgins & Davies 1996).This population was described by Mathews in 1929 as a separate subspecies. The Chatham Island population has also been included in this subspecies.A review of white-fronted tern taxonomy is needed using modern DNA techniques and a comparison of plumage, bare part colours, anatomy, body measurements, vocalisations, and body lice. Comparisons are needed of birds from Auckland, Chatham, Stewart, South, and North Islands and birds in Australia which are described as a separate subspecies *incerta*.

L1. The movements of southern white-fronted terns needs further research. Do these birds disperse within New Zealand and does each population migrate to Australia? Chicks should be colour-banded with island colours and year cohort markers to study movements in this subspecies. Recruitment of chicks into natal colonies or geographic zones also needs study. In particular, are birds from the Auckland and Chatham Island groups physically and reproductively isolated from mainland populations?

Antarctic Tern *Sterna vittata bethunei*

Conservation Status:	Endemic subspecies
IUCN rank:	Vulnerable (C2a)
Molloy and Davis rank:	not listed

Distribution

Breeds at The Snares, Auckland, Campbell, Antipodes, and Bounty Islands. Also breeds on offshore islands around southern Stewart Island including Islet Cove, Port Pegasus, Moggy, Putauhina, Solomon, and possibly Big South Cape Island.

Population

The New Zealand subspecies is considered to have less than 1000 breeding pairs (Robertson & Bell 1984). There are 70 pairs at The Snares but no estimates are available from other island groups. The Macquarie Island population (sometimes included in *bethunei*) has 40 breeding pairs. Elsewhere, other subspecies of Antarctic terns have larger populations, including an estimated 35,000 breeding pairs at the South Shetland Islands.

Antarctic tern defending its nest, Campbell Island, 1987

There are less than 1000 breeding pairs of the New Zealand subspecies of Antarctic tern. The subspecies breeds on the subantarctic islands and a few islands off southern Stewart Island.

Threats

Antarctic terns are vulnerable to predation by introduced mammals. Surprisingly, the species still breeds on Campbell Island in the presence of Norway rats and fomerly feral cats. Some egg predation by rats has been observed on Campbell Island but chicks are also successfully reared (Sadleir et al. 1986). Feral cats may take some adults or chicks on Auckland Island although cat predation has not been observed at this site. Feral cats, however, have been recorded killing terns at other islands (Higgins & Davies 1996). Pacific rats and ship rats might prey on eggs and chicks at colonies on the islands off Stewart Island. Weka are also a threat to nesting birds on the islands off Stewart Island. Feral sheep were observed trampling nests on Campbell Island prior to sheep being eradicated (G. Taylor pers. obs.). Feral goats, rabbits, and cattle may have caused similar problems on Auckland, Rose, and Enderby Islands in the past. Brown skuas and black-backed gulls probably take a few eggs and chicks at most colonies. Predation by these species may be more severe if alternate natural food supplies have dwindled (e.g. declines of albatrosses, petrels, penguins, and seals). Visitor access to breeding colonies should be strictly controlled to minimise the impact on eggs and chicks (both are very cryptic and easily trampled by unwary humans).

Previous Conservation Actions

1. Cattle and sheep were eradicated from Campbell Island by 1984 and 1991 respectively.
2. Feral goats were eradicated from Auckland Island in 1995.
3. Cattle and rabbits were eradicated from Enderby Island in 1993 and rabbits from Rose Island in 1993.
4. The breeding biology, plumages, seasonal movements, foraging behaviour and diet of this subspecies was studied at The Snares by Sagar (1978) and Sagar & Sagar (1989).
5. The breeding timetable, nesting sites, and seasonal movements of this subspecies were studied at Campbell and Antipodes Islands by Sadleir et al. (1986).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the breeding islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. Norway rats should be eradicated from Campbell Island.

M2. Feral cats and pigs should be eradicated from Auckland Island.

M3. Ship and Pacific rats should be eradicated from islands off southern Stewart Island if agreement is reached with local iwi.

M4. Weka should be removed from those islands off Stewart Island which have nesting colonies of Antarctic terns, provided agreement is reached with local iwi or the sites are not considered critical for the survival of weka in this region.

Future Survey and Monitoring Needs

H1. All larger islands in the New Zealand subantarctic should be visited once every 5 years to ensure that no new mammalian predators have established on these islands.

M1. Confirmation is needed that Antarctic terns still nest on the islands off Stewart Island. In particular, a survey is needed to determine which islands are used as breeding colonies and counts made of breeding pairs where possible.

M2. The size of breeding populations is poorly known on all the subantarctic islands except The Snares. Surveys are needed at each island group to estimate the number of breeding pairs. If a full census is not possible then counts of Antarctic tern flocks would also be useful.

M3. The Snares Island population should be monitored every 10 years to establish trends in Antarctic tern populations in the New Zealand region.

Research Priorities

M1. The Snares population has been studied by Sagar (1978). Colour-banded birds are present in the population including birds banded as chicks. This population should continue to be studied to provide information on population dynamics (age at first breeding, longevity, adult mortality rates, survival and recruitment of fledglings, natal philopatry etc.).

L1. Breeding success data have only been collected from a small sample of nests at The Snares. There are no data available from other New Zealand populations. Information is needed to help understand why New Zealand has very small breeding populations of Antarctic terns compared with populations of other subspecies, e.g. South Shetland Islands.

L2. The movements of Antarctic terns during the non-breeding season are still poorly known. It appears some populations are sedentary, e.g. Campbell Island. Winter counts are needed at each island, including an assessment to determine which age groups are present on each island during the winter (May-August).

L3. The taxonomy of Antarctic terns still needs further work. HBW recognises six subspecies including *S. v. macquariensis* from Macquarie Island. HANZAB recognises only five subspecies. The Macquarie Island population overlaps in plumage features and measurements between the subspecies *bethunei* and *vittata*. Subspecies were originally separated on plumage features and body measurements. A revision is needed using modern DNA techniques, and a closer examination of plumage, morphology, vocalisations, and feather lice from a larger sample of birds from each island group.

Pitt Island Shag *Stictocarbo featherstoni*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds only at the Chatham Islands (Chatham, Pitt, Rangatira, Mangere, Little Mangere, Star Keys, The Pyramid, Big and Middle Sister, Murumurus, Rabbit, The Castle). The species feeds at sea near the breeding islands and has never been recorded away from the Chatham Islands.

Population

Robertson & Bell (1984) estimated that there were less than 1000 breeding pairs. A 1997 census over the entire breeding range on the Chatham Islands found 669 breeding pairs at scattered sites (M. Bell pers. comm. 1998).

Threats

The species usually nests on cliffs or on offshore islands and is probably not at risk from dogs, pigs, or stock. However, a few nests on Chatham and Pitt Islands have been found at sites accessible to feral cats. Possibly a few birds are taken by these predators. Norway and ship rats may take eggs and chicks at some colonies on Chatham Island, although there are no observations to measure their effect. Weka possibly take eggs or chicks at some colonies on Chatham and Pitt Island. Pitt Island shags are reasonably tolerant of disturbance by humans (compared with Chatham Island shags). Occasionally, shooting of shags is reported (M. Bell pers. comm. 1998). Shags are sometimes caught in crayfish pots but the effect on populations is unknown (D. Bell pers. comm. 1998). Set-netting presents a moderate risk to this species although this method of fishing is uncommon at the Chatham Islands. The risk of oil spills impacting on this subspecies is minimal because shipping volume is very low near the Chatham Islands.

Previous Conservation Actions

1. Sheep and cattle were removed from Rangatira Island in 1961.
2. Sheep were removed from Mangere Island in 1968.
3. A census of all breeding pairs was carried out in 1997 (M. Bell pers. comm. 1998).

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching offshore island colonies. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. Feral cats and weka should be removed from part or all of Pitt Island if suitable agreements are reached with the residents. Sheep, cattle, and pigs should be removed (by fencing?) from areas on Pitt Island and Chatham Island that are suitable for shag breeding colonies. Fencing will need to be arranged with private landowners if domestic stock is also found to impact on shag colonies.

Future Survey and Monitoring Needs

H1. The breeding population at two accessible colonies (Pitt Island?, Rangatira Island?) should be monitored annually to determine trends in the breeding population (number of breeding pairs).

M1. A census of the entire adult population (breeders and non-breeders) should be attempted once suitable methodology for counting all birds has been determined (possibly dawn or dusk counts of roosting birds).

M2. The entire breeding population should be censused again at 10-year intervals.

Research Priorities

M1. The population dynamics of Pitt Island shags are unknown. There is no information available on age of first breeding, longevity, adult mortality rates, chick survival and recruitment, natal philopatry, pair and nest site fidelity, etc. Studies should consider either banding cohorts of chicks with a single colour-band for each year class plus a locality colour-band, or individually colour-banding chicks (or adults if they can be captured) so that on-going disturbance at the colony can be minimised.

L1. The taxonomy of the spotted shag group (spotted shag, blue shag and Pitt Island shag) needs further assessment. Some authors consider spotted shags to be monotypic. A review is needed using modern DNA techniques and a comparison of plumage, anatomy, body measurements, vocalisations, and body lice.

L2. The Pitt Island shag is one of the least known seabirds breeding in New Zealand. Almost no work has been done on this species. There is nothing known about the diet, social organisation, vocalisations, and breeding biology. Very little information has been collected on morphometrics, weights, and moult. Work on almost any aspect of the species biology and ecology is needed.

Masked Booby *Sula dactylatra fullagari*

Conservation Status: Indigenous subspecies

IUCN rank: Vulnerable (B1+B2c, C2a, D2)

Molloy and Davis rank: not listed

Distribution

Breeds at the Kermadec Islands (North Meyer, South Meyer, Dayrell, North Chanter, South Chanter, West Chanter, Macauley, Haszard Islet, Curtis, Cheeseman). Elsewhere, the subspecies breeds only in the north Tasman Sea at Lord Howe and Norfolk Island groups. Other subspecies breed in the Caribbean Sea; southwest Atlantic Ocean; Indian Ocean; northern Australia; and western, central, and eastern Pacific Ocean.

Population

There were 36 breeding pairs on the islets off Raoul Island in 1966/67 (Merton 1970). Macauley Island had 100 breeding pairs in 1988 (Tennyson et al. 1989) and Curtis Island had 55 breeding pairs in 1989 (Tennyson & Taylor 1990a). Bell (1970) found 75 pairs and 25 pairs respectively at these islands in 1970. The population on Norfolk and Lord Howe Island groups is 500-1000 pairs. The total population of subspecies *fullagari* is less than 1200 breeding pairs. This makes masked boobies one of our rarest seabird taxa. Population sizes of other subspecies are also small except at a few locations. The largest population of masked boobies is at the Galapagos Islands which has 25,000 to 50,000 pairs.

Threats

Masked boobies are sensitive birds and very easily disturbed by prolonged human activity at the breeding grounds. The species does not nest in association with human habitation at any island group (Nelson 1978). Visitor access to these breeding sites needs to be strictly controlled. Elsewhere, masked booby populations are threatened by egg collection and people killing adults, but the New Zealand populations are fully protected and breed on remote islands. Feral cats and possibly rats take eggs and chicks at some islands, and dogs are capable of killing adult birds. Feral goats formerly disturbed nesting birds on Macauley Island. Nest sites may be limited at the Kermadec Islands because the small islands are covered in forest or dense *Cyperus* sedges. The loss of open ground on Macauley Island may eventually push this species to nesting only on clifftops (Taylor & Tennyson 1988). Fires may cause temporary losses during the breeding season but would be unlikely to kill the surface-nesting adults. Volcanic activity at Curtis or Raoul Islands may disrupt breeding in some seasons although the closely related Australasian gannet seems to cope with periodic volcanic eruptions on White Island.

Previous Conservation Actions

1. Feral goats were eradicated from Macauley Island in 1970 and from Raoul Island by 1984.
2. The populations nesting on the islets off Raoul Island were surveyed in 1966/67 (Merton 1970).
3. The population nesting on Macauley Island was surveyed in 1970 (Bell 1970) and 1988 (Tennyson et al. 1989). Birds were banded in both these years.
4. The population breeding on Curtis Island was surveyed in 1970 (Bell 1970) and 1989 (Tennyson & Taylor 1990a). Birds were banded in the latter expedition.

Future Management Actions Needed

H1. Pest quarantine measures are needed to prevent new animal and plant pest species reaching the Kermadec Islands. A pest contingency plan should be available to enable a rapid response to any new introductions or events that may cause an introduction.

M1. Feral cats, Norway and Pacific rats should be eradicated from Raoul Island.

L1. A new colony of masked boobies should be established on Raoul Island once predators are eradicated. Models of breeding birds and playback of calls may be needed to lure adult birds to the new colony site.

L2. Pacific rats should be eradicated from Macauley Island.

Future Survey and Monitoring Needs

M1. The populations nesting on each island in the Kermadec Island group should be monitored every 10 years to determine number of breeding pairs.

L1. All birds at the Kermadec Islands should be checked for bands during monitoring trips.

Research Priorities

M1. The taxonomy of masked boobies is still uncertain. The Tasman Sea subspecies has been recently described, based on eye colouring and wing dimensions (O'Brien & Davies 1990). The validity of all subspecies needs further assessment looking in particular whether or not New Zealand birds should be included in *fullagari*. Assessments should include DNA techniques and examination of morphometrics, plumage, bare part characteristics, and vocalisations.

L1. The timing of the breeding cycle is poorly known in New Zealand. Monthly visits are needed to the Meyer Islets to record the number of birds ashore and number of nests and record if eggs or chicks are present. Nest sites should be marked and a sample of pairs could be banded to determine if pairs re-nest in the same season as has been reported at other colonies.

L2. The diet of the birds at the Kermadec Islands and other Tasman Sea populations is poorly known. Elsewhere the diet has been studied thoroughly, e.g. populations breeding in the South Atlantic and North Pacific Oceans. Food samples from New Zealand birds should be collected and sent to diet experts, e.g. Dr Mike Imber (DOC, Wellington), whenever the opportunity arises.

L3. The breeding biology of this species has been well studied outside New Zealand. The population dynamics of masked boobies are poorly known (e.g. age of first breeding, adult survival rate, chick recruitment, etc.). Studies are best undertaken on more accessible colonies elsewhere. All New Zealand populations nest on fragile seabird islands, and collecting long-term information about this species would have a significant impact on other seabird colonies.

Masked booby adult and chick, Curtis Island, 1989

The masked booby is a tropical gannet that specialises in feeding on flying fish. The total population of subspecies *fullagari* is less than 1200 breeding pairs, confined to Lord Howe, Norfolk, and Kermadec Islands. Masked boobies are very sensitive to human disturbance and seldom nest on inhabited islands.

Buller's Albatross *Thalassarche bulleri*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds at the Snares Islands (Main or North-East, Broughton, Alert Stack, Daption Rocks, Toru Islet) and Solander Islands (Big Solander, Little Solander, adjacent offshore stacks). Birds forage during the breeding season in the Tasman Sea, Pacific Ocean east of South Island, and over shelf areas south of Stewart Island (Stahl et al. 1998). After breeding, the species disperses across the South Pacific Ocean, north of the Antarctic Convergence, reaching the Humboldt Current off Chile and Peru (J-C Stahl & P. Sagar pers. comm. 1998).

Population

The total annual breeding population was estimated at 13,760 pairs in 1992 (Sagar et al. 1994) but this has been recently revised to c.11,500 breeding pairs (Sagar et al. 1999). There were 8460 breeding pairs on Snares Islands in 1992 (Sagar et al. 1994), a 64% increase between counts made in 1969 and 1992. The Snares population has continued to increase and 8877 pairs were present in 1997, an 8% increase since 1992 (Sagar et al. 1999). The Solander Islands had an estimated 4300 to 5300 breeding pairs in 1985, based on a less reliable aerial count of Big Solander Island and an accurate ground count of chicks on Little Solander Island (Cooper et al. 1986). A comprehensive ground and aerial survey in 1996 indicated a population of only 2625 breeding pairs. However, the number of breeding pairs on The Snares in 1996 was 15% lower than recent years. If a correction factor was applied to allow for possibly fewer pairs present in 1996, then 3088 pairs may nest on the Solander Islands. Comparable counts made on Little Solander Island in 1985 and 1996 suggest that the population has declined by 18.7% or at best stayed stable in this period (Sagar et al. 1999)

Threats

There are no introduced mammals on the Snares or Solander Islands. Weka were introduced to Big Solander Island and may have a slight impact on breeding success. Temporarily abandoned eggs were broken and eaten by weka in February 1996 (G.Taylor pers. obs.) and young unguarded chicks may also be at risk. All breeding islands have restricted access (Nature Reserves or Specially Protected Areas) which limits human disturbance at nest sites. The species is sensitive to being handled during incubation, and some birds deserted nests on Big Solander Island in February 1996 (G.Taylor pers. obs.). Avian pox virus (spread by bird fleas) has caused high chick mortality in some seasons at colonies of shy albatrosses (*Thalassarche cauta*) off Tasmania (Gales 1993). Avian diseases may be a potential threat to adults and chicks of Buller's albatross. Leeches (*Ornithobdella* spp.) and ticks (*Ixodes* spp.) are potential vectors of avian disease at the Snares and Solander Islands. Fire could be a risk to breeding birds on the larger islands because Buller's albatross often nest under forest or amongst shrubs, and the incubation period is during February-March (the islands' driest months of the year).

Buller's albatross was the most frequently caught albatross on southern bluefin tuna long-lines in the New Zealand EEZ between 1988 and 1992 (Murray et al. 1993). All birds autopsied were adults with both sexes evenly represented. All the captures reported by observers were on the Puysegur Bank near the Solander Islands (Murray et al. 1993). From the apparent decline of birds at the Solander Islands, it appears most of the long-line mortality is coming from this population. Recent summaries of seabirds captured on tuna long-lines in the New Zealand EEZ show that Buller's albatross formed 8% of the birds captured between 1988 and 1997 (Baird et al. 1998). The species is also caught on long-lines on the high seas and there is a report of a banded bird caught south-west of the Galapagos Islands (Warham 1982). Small numbers of Buller's albatross are caught in trawl fisheries, especially squid fisheries in southern New Zealand (Bartle 1991, DOC fisheries observer programme unpub.). Previously, most birds were killed by net-sonde monitor cables on Russian trawlers, however, this source of mortality has been reduced by the phasing out of these devices in the New Zealand EEZ after 1992. The commencement of new long-lining fisheries off Peru and Chile may put this species at risk during the non-breeding season (Spear et al. 1995). Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. Plastics are known to be ingested by this species (West & Imber 1986). Buller's albatross, however, forage widely in the South Pacific Ocean, so the species may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. Buller's albatross have been studied at the Snares Islands since 1948. Richdale (1949a, 1949b) studied the behaviour of birds during egg-laying and incubation, and banded a sample of breeding birds. Further adults were banded in 1961, and aspects of the breeding cycle and breeding biology were subsequently studied between 1966 and 1977 (Richdale & Warham 1973, Horning & Horning 1974, Sagar & Warham 1998). Information was also collected on adult survival, longevity, pair-bond, and nest site fidelity (Richdale & Warham 1973, Sagar & Warham 1993). Breeding birds were censused on North-east Island and adjacent islands and islets in 1969 (Warham & Bennington 1983).

2. A detailed study was made of courtship displays and vocalisations at the Snares Islands in 1982/83 (Warham & Fitzsimons 1987). Five breeding pairs were found on Toru Islet in 1984 (Miskelly 1984). Diet samples collected at the Snares Islands were analysed by West & Imber (1986).

3. The population on the Solander Islands was estimated in 1985, and chicks were banded on both Little and Big Solander Islands (Cooper et al. 1986).

4. A new study of Buller's albatross began on the Snares Islands in 1992. An accurate ground census was carried out on North-east Island and adjacent islands and stacks in 1992 (Sagar et al. 1994) and was repeated in 1997 (Sagar

et al. 1999). A study colony was established and breeding pairs and chicks were banded annually. Annual surveys were undertaken to collect information on breeding productivity and adult survival. Methods for sexing birds and natal philopatry were assessed (Sagar et al. 1998). Satellite tracking of breeding birds during incubation and chick rearing was carried out to obtain data on movements at sea during the breeding season (Sagar & Weimerskirch 1996). The annual distribution of Buller's albatross in the Australasian area was reviewed by Stahl et al. (1998).

5. A concurrent study was started in 1996 at the Solander Islands to collect information on population dynamics (adult survival, chick recruitment). A comprehensive ground and aerial census of breeding pairs was completed in February 1996 (Sagar et al. 1999).

6. A comparison of the diet of Buller's albatross from Solander Island and The Snares has been studied recently. Seasonal variation in types of foods fed to chicks will be assessed and also the importance of fisheries waste in the diet. The research programme will correlate diet with foraging zones (using satellite telemetry) and study sexual differences in the type of food items consumed. Meal size and feeding frequency by adults during the chick-rearing period are also being studied (P. Sagar & J-C Stahl pers. comm. 1998).

7. In 1998, FORST funding was obtained by P. Sagar (NIWA) for a further 6-year research programme entitled "Modelling the effects of fisheries mortality on seabirds". There are three main objectives to this programme:

   a) Population dynamics of the Snares and Solander Islands birds, specifically population size and trends, annual adult survival, breeding frequency, breeding success, recruitment, age of first breeding, and survival of known-age birds.

Buller's albatross on nest, Big Solander Island, 1996

Buller's albatross was the most frequently caught albatross on southern bluefin tuna long-lines in the New Zealand EEZ between 1988 and 1992. All the captures reported by fisheries' observers were on the Puysegur Bank near the Solander Islands. The Solander Islands populations have declined in recent years.

b) Foraging, specifically to describe foraging patterns of birds of different age, sex, and population. This may determine foraging decision rules with respect to weather and moon phase.

c) Develop a spatially explicit model of albatross foraging to assess fishery mortality risk by comparing the distribution and abundance of Buller's albatross with the extent of fishing activity in different areas of ocean.

8. Public awareness of the plight of albatross species has increased in recent years with media exposure and increased publication of work implicating oceanic fisheries in the decline of some albatross species (Gales 1998). Contact with the fishing industry has been initiated, and investigations have started to determine ways of addressing the bycatch problem.

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

M1. Weka should be eradicated from Big Solander Island.

Future Survey and Monitoring Needs

H1. Information is needed from observer programmes in South American EEZs to determine if Buller's albatross are being caught by long-liners or trawlers in these areas.

H2. Annual monitoring of study colonies should continue at the Snares and Solander Islands until the completion of the current research programmes. A population census should be conducted every 5 years at both island groups.

Research Priorities

H1. The movements and dispersal patterns of fledglings needs further research using satellite telemetry. The dispersal and migrations of adults during the non-breeding season is still poorly known.

L1. The growth rate and development of chicks has not been studied in detail at any site.

L2. The development of adult plumage and bill characters needs investigation. It is not yet known at what age adult bill characters and plumage are developed. Research is also needed to determine means of separating adult and juvenile Pacific albatross from Buller's albatross at sea and in the hand.

Grey-headed Albatross *Thalassarche chrysostoma*

Conservation Status: Indigenous species

IUCN rank: Endangered (A1a, d)

Molloy and Davis rank: Category B

Distribution

The only New Zealand breeding population is at Campbell Island. Elsewhere breeds at Macquarie, Kerguelen, Crozet, Marion, Prince Edward, South Georgia, and Chile (Diego Ramirez Island). Birds disperse widely over the Southern Ocean and temperate seas of the South Atlantic, Indian, and South Pacific Oceans. Band recoveries from Campbell Island birds suggest they forage in the Tasman Sea, south of Australia and east of New Zealand. Birds occasionally forage over shelf break waters but prefer deep pelagic seas (Waugh 1998, Waugh et al. 1999a).

Population

The total annual breeding population at all localities is about 92,300 pairs (equivalent to a total population of 600,000 individuals in this biennially breeding species) (Gales 1998). The breeding population at Campbell Island is currently about 6000-9000 pairs per annum (P. Moore pers. comm. 1998) and has declined since the 1940s (Moore & Moffat 1990c). Three grey-headed albatross colonies declined by 79-87% since the 1940s (Moore 1995). At one of these colonies, the decline appears to have been continuous, rather than over the shorter period that occurred for Campbell albatrosses (Waugh et al. 1999b). The current decline (1992-96), estimated by counts at three colonies, is 3.1% to 3.7% per annum. SURGE computer modelling of band recovery data indicates that the population is declining at 2.8% per annum, apparently from low juvenile survival and low fecundity (Waugh et al. 1999b). Adult survival from 1984-95 varied little, at an average of 0.953, which is similar to grey-headed albatross populations on South Georgia. Average survival of chick cohorts from 1975-89 were estimated for Age 1-5 years at 0.235, and for Age 6-20 years at 0.94 (Waugh et al. 1999b). Survival of juveniles to first recapture at 16% is similar to that recorded at South Georgia (18.6% - 19.1%) during the 1970s and 1980s. However, less than 5% of South Georgia juveniles currently survive to recruit to the breeding population. These high losses are attributed to the impacts of long-line fisheries (Croxall et al. 1998).

All populations that have been studied are either stable or declining, except the small Marion Island population which declined between 1970 and 1990 but began to increase slightly after 1992 (Gales 1998). Overall, world populations may decline by 50% or more over three generations (1960-2020) if past and present levels of juvenile mortality and lack of recruitment continue, especially as long-line fisheries are expanding in the Atlantic Ocean and elsewhere (Prince et al. 1998).

Threats

Few land-based threats exist today. The biggest impact is from a natural predator, the brown skua, which is an efficient predator of eggs and weak chicks. As density and size of albatross colonies decrease they may have an even more adverse effect, as seems to be the case for declining rockhopper penguin colonies (P. Moore pers. comm. 1998). Formerly, feral sheep disturbed nesting birds and may have increased the level of brown skua predation on eggs and chicks. There was no evidence from studies in 1984 that Norway rats preyed on eggs and chicks of this species (Taylor 1986). Feral cats may have taken a few young chicks in the past. The cat population may have died out because sightings have not been confirmed since the mid-1980s (Moore 1997). Disturbance by human visitors has some impact because the species is more sensitive to disturbance than Campbell albatross and some birds will abandon nests if handled during incubation (G.Taylor pers. obs.). The fire risk on Campbell Island is low because the climate is typically wet although peat fires are a possible risk.

Grey-headed albatross preening its chick, Bull Rock colony, Campbell Island, 1984

Three grey-headed albatross colonies at Campbell Island have declined by 79-87% since the 1940s. The current decline (1992-96), estimated by counts at three colonies, is 3.1% to 3.7% per annum. Large numbers of grey-headed albatross have been caught on southern bluefin tuna long-lines, particularly in the high seas. Juvenile grey-headed albatrosses seem most at risk.

Ixodes uriae ticks are common on birds at the colonies (Moore & Moffat 1990a). Ticks and Norway rats may be a vector for diseases such as avian cholera, which has killed rockhopper penguins at Campbell Island (de Lisle et al. 1990), or for other diseases such as avian pox or avian malaria. Malarial antibodies have been recorded from yellow-eyed penguins on Campbell Island (Graczyk et al. 1995).

At sea, the main threat is from long-line fishing (Gales 1993). Large numbers of grey-headed albatross have been caught on southern bluefin tuna long-lines particularly in the high seas off Australia and the Indian and South Atlantic Oceans (Prince et al. 1994, Uozumi 1998, Gales 1998). Very few are killed by long-lines in the New Zealand EEZ (Murray et al. 1993, Baird et al. 1998) because the species typically feeds over deep water away from the continental shelf. Grey-headed albatross was the fourth most common seabird species caught on tuna long-lines over the Australian EEZ between 1991-95 (Gales et al. 1998) and were the second commonest species in 1996 (Brothers et al. 1998). A few adults are caught but the vast majority caught in Australasian seas are juveniles (Gales et al. 1998). The high capture rate of juveniles on long-lines coincides with a low recruitment rate of juveniles at colonies (Prince et al. 1994, Croxall et al. 1998). This is probably the key factor contributing to the current decline of this species. However, because the decline at Campbell Island appears to have started prior to the 1960s and long-lining activity only started to spread in the Southern Ocean in the late 1960s (Polacheck & Tuck 1995) there is also likely to be a natural phenomenon occurring (Waugh et al. 1999b). Other species at Campbell Island (rockhopper penguins, elephant seals) have also declined since the 1940s (Cunningham & Moors 1994, Taylor & Taylor 1989). These declines have been attributed to changes in food availability as a result of ocean warming since the 1950s. This same factor may have had an impact on grey-headed albatross populations. Small numbers of grey-headed albatross were killed by Russian trawlers fishing for squid in 1990 (Bartle 1991). Most of the mortality behind trawlers was caused by net-sonde monitor cables which were banned from use in the New Zealand EEZ in 1992. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills.

Previous Conservation Actions

1. The breeding cycle and aspects of the breeding biology of grey-headed albatross were studied by J. Sorenson in the 1940s (Bailey & Sorensen 1962).

2. Feral sheep were fenced out and eradicated from the northern half of Campbell Island in 1970.

3. Cohorts of chicks were banded at Courrejolles colony up to 1970 and at Bull Rock South colony from 1970 by Meteorological Station staff and visiting biologists.

4. Information was collected on the distribution of breeding colonies, morphology, and breeding biology of grey-headed albatross in 1975 (Robertson 1980). An estimate was made of the breeding population at these colonies in 1975.

5. The effects of Norway rats were studied on this species in 1984 (Taylor 1986). Study nests were marked at Bull Rock South colony, and adult birds were banded at nests. These pairs were used to determine breeding productivity and to establish a baseline for the collection of adult survival data (Taylor 1986). Replacement of old worn aluminium and monel bands was started in 1984. Colony photographs taken in 1984 and 1986 revealed that albatross populations had declined at some colonies when compared with photographs taken in the 1940s.

6. Permanent photopoints were established in 1987, and each colony was photographed and counts made of breeding pairs (Moore 1995). Breeding productivity and growth rates of chicks were studied in 1987/1988 and large numbers of banded birds were captured (Moore & Moffat 1990c). Estimates of productivity were collected in most years from 1987 to 1997 (Waugh et al. 1999b).

7. A detailed study on the distribution and size of breeding populations was initiated by Peter Moore (DOC) in the 1990s. Ground counts of accessible colonies have been undertaken since 1992. This was intensified in three seasons (1995-96, 1996-97, and 1997-98) to establish more accurate trends, separate out the trends of Campbell and grey-headed albatrosses and to link ground counts with photopoint counts.

8. The population dynamics, diet, feeding frequency, and foraging activity of grey-headed albatross were studied recently by S. Waugh (see Waugh 1998, Waugh et al. 1995, 1999b, Waugh et al. in press a,b, Cherel et al. in press). Band recoveries at Bull Rock South colony have been analysed to calculate survival rates of adults and recruitment rates of chicks (Waugh et al. 1999b). Movements of banded birds were analysed (Waugh et al. 1999a) and geographical variation in morphometrics of grey-headed albatross populations were assessed (Waugh et al. in press c).

9. Public awareness of the plight of albatross species has increased in recent years with media exposure and increased publication of work implicating oceanic fisheries in the decline of some albatross species (Gales 1998). Contact with the fishing industry has been initiated, and investigations have started to determine ways of addressing the bycatch problem.

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

M1. Norway rats should be eradicated from Campbell Island.

Future Survey and Monitoring Needs

H1. A baseline estimate is now available of the breeding population of grey-headed albatross at Campbell Island based on ground photopoints and ground counts. Ground counts of the accessible colonies should be conducted every 10 years for 3 consecutive years to find the trends for each albatross species. Ground counts should follow methods set down in Moore (1999). Photopoints should be repeated at least every 5 years to monitor the combined population and to replace the 10-yearly ground counts if they are not possible. Photopoints and telescope counts of inaccessible colonies must also be repeated. Counting methods and timing of counts and photopoints should follow that established in 1995-1996 to 1997-1998 (see Moore & Blezard 1999a,b), but the most critical time is early to mid-October. Oblique aerial photographs could be taken on an opportunistic basis (October to December).

H2. A thorough search should be made in at least 2 and possibly up to 4 consecutive years (during October to December) at 5-year intervals to recover banded birds. This will help to determine long-term trends in adult survival and chick recruitment. The frequency of breeding by banded pairs should be noted during these surveys to help determine the size of the total breeding population. Emphasis should be put into searches of study areas, followed by the rest of Bull Rock South, Courrejolles Isthmus, and then the remaining colonies. (NB. No systematic searches have been done outside Bull Rock South, so this may lead to an inaccurate assessment of dispersal and recruitment, plus loss of data from other colonies.) The database and methods of analysis (e.g. SURGE) established by Sue Waugh should be augmented and used in future analyses for comparison of trends.

Research Priorities

The ecology and biology of grey-headed albatrosses has been studied in detail at South Georgia (Tickell & Pinder 1975, Prince et al. 1994, Croxall et al. 1998) and Campbell Island (see references above). Topics of research from the New Zealand population include:

H1. The foraging zones and at sea distribution and movements of adults and fledglings needs further research using satellite telemetry. Information is also needed on sexual and seasonal differences in foraging zones and correlation of diet with foraging zones and possible interactions with the fisheries. Some data was collected on adult foraging range in January 1997 (S. Waugh unpub.).

H2. More research is needed by observers on fishing boats to study behaviour and interactions of grey-headed albatross with different fishing practises. All dead birds collected should be autopsied and skins examined to provide information on age, sex, and moult patterns of birds.

L1. The calls of grey-headed albatross were studied by Warham & Fitzsimons (1987), but more work is needed to determine sexual and individual variations in calls and to correlate calls with behaviour and displays. A comparison is also needed of the calls of the birds at Campbell Island with those at colonies in the Indian Ocean and South Georgia.

Chatham Albatross *Thalassarche eremita*

Conservation Status:	Endemic species
IUCN rank:	Critically endangered (B1+B2c)
Molloy and Davis rank:	Category B

Distribution

Only breeds at the Chatham Islands (The Pyramid), although a few birds have been recorded ashore at The Snares Western Chain (Miskelly 1984, 1997) and Albatross Island (Tasmania) (Reid & James 1997). The species is confined to the South Pacific Ocean and migrates to seas off South America (Chile, Peru) after breeding (Haase 1994, Spear et al. 1995, C. Robertson pers. comm. 1999).

Population

An estimated 3200 to 4200 pairs breed on The Pyramid based on aerial photographs (C. Robertson, in Croxall & Gales 1998). An estimate of available nest sites observed late in the breeding season (during chick banding in 1993) indicated a breeding population of c. 2500 pairs (G. Taylor, pers. obs.). However, some nests may have disappeared by that stage of the season because many nests were made of flimsy material including old corpses, feathers, and guano. Three cohorts of chicks were banded in 1993-95 and an estimated 1200-1500 chicks fledged in each of these seasons (C. Robertson in Croxall & Gales 1998).

Threats

There are no introduced mammals on The Pyramid. The habitat quality on the island has deteriorated since a severe easterly storm in 1985 (Robertson 1998). The island is largely bare of soil and nest material is scarce. The loss of soil and drying of the island may induce greater egg and chick mortality as has been observed with northern royal albatross at the Sisters Islands. Nest sites are precarious and prone to collapse when very dry. The exposed nature of the colony means that local storms can have an impact on breeding success in parts of the colony (C. Robertson in Croxall & Gales 1998). There is still a problem of illegal harvesting of Chatham albatross chicks by some Chatham Islanders. Although numbers taken seem small, the population may be affected. This species was harvested by Moriori and latterly by other settlers, but owing to difficult access and the remote nature of the island, usually only small numbers were taken and the harvest was not annual (Robertson 1991). A potential threat to Chatham albatross is avian pox virus (apparently spread by bird fleas and ticks). This virus has caused high chick mortality in some seasons at colonies of shy albatrosses off Tasmania and black-browed albatrosses at the Falkland Islands (Gales 1993). Avian diseases may be a potential threat to chicks at The Pyramid and should be looked for in seasons of abnormal chick mortality.

The first confirmed capture of a Chatham albatross on a tuna long-liner was reported in 1997 (Baird et al. 1998). Four birds were also caught in 1997 by a demersal long-liner fishing for ling (Anon 1997). The commencement of any new long-lining fisheries off Peru and Chile would put this species at risk during the non-breeding season (Spear et al. 1995). One juvenile, banded as a chick in 1995, was caught a month after fledging on a swordfish long-line south of the Juan Fernandez Islands (C. Robertson in Croxall & Gales 1998). Chatham albatross attend trawlers off eastern South Island so may be at risk of entanglement in nets or the trawl warps. However no specimens have been recovered from observed vessels (DOC fisheries observer programme unpub.). Little is known about the possible effects of pollutants such as plastics and oil spills. The species apparently ingests plastics very rarely because only 10 pieces have been found in nests on The Pyramid (C. Robertson pers. comm. 1999). A recent study of organochlorine contaminants in Chatham albatross found PCDD, PCDF, PCB and DDT group residues present at considerably lower concentrations than those reported from albatross species breeding in the North Pacific Ocean. The PCB levels in Chatham albatross were slightly lower than those found in the northern royal albatross, but DDT group levels were higher than the levels found in northern royal albatross and Pacific albatross breeding at the Chatham Islands (Jones 1999). The hazard effects of these compounds is still at a low level and should not affect reproductive capability in the near future (Jones 1999).

Previous Conservation Actions

1. A few visits to The Pyramid between 1973 and 1976 helped to estimate the size of the population, determine the laying and hatching period, and other aspects of the breeding cycle (Robertson 1991). Further observations on the hatching period were recorded by Tennyson et al. (1993).
2. Courtship behaviour was studied in November 1991 (Robertson & Page 1992).
3. Three cohorts of chicks were banded by conservation staff and members of the local community in 1993-95 (C. Robertson in Croxall & Gales 1998).
4. A study plot was established in 1995 for annual monitoring, and observations commenced on the breeding biology of this species. One bird had a satellite transmitter attached to monitor movements during chick rearing and dispersal after breeding. Further satellite transmitters were attached to 10 birds in 1998 (C. Robertson pers. comm. 1999).

Future Management Actions Needed

E1. The issue of seabird harvesting (and in particular albatross harvesting) in the Chatham Islands needs to be resolved with the local community.

E2. Access conditions for people carrying out essential conservation tasks on The Pyramid need to be resolved with the owners to assist in long-term monitoring and protection of the Chatham albatross.

M1. Ideally, The Pyramid should be legally protected by a conservation covenant in recognition of the unique values of this island.

M2. The possibility of establishing a new colony of Chatham albatross in the Chathams should be considered. Suitable sites might include Mangere Island, the upper south slopes of Rangatira Island, or parts of Pitt Island, e.g. Rangiauria. Potential establishment techniques would include putting models of albatrosses on these islands, playback of Chatham albatross calls (see Podolsky 1990 for methods), and possibly transferring chicks to the new colony site.

Future Survey and Monitoring Needs

H1. An accurate ground census is needed of the Chatham albatross breeding population. This should be conducted during the incubation period (mid-September to mid-November).The census should be carried out in 3 consecutive years to determine the extent of annual variation in breeding pairs. A repeat census should be carried out at 5-year intervals.

H2. A correlation of aerial counts and ground based counts is needed to help determine historical trends in this population.

Research Priorities

E1. The population dynamics of this species needs research. Information is needed on adult survival rates, fledgling survival rates and recruitment of juveniles to the breeding population, age of first breeding, and species longevity. A sample of 200-400 adults (breeding pairs) should be banded to measure adult survival rates. If the species proves sensitive to handling, then colour-banding will be needed to mark individuals.

H1. The movements and dispersal patterns of adults and fledglings should be studied using satellite telemetry. Research is needed to determine where adults forage during incubation shifts and during chick rearing. (This is currently being studied by C. Robertson, DOC.) Sexual differences need to be assessed. The dispersal of adults during the non-breeding season is poorly known.

H2. The diet of Chatham albatross is virtually unknown. Seasonal variation in types of food fed to chicks needs to be determined and also the importance of fisheries waste in the diet. Research is needed to correlate diet with foraging zones (using satellite telemetry) and to determine if there are sexual differences in the type of food items consumed.

M1. The breeding cycle and breeding biology of Chatham albatross still needs further research. Information is needed on dates of return to colonies, peak of laying, hatching and fledging, incubation period and shifts, chick growth rates, breeding success and breeding frequency.

L1. The development of adult plumage and bill characters needs investigation. It is not yet known when adult bill characters and plumage are developed. Research is also needed to determine means of distinguishing juveniles of Chatham, shy, white-capped, and Salvin's albatross at sea and in the hand. Knowledge of their distribution at sea is hampered by not being able to separate juveniles of this group.

L2. The vocalisations of Chatham albatross have not been studied in detail and need to be referenced against the bird's sexual displays. Research is needed to determine the full range of calls and to identify sexually dimorphic calls or individually recognisable call variations. Comparisons are also needed with the calls of shy, white-capped, and Salvin's albatrosses. This research may help explain the potential for interbreeding in these species.

Campbell Albatross *Thalassarche impavida*

Conservation Status: Endemic species

IUCN rank: Vulnerable (A1a,d + D2)

Molloy and Davis rank: Category B

Distribution

Breeds only at the Campbell Islands (Campbell Island, Jeanette Marie). The distribution at sea may be confined to the Tasman Sea, south of Australia and south Pacific Ocean (Waugh et al. 1999a).

Population

An estimated 19,000 to 26,000 breeding pairs are present on Campbell Island based on counts and photographs in the period 1987-94 (P. Moore pers. comm. 1998, Gales 1998). At one colony (Bull Rock North) with a good photographic record since the 1940s, it appears that there was a slight increase in numbers until about 1970, then a rapid decline until the early 1980s (at rates of 5.9% per annum from 1966-81) followed by a subsequent slow increase (Waugh et al. 1999b). Counts at the Bull Rock colonies from 1992-96 indicate current population increases of 1.1% to 2.1% per annum. SURGE computer modelling of band recovery data also indicates that the population is increasing at 1.1% per annum (Waugh et al. 1999b). Breeding success from 1984-94 averaged 66% per annum. Adult survival from 1984-95 varied little, at an average of 0.945 per annum. Average survival rates of chick cohorts from 1975-89 were estimated for Age 1-5 years at 0.286, and for Age 6-20 years at 0.962 (Waugh et al. 1999b).

Threats

Few land-based threats appear to exist today. The biggest impact is from a natural predator, the brown skua, which is an efficient predator of eggs and weak chicks. Formerly, feral sheep disturbed nesting birds and may have increased the level of brown skua predation on eggs and chicks. There was no evidence from studies in 1984 that Norway rats preyed on eggs and chicks of this species (Taylor 1986). Feral cats may have taken a few young chicks in the past. The cat population may have died out because there have been no confirmed sightings since the mid-1980s (Moore 1997). Disturbance by human visitors is minimal because few people visit the colonies at the northern end of Campbell Island. The species is more tolerant of humans than grey-headed albatrosses in the same colonies, but occasionally birds abandon nests when approached by humans. Fires are a lower risk on Campbell Island because the climate is very wet. Ticks are common on birds at the colonies. Ticks collected from 5 birds in 1988 were all *Ixodes uriae*, as they were for 7 other bird species on Campbell Island (Moore & Moffat 1990a). These and Norway rats may be a vector for diseases such as avian cholera, which has killed rockhopper penguins at Campbell Island (de Lisle et al. 1990), or for other potential diseases such as avian pox or avian malaria. Malarial antibodies have been recorded from yellow-eyed penguins on Campbell Island (Graczyk et al. 1995).

At sea, the main threat is from long-line fishing (Gales 1993). Large numbers of Campbell albatross have been caught on southern bluefin tuna long-lines in New Zealand and Australian seas (Murray et al. 1993, Gales et al. 1998). Campbell albatross forms 11% of the seabirds killed on tuna long-line vessels in the New Zealand EEZ and returned for identification in the period 1988-97 (Baird et al. 1998) Both adults and juveniles are caught, but the high capture rate of juveniles (Gales et al. 1998) coincides with a low recruitment of juveniles at the breeding colonies (Waugh et al. 1999b). The steepness of the decline of Campbell albatrosses in the 1970s suggests that increased adult mortality was responsible, and this was most likely a result of fishing bycatch (Waugh et al. 1999b). The period of greatest fishing effort in the tuna long-lining fishery in the New Zealand EEZ was 1971-82 (Murray et al. 1993).

Small numbers of Campbell albatross are caught by trawlers fishing for hoki, scampi, and squid (DOC fisheries observer programme unpub.). Bartle (1991) reported no captures of Campbell albatross by Russian squid trawlers in 1990. Other species at Campbell Island (rockhopper penguins, elephant seals) have declined since the 1940s (Cunningham & Moore 1994, Taylor & Taylor 1989). These declines have been attributed to changes in food availability as a result of ocean warming since the 1950s. This same factor may have had some impact on the Campbell albatross declines. Little is known about the possible effects of pollutants such as plastics, chemical contaminants and oil spills, but because the species appears to remain largely in the Australasian region, these factors are probably not a significant risk to Campbell albatross.

Previous Conservation Actions

1. The breeding cycle and aspects of the breeding biology of Campbell albatross was studied by J. Sorenson in the 1940s (Bailey & Sorensen 1962).
2. Feral sheep were fenced out and eradicated from the northern half of Campbell Island in 1970.
3. Cohorts of chicks were banded at Courrejolles colony up to 1970 and at Bull Rock South colony from 1970 by Meteorological Station staff and visiting biologists.
4. Information was collected on the distribution of breeding colonies, morphology, and breeding biology of Campbell albatross in 1975 (Robertson 1980). An estimate was made of the breeding population at these colonies.
5. The effects of Norway rats were studied on this species in 1984 (Taylor 1986). Study nests were marked at Bull Rock South colony, and adult birds were banded at nests. These pairs were used to determine breeding productivity and to establish a baseline for the collection of adult survival data (Taylor 1986). Replacement of old worn aluminium and monel bands was started in 1984. Colony photographs taken in 1984 and 1986 revealed that albatross populations had declined at some colonies when compared with photographs taken in the 1940s.
6. Permanent photopoints were established in 1987, and each colony was photographed and counts made of breeding pairs (Moore 1995). Breeding

productivity and growth rates of chicks were studied in 1987/1988, and large numbers of banded birds were captured (Moore & Moffat 1990c). Estimates of productivity were collected in most years from 1987 to 1997 (Waugh et al. 1999b).

7. A detailed study on the distribution and size of breeding populations was initiated by Peter Moore (DOC) in the 1990s. Ground counts of accessible colonies have been undertaken since 1992. This was intensified in three seasons (1995-96, 1996-97, and 1997-98) to establish more accurate trends, separate out the trends of Campbell and grey-headed albatrosses, and to link ground counts with photopoint counts.

8. The population dynamics, diet, feeding frequency, foraging activity, and movements of Campbell albatross has been studied recently by S. Waugh (see Waugh 1998, Waugh et al. 1995, 1999b, Waugh et al. in press a,b, Cherel et al. in press). Band recoveries at Bull Rock South colony have been analysed to calculate survival rates of adults and recruitment rates of chicks (Waugh et al. 1999b). Movements and distant recoveries of banded birds were analysed (Waugh et al. 1999a).

9. Observations on the extent of inter-breeding between Campbell albatross and black-browed albatross were carried out between 1984 and 1995 (Moore et al. 1997b).

10. Public awareness of the plight of albatross species has increased in recent years with media exposure and increased publication of work implicating oceanic fisheries in the decline of some albatross species (Gales 1998). Contact with the fishing industry has been initiated, and investigations have started to determine ways of addressing the bycatch problem.

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

M1. Norway rats should be eradicated from Campbell Island.

Future Survey and Monitoring Needs

H1. A baseline estimate is now available of the breeding population of Campbell albatross based on photopoints and ground counts. Ground counts of the accessible colonies should be conducted every 10 years for 3 consecutive years to find the trends for each albatross species. Ground counts should follow methods set down in Moore (1999). Photopoints should be repeated at least every 5 years to monitor the combined population and replace the 10-yearly ground counts if they are not possible. Photopoints and telescope counts of inaccessible colonies must also be repeated. Counting methods and timing of counts and photopoints should follow that established in 1995-96 to 1997-98 (see Moore & Blezard 1999a,b), but the most critical time is early to mid October.

Oblique aerial photographs could be taken on an opportunistic basis (October to December).

H2. A thorough search should be made in 2 consecutive years (during October to December) at 5-year intervals to recover banded birds. This will help to determine long-term trends in adult survival and chick recruitment. Emphasis should be put into searches of study areas, followed by the rest of Bull Rock South, Courrejolles Isthmus, and then the remaining colonies. (NB. No systematic searches have been done outside Bull Rock South, so this may lead to an inaccurate assessment of dispersal and recruitment, plus loss of data from other colonies.) The database and methods of analysis (e.g. SURGE) established by Sue Waugh should be augmented and used in future analyses for comparison of trends.

Research Priorities

H1. More research is needed by observers on fishing boats to study behaviour and interactions of Campbell albatross with different fishing practises. All dead birds collected should be autopsied and skins examined to provide information on age, sex, and moult patterns of birds.

H2. The foraging zones and at sea distribution and movements of adults and fledglings needs research using satellite telemetry. Information is also needed on sexual and seasonal differences in foraging zones and correlation of diet with foraging zones and possible interactions with the fisheries. Note that some data was collected on adult foraging range in January 1997 (S. Waugh unpub.).

L1. The calls of Campbell albatross were studied by Warham & Fitzsimons (1987), but more work is needed to determine sexual and individual variations in calls and to correlate calls with behaviour and displays. A comparison is also needed of the calls of the Campbell albatross and black-browed albatross breeding at Campbell Island to help understand how interbreeding occurs between these species.

Pacific (Northern Buller's) Albatross *Thalassarche* (*platei*) nov. sp.

Conservation Status:	Endemic species
IUCN rank:	Vulnerable (D2)
Molloy and Davis rank:	Category B

Distribution

Breeds at the Chatham Islands (Forty-Fours, Big Sister, Little Sister) and Three Kings Islands (Rosemary Rock). Birds appear to forage east of New Zealand and the Chatham Islands. The species disperses after breeding across the South Pacific Ocean to the west coast of South America (Stahl et al. 1998, Spear et al. 1995).

Population

There are possibly 16,000 breeding pairs at the Forty-Fours and 1500 on Big Sister Island (estimate based on the area of occupancy). Counts made on Little Sister Island between 1994-1996 indicated 630-670 breeding pairs (C. Robertson in Croxall & Gales 1998). There are about 20 breeding pairs at Rosemary Rock (McCallum et al. 1985).

Threats

There are no introduced mammals on any of the breeding islands. Habitat quality on the open plateau on the tops of the Forty-Fours and Sisters has deteriorated since a severe easterly storm in 1985 (Robertson 1998). Fortunately, Pacific albatross mainly nest on steep cliff margins (Sisters) or rough plateau basins (Forty-Fours) where there is more soil and vegetation than the open plateau tops. However, the drying of these islands may induce greater egg and chick mortality through increased collapsing of nest structures (Robertson & Sawyer 1994). The exposed nature of all the colonies means that local storms can have an impact on breeding success in parts of the colony (C. Robertson in Croxall & Gales 1998). A potential threat to Pacific albatross is avian pox virus (apparently spread by bird fleas and ticks). This virus has caused high chick mortality in some seasons at colonies of shy albatrosses off Tasmania and black-browed albatrosses at the Falkland Islands (Gales 1993). Avian diseases may be a potential threat to chick survival and should be looked for in seasons of abnormal chick mortality. While some illegal harvesting of albatross chicks by locals still occurs at the Chatham colonies, anecdotal evidence suggests that few if any Pacific albatross chicks are taken (Robertson 1991).

There appears to be no evidence that Pacific albatross are caught on tuna long-lines. However, until recently, there has been no observer coverage on long-liners operating on the Chatham Rise, an area used by Pacific albatross. One confirmed Pacific albatross has been killed by trawling (DOC fisheries observer programme unpub.). The similar looking Pacific albatross and Buller's albatross have only recently been separated taxonomically (Robertson & Nunn 1998) so the potential impact of trawl fisheries on Pacific albatross may have been masked. This species regularly follows crayfish boats at the Chatham Islands and takes discards from the pots (G.Taylor pers. obs.).They may be vulnerable, therefore, to fishing activities in the unmonitored seas east of the Chatham Islands and off South America.The commencement of any new long-lining fisheries off Peru and Chile could put this species at risk during the non-breeding season (Spear et al. 1995). Little is known about the possible effects of pollutants such as plastics and oil spills. A recent study of organochlorine contaminants in Pacific albatross found PCDD, PCDF, PCB and DDT group residues present at considerably lower concentrations than those reported from albatross species breeding in the North Pacific Ocean. The contaminant levels in Pacific albatross were slightly lower than those found in the northern royal albatross and Chatham albatross (Jones 1999).The hazard effects of these compounds is still at a low level and should not affect reproductive capability in the near future (Jones 1999).

Previous Conservation Actions

1. Studies were conducted on the breeding cycle of this species on Chatham Islands in the 1970s and 1990s. The laying and hatching periods were determined and adult birds were banded (Robertson 1991, C. Robertson in Croxall & Gales 1998). Recent research on Little Sister Island has included a census of breeding pairs, estimates of breeding productivity (57-60% to end of guard stage), recapture of banded birds, and an estimate of adult survival in the period 1974-95 (0.935 per annum) (C. Robertson in Croxall & Gales 1998). The breeding distribution on the Forty-Fours was mapped by Robertson & Sawyer (1994). The timing of incubation shifts, breeding frequency, and measurement of chick growth rates in the first part of the chick rearing period have been studied in recent seasons (C. Robertson pers. comm. 1999).

2. The species was found nesting on Rosemary Rock in 1983 (Wright 1984) and further counts were made of the number of breeding pairs in 1985 (McCallum et al. 1985).

3. A small diet sample collected at the Chatham Islands between 1972-1976 was analysed by West & Imber (1986).

Future Management Actions Needed

H1. Agreement needs to be reached with the private owners of the Forty-Fours and the Sisters to enable on-going research programmes to continue on these islands. Access to these sites is necessary to assist in long-term monitoring and protection of the albatross populations.

M1. Ideally, the Sisters and Forty-Fours should be legally protected by a conservation covenant in recognition of the unique values of these islands.

L1.The establishment of a new colony of Pacific albatross in the Chatham Islands should be considered. Suitable sites might include Mangere Island, the upper south slopes of Rangatira Island or parts of Pitt Island, e.g. Rangiauria. Potential establishment techniques would include putting models of albatrosses on these islands, playback of Pacific albatross calls, and also transferring chicks to the new colony site (see Podolsky 1990 for methods).

Future Survey and Monitoring Needs

H1. Observer coverage is needed on long-liners and trawlers operating east of the North Island and especially east of the Chatham Islands to assess potential impact of these fisheries on Pacific albatross.

H2. An accurate ground census is needed of the Pacific albatross breeding population on the Forty-Fours and Big Sister. This should be conducted during the incubation period (mid-November to mid-January). The census should be carried out in 2-4 consecutive years to determine the extent of annual variation in breeding pairs. A repeat census should be carried out every 10 years.

H3. A correlation of aerial counts and ground-based counts is needed to help determine historical trends in the Chatham Islands populations of Pacific albatross.

H4. The breeding population on Little Sister should be monitored by ground counts during the incubation period whenever the opportunity arises and at least every 5 years.

L1. The breeding colony on Rosemary Rock should be monitored every 10 years, and a census undertaken of breeding pairs in December.

Research Priorities

H1. The population dynamics of this species stills needs research. Additional information is needed on adult survival rates and research is needed on fledgling survival rates and recruitment of juveniles to the breeding population, age of first breeding, and species longevity. A sample of 200-400 adults (breeding pairs) should be banded to measure adult survival rates. If the species proves sensitive to handling, then colour-banding will be needed to mark individuals.

H2. The diet of Pacific albatross needs further quantitative studies. Seasonal variation in types of foods fed to chicks need to be determined and also the importance of fisheries waste in the diet. Research is needed to correlate diet with foraging zones (using satellite telemetry) and to determine if there are sexual differences in the type of food items consumed.

H3. The movements and dispersal patterns of adults and fledglings should be studied using satellite telemetry. Research is needed to determine where adults forage during incubation shifts and during chick rearing. Sexual differences need to be assessed. The dispersal of adults during the non-breeding season is poorly known.

M1. The breeding cycle and breeding biology of Pacific albatross needs further research. Information is needed on dates of return to colonies and peak of chick departure, chick growth rates throughout the chick period, and breeding success.

L1. The development of adult plumage and bill characters needs investigation. It is not yet known at what age adult bill characters and plumage are developed.

Research is also needed to determine means of separating adult and juvenile Pacific albatross from Buller's albatross at sea and in the hand.

L2. The vocalisations of Pacific albatross have not been studied and need to be referenced against the bird's sexual displays. Research is needed to determine the full range of calls and to identify sexually dimorphic calls or individually recognisable call variations. Comparisons should be made with the calls of the well-studied Buller's albatross.

Salvin's albatross, Bounty Islands. Photo: C. Robertson

A 1997 survey of the Bounty Islands produced a new population estimate of 30,752 pairs of Salvin's albatross. The birds nest on barren islands amongst large colonies of erect-crested penguins and fur seals. (See overleaf.)

Salvin's Albatross *Thalassarche salvini*

Conservation Status: Indigenous species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds at the Bounty Islands (nine islands and islets), Western Chain of The Snares Islands (Toru, Rima Islets), and possibly Chatham Islands (The Pyramid). Elsewhere, breeds at the Crozet Islands (Penguin Island) (Jouventin 1990). Disperses widely in the Southern Ocean and is found in the South Pacific and Indian Oceans. The status of birds in the South Atlantic is unknown (vagrant or circumpolar migration?). It is unknown if birds disperse westwards because they are apparently rare in the Indian Ocean. Salvin's albatross presumably disperses eastwards from the breeding grounds because they are reported from the Peru current in the Eastern Pacific Ocean (Harrison 1983).

Population

The main population is at the Bounty Islands where 76,000 breeding pairs were estimated in 1978 based on nest densities and the area occupied by albatrosses on each island (Robertson & Van Tets 1982). A ground count of nests on Proclamation Island (Bounty Islands) in November 1997 found 3062 breeding pairs (Clark et al. 1998) whereas Robertson & Van Tets (1982) estimated that there were 8656 Salvin's albatross nests on the same island in 1978. The 1997 population figure is 35.3% of that recorded in 1978. Andrea Booth & Jacinda Amey (pers. comm. 1999) estimated that there were 30,752 pairs of Salvin's albatross on the Bounty Islands in 1997 using the formula of 139,780 m^2 of suitable nesting habitat in the Bounty group and an average nest density of 0.22 pairs per m^2. Unfortunately, the 1978 and 1997 expeditions had different base maps for calculating island areas and therefore had different estimates of the areas of suitable nesting habitat. This limits the usefulness of direct comparisons between the two population estimates. Miskelly (1984) counted 588 chicks on 11-12 February 1984 on the Snares Western Chain and estimated that fewer than 650 breeding pairs would be present. Two empty nests were occupied at The Pyramid in 1995 (C. Robertson in Croxall & Gales 1998). Four breeding pairs were recorded at Penguin Island in the 1980s, the only reported breeding site outside of New Zealand of this otherwise endemic New Zealand species (Jouventin 1990).

Threats

Very few threats are known for Salvin's albatross. All birds nest on barren islands free of introduced mammals. These islands are remote and access is very difficult. The impact of visitor disturbance is unknown but is probably insignificant owing to the few visits made to the breeding colonies. Small numbers of Salvin's albatross have been caught on long-lines set for tuna and ling in the New Zealand EEZ (Baird et al. 1998). However, the species forages widely in the Southern Ocean, including the South Atlantic Ocean, and therefore may be exposed to a number of long-line fisheries on the high seas. There is no evidence that Salvin's albatrosses have been killed by trawler fisheries in New Zealand seas (Bartle 1991, DOC fisheries observer programme unpub.). Populations of rockhopper and erect-crested penguins have declined since the 1950s at Antipodes Island (A. Tennyson & G. Taylor unpub.). Similar large declines of penguins at Campbell Island have been attributed to changes in food availability as a result of ocean warming since the 1950s (Cunningham & Moors 1994). The same factors may have had an impact on Salvin's albatross populations. Avian pox virus (spread by bird fleas and ticks) has caused high chick mortality in some seasons at colonies of shy albatrosses off Tasmania and avian diseases may also occur in some seasons at Salvin's albatross colonies. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. This species, however, forages off Africa and South America, so it may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. Sagar (1977) counted a minimum of 144 breeding pairs on Rima Islet (Snares Western Chain) in November 1976.
2. The size of the breeding population on the Bounty Islands was estimated in November 1978, and observations were made on the breeding cycle of this species (Robertson & Van Tets 1982).
3. The size of the breeding population at the Snares Western Chain was estimated in 1984 (Miskelly 1984).
4. A cohort of 1000 chicks was banded at the Bounty Islands in 1985.
5. A study population was banded on Snares Western Chain in 1995/96 to begin monitoring of survival parameters (J. Amey pers. comm. 1996).
6. A census was made of birds breeding on Proclamation Island (Bounty Islands) in 1997 and data were collected on hatching dates and breeding success up to January 1998 (Clark et al. 1998). A new estimate was made of the size of the Bounty Island population (A. Booth & J. Amey pers. comm. 1999).

Future Management Actions Needed

M1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

Future Survey and Monitoring Needs

H1. Nest counts (both breeding pairs and empty nest sites) are needed from each island at the Bounty Island group to serve as a baseline for future population changes. Further analysis of the techniques used by Robertson & van Tets (1982) may reveal if long-term changes have occurred in the size of the breeding population at the Bounty Islands.

H2. Information is needed from fisheries observer programmes in South African and South American EEZs to determine if Salvin's albatrosses are being caught by long-liners or trawlers there.

M1. The breeding population on a sample of two islands at both the Snares Western Chain and the Bounty Islands should be counted for 2 consecutive years every decade to monitor population trends in this species.

L1. Confirmation is needed on the breeding status of Salvin's albatross at The Pyramid.

Research Priorities

H1. The population dynamics of this species still needs research. Information is needed on adult survival rates, fledgling survival rates and recruitment of juveniles to the breeding population, natal philopatry, and species longevity. Three to five cohorts of chicks should be banded at two adjacent islands at the Bounty and Snares Western Chain to determine recruitment rates and natal fidelity of chicks. A sample of 200-400 adults (at least 100 breeding pairs) should be banded at one island in each group to measure adult survival rates.

H2. The diet of Salvin's albatross is virtually unknown. Seasonal variation in types of foods fed to chicks need to be determined and also the importance of fisheries waste in the diet. Research is needed to correlate diet with foraging zones (using satellite telemetry) and to determine if there are sexual differences in the type of food items consumed.

H3. The movements and dispersal patterns of adults and fledglings should be studied using satellite telemetry. Research is needed to determine where adults forage during incubation shifts and during chick rearing. Sexual differences need to be assessed. The dispersal of adults during the non-breeding season is poorly known. Adults from both the Snares and Bounty populations should be studied to determine if these populations have different foraging zones or follow different migration routes after breeding.

M1. The breeding cycle and breeding biology of Salvin's albatross are still poorly known. Information is needed on dates of return to colonies, laying and fledging (both duration and peaks), incubation period and shifts, chick growth rates, breeding success, and breeding frequency.

L1. The development of adult plumage and bill characters needs investigation. It is not yet known when adult bill characters and plumage are developed. This information would be useful in determining the ages of birds killed on long-lines or found dead on New Zealand beaches. Research is also required to determine means of distinguishing juveniles of Chatham, shy, white-capped, and Salvin's albatross at sea and in the hand. Knowledge of their distribution at sea is hampered by not being able to separate juveniles of this group.

L2. The vocalisations of Salvin's albatross have not been studied in detail and need to be referenced against the bird's sexual displays. Research is needed to determine the full range of calls and to identify sexually dimorphic calls or individually recognisable call variations. Comparisons are also needed with the calls of shy, white-capped, and Chatham albatrosses. This research may help explain the potential for interbreeding in these species.

White-capped albatross on nest with chick, Disappointment Island, 1988

White-capped albatross have been the seabird species most frequently killed in the squid trawl fishery in southern New Zealand. Large numbers of birds are also caught on tuna long-lines set in New Zealand seas. Despite these losses, the population on Disappointment Island appears to have increased slightly in recent years. (See overleaf.)

White-capped Albatross *Thalassarche steadi*

Conservation Status: Endemic species

IUCN rank: Vulnerable (D2)

Molloy and Davis rank: Category C

Distribution

Breeds at Auckland Islands (Disappointment, Auckland, Adams), Antipodes Islands (Bollons Island) and Chatham Islands (Forty-Fours) (Robertson et al. 1997). The distribution at sea is still poorly known. White-capped albatross are probably the commonest albatross seen over shelf waters adjacent to the New Zealand mainland. Birds were thought to disperse widely in the Southern Ocean and occur in the South Pacific and Indian Oceans (Harrison 1983). However, the status of birds in these areas and also the South Atlantic Ocean is poorly known owing to confusion with the closely related shy albatross and Salvin's albatross. Birds with characters of Auckland Island birds are most common off South Africa in August to October which coincides with the non-breeding period of white-capped albatross. However, C. Robertson (pers. comm. 1998) considers that white-capped albatross may be confined to New Zealand seas.

Population

Most birds breed on Disappointment Island. Based on partial or complete counts from the air and ground photos between 1972 and 1994, there are an estimated 70,000 to 80,000 breeding pairs. Comparable areas have shown a moderate increase during the same period. There are an estimated 3000 pairs on Auckland Island and 100 pairs on Adams Island (C. Robertson in Croxall & Gales 1998). The total Auckland Island breeding population was previously estimated in 1972 as 64,000 breeding pairs (Robertson 1975). Tennyson et al. (1998) estimated that about 20 pairs were nesting on Bollons Island in 1995. One pair was incubating at the Forty-Fours in December 1991 (Robertson & Page 1992) and December 1996 (Robertson et al. 1997). The population of white-capped albatross in New Zealand appears to be increasing although further work is needed to confirm this trend.

Threats

Feral pigs have had a significant impact on the breeding population on Auckland Island. Only colonies on cliff ledges inaccessible to pigs have remained intact. Pigs made a significant reduction in the nesting area between 1972 and 1981 (Robertson & Jenkins 1986). Feral cats may possibly take a few chicks on Auckland Island. All the remaining breeding grounds are free of introduced mammals. Fire is unlikely to be a problem at any breeding site because the Auckland Islands are too wet and the Bollons Island colony is on a damp south-facing slope (Clark & Robertson 1996). The species is sensitive to disturbance during breeding, and birds will sometimes desert nests if too closely approached or handled (C. Robertson & K. Walker pers. comm. 1993). The impact of tourism on the colony on Auckland Island is unknown but is probably insignificant owing to the few visits made to the breeding colonies and the DOC permit requirement to keep 5 m from nesting birds.

White-capped albatross have been the seabird species most frequently killed in the squid trawl fishery in southern New Zealand (Bartle 1991, DOC fisheries observer programme unpub.). An estimated 2300 birds were killed by this fishery in 1990 alone. All birds caught were breeding adults. Most died or were injured after colliding with net-sonde monitor cables used on Russian trawlers (Bartle 1991). This source of mortality has been eliminated after the phasing out of these devices in the New Zealand EEZ in 1992 (Anon 1997). However, a small number of birds also became entangled in trawl nets and warps when hauling the net onboard ships (Bartle 1991). Large numbers of white-capped albatross have been caught by tuna long-liners in the New Zealand and Australian EEZs (Murray et al. 1993, Gales et al. 1998). The species is the most commonly killed albatross on tuna long-lines in New Zealand, forming 15% of the birds returned for autopsy between 1988 and 1997 (Baird et al. 1998). Despite this level of observed mortality, the population as a whole appears to have remained stable or shown a slight increase in the past 20 years (Croxall & Gales 1998), possibly owing to the extra food available from fisheries discards. Avian pox virus (spread by bird fleas) has caused high chick mortality in some seasons at colonies of shy albatrosses off Tasmania. Avian diseases may also occur in some seasons at white-capped albatross colonies. Potential vectors for these diseases include mice on Auckland Island, bird fleas, and ticks. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills. These pollutants are not likely to be significant if the species remains largely in the New Zealand region. However, if this species forages off Africa and South America, it may be at greater risk from pollutants than some other New Zealand breeding species.

Previous Conservation Actions

1. Ground and aerial photographs have been taken of the Disappointment Island colony in 1972, 1981, 1985, 1990, and 1993 (Robertson 1975, Robertson & Jenkins 1986, Robertson in Croxall & Gales 1998) .

2. A study was made of birds on Disappointment Island in January 1993. However, only a few birds were banded because most deserted nests after handling (C. Robertson pers. comm. 1993). Information was gained on the hatching period and incubation shifts (Clark & Robertson 1996, Robertson et al. 1997).

3. A pair was observed nesting on the Forty-Fours (Chatham Islands) in 1991 (Robertson & Page 1992) and again in 1996 (Robertson et al. 1997).

4. A new colony was discovered on Bollons Island in 1994 (Clark & Robertson 1996). Further counts were made at this colony in 1995 (Tennyson et al. 1998).

5. Public awareness of the plight of albatross species has increased in recent years with media exposure and increased publication of work implicating oceanic fisheries in the decline of some albatross species (Gales 1998).

Contact with the fishing industry has been initiated, and investigations have started to determine ways of addressing the bycatch problem.

Future Management Actions Needed

E1. There needs to be further development of appropriate mitigation devices or techniques to minimise or eliminate seabird bycatch, especially from long-line fisheries. Liaison is needed with the fishing industry to ensure that incidental bycatch is monitored and to co-ordinate actions to minimise further seabird losses associated with fishing practises.

H1. Feral pigs and cats should be eradicated from Auckland Island.

Future Survey and Monitoring Needs

H1. Information is needed from observer programmes in the South African and South American EEZs to determine if white-capped albatross are being caught by long-liners or trawlers in these areas.

H2. An accurate census is needed of breeding pairs at Adams Island and Auckland Island.

H3. A discreet colony on Disappointment Island should be monitored at 5-year intervals to gauge changes in the status of the population. Ground counts are needed to determine the number of breeding pairs and numbers of non-breeders. These should be compared against aerial photos taken at the same period.

M1. The entire colony on Disappointment Island should be photographed and counted at 10-year intervals and trends compared against the small colony in (H2) above.

L1. An accurate count is needed of the Bollons Island colony once every 10 years.

L2. The breeding status of white-capped albatross at the Forty-Fours should be monitored every 5-10 years.

Research Priorities

The species is very poorly known and virtually all aspects of their biology and ecology need research. The species appears to be very sensitive to disturbance and this may restrict the collection of information. To overcome this problem it may be necessary to colour-band birds prior to breeding or during the chick rearing period. Study colonies should be set up in accessible sites to improve the chance of re-sighting banded adults.

H1. The population dynamics of this species still needs research. Information is needed on adult survival rates, fledgling survival rates and recruitment of juveniles to the breeding population, age at first breeding, natal philopatry, and species longevity. Three to five cohorts of chicks should be banded at two adjacent study colonies on Disappointment Island to determine recruitment rates and natal fidelity of chicks. A sample of 200-400 adults (breeding pairs) should be banded at Disappointment Island to measure adult survival rates.

H2. The movements and dispersal patterns of adults and fledglings at an Auckland Island colony should be studied using satellite telemetry. Research is needed to determine where adults forage during incubation shifts and during chick rearing. Sexual differences need to be assessed. The dispersal of adults during the non-breeding season is poorly known. Satellite transmitters should be attached to birds to monitor movements during the non-breeding season. Banding adults and cohorts of chicks may also be useful in determining movements of this species.

H3. The diet of the white-capped albatross is virtually unknown. Seasonal variation in types of food fed to chicks need to be determined and also the importance of fisheries waste in the diet. Research is needed to correlate diet with foraging zones (using satellite telemetry) and to determine if there are sexual differences in the type of food items consumed.

M1. The breeding cycle and breeding biology of white-capped albatross are virtually unknown. Information is needed on dates of return to colonies, laying and fledgling periods and peaks, incubation period and shifts, chick growth rates, breeding success, and breeding frequency. The reported fledging period of mid-August (Marchant & Higgins 1990) seems unlikely if hatching starts in late January. It would also imply that the species is a biennial breeder (because there would be less than 3 months to complete moult).

L1. The development of adult plumage and bill characters needs investigation. It is not yet known when adult bill characters and plumage are developed. This information would be useful in determining the ages of birds killed on long-lines or found dead on New Zealand beaches. Research is also required to determine means of distinguishing juveniles of Chatham, shy, white-capped and Salvin's albatross at sea and in the hand. Knowledge of their distribution at sea is hampered by not being able to separate juveniles of this group. Good reliable characters also need to be determined to separate adult white-capped and shy albatrosses in the hand (e.g. morphometrics, plumage features, bill colours).

L2. The vocalisations of white-capped albatross have not been studied in detail and need to be referenced against the bird's sexual displays. Research is needed to determine the full range of calls and to identify sexually dimorphic calls or individually recognisable call variations. Comparisons are also needed with the calls of shy, Salvin's, and Chatham albatrosses. This research may help explain the potential for interbreeding in these species.

12. References (Part A)

Adams, L. 1998. *Draft Westland petrel* (*taiko*)(*Procellaria westlandica*) *recovery plan 1998-2008*. Department of Conservation, West Coast Conservancy, Hokitika.

Allan, R., Lindesay, J. & Parker, D. 1996. *El Nino, Southern Oscillation & climatic variability*. CSIRO Publishing, Australia.

Alexander, K., Robertson, G. & Gales, R. 1997. *The incidental mortality of albatrosses in longline fisheries*. Australian Antarctic Division, Tasmania.

Alterio, N., Moller, H. & Ratz, H. 1998. Movements and habitat use of feral house cats *Felis catus*, stoats *Mustela erminea* and ferrets *Mustela furo*, in grassland surrounding yellow-eyed penguin *Megadyptes antipodes* breeding areas in spring. *Biological Conservation* 83: 187-194.

Amey, J. & Moore, P. 1995. *Yellow-eyed penguin on Campbell Island*. Department of Conservation, Wellington.

Anon. 1997. *Managing the incidental capture of seabirds in New Zealand Fisheries*. Unpublished discussion document, New Zealand Ministry of Fisheries and Department of Conservation, Wellington.

Atkinson, I. A. E. & Bell, B. D. 1973. Offshore and Outlying Islands. In: *The natural history of New Zealand - an ecological survey*. Williams, G. R. (ed), A. H & A.W. Reed, Wellington, pp 372-392.

Atkinson, I. A. E. & Taylor, R. H. 1992. Distribution of alien mammals on New Zealand islands, 2nd edn. *DSIR Land Resources Contract Report* No. 92/59. Prepared for Department of Conservation, Wellington.

Auman, H. J., Ludwig, J. P., Giesy, J. P. & Colborn, T. 1998. Plastic ingestion by Laysan albatross chicks on Sand Island, Midway Atoll, in 1994 and 1995. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 239-244.

Bailey, A. M. & Sorensen, J. H. 1962. Subantarctic Campbell Island. *Proceedings Number 10*, Denver Museum of Natural History.

Baird, S. J., Francis, M., Griggs, L. & Dean, H. 1998. Annual review of bycatch in southern bluefin tuna and related tuna longline fisheries in the New Zealand 200 n. mile Exclusive Economic Zone. Unpublished report presented at CCSBT - ERS working group 3, Tokyo, Japan. Prepared by NIWA, Wellington.

Baker, A. J. & Coleman, J. D. 1977. The breeding cycle of the Westland black petrel (*Procellaria westlandica*). *Notornis* 24: 211-231.

Balneaves, J.M. & Hughey, K. 1990. The need for control of exotic weeds in braided river beds for conservation of wildlife. In: *Proceedings of the 9th Australian Weeds Conference*. Adelaide, South Australia, pp 103-108.

Bancroft, F. 1998. Department of Conservation Chatham Islands end of breeding season report 1997-1998: Chatham Island petrel (*Pterodroma axillaris*). Unpublished report, Chatham Islands Area Office, Department of Conservation, Chatham Islands.

——— 1999. Department of Conservation Chatham Islands end of breeding season report 1998-1999: Chatham Island petrel (*Pterodroma axillaris*). Unpublished report, Chatham Islands Area Office, Department of Conservation, Chatham Islands.

Barnes, P. & Walshe, K. A. R. 1997. Underwater setting methods to minimise the accidental and incidental capture of seabirds by surface longliners. Report on a prototype device developed by Akroyd Walshe Ltd. *Science for Conservation* 66, Department of Conservation, Wellington.

Bartle, J.A. 1968. Observations on the breeding habits of Pycroft's petrel. *Notornis* 15: 70-99.

—— 1985. Westland Black Petrel. In: *Complete book of New Zealand birds.* Robertson, C. J. R. (ed), Reader's Digest, Sydney, p 91.

—— 1990. Sexual segregation of foraging zones in procellariiform birds: implications of accidental capture on commercial fishery longlines of grey petrels (*Procellaria cinerea*). *Notornis* 37: 146-150.

—— 1991. Incidental capture of seabirds in the New Zealand subantarctic squid trawl fishery, 1990. *Bird Conservation International* 1: 351-359.

Bartle, J. A., & Paulin, C. D. 1986. Bird observations, Auckland Islands, December 1976. In: Preliminary reports of expeditions to the Auckland Islands Nature Reserve 1973-1984. Penniket, A., Garrick, A. & Breese, E. (eds), *Reserves Series,* Department of Lands and Survey, Wellington, pp 51-61.

Bartle, J. A., Hu, D., Stahl, J-C., Pyle, P., Simons, T. R. & Woodby, D. 1993. Status and ecology of gadfly petrels in the temperate North Pacific. In: *The status, ecology and conservation of marine birds of the north Pacific.* Vermeer, K., Briggs, K. T., Morgan, K. H, & Siegel-Causey, D. (eds), Canadian Wildlife Service Special Publication, Ottawa, pp 101-111.

Bell. B. D. 1970. Macauley expedition 1970. Unpublished report, New Zealand Wildlife Service File 30/ 3/13.

—— 1975. Report on the birds of the Auckland Islands Expedition 1972-73. In: Preliminary results of the Auckland Islands Expedition 1972-1973. Yaldwin, J. C. (ed), *Reserves Series* No. 1975/3, Department of Lands and Survey, Wellington, pp 136-142.

Bell, E. A. & Sim, J. L. 1998a. Survey and monitoring of black petrels on Great Barrier Island 1996. *Science for Conservation* 77, Department of Conservation, Wellington.

—— 1998b. Survey and monitoring of black petrels on Great Barrier Island 1997. *Science for Conservation* 78, Department of Conservation, Wellington.

Bell, M. 1997. Chatham Islands. *OSNZ News* 84: 16.

Bell, M. & Bell, D. 1997. Chatham Island terns. *OSNZ News* 82: 7.

Beer, C. G. 1965. Clutch size and incubation behavior in black-billed gulls (*Larus bulleri*). *Auk* 82: 1-18.

—— 1966. Adaptations to nesting habitat in the reproductive behaviour of the black-billed gull *Larus bulleri*. Ibis 108: 394-410.

Best, H. A. & Owen, K. L. 1974. Distribution of breeding sites of the Westland black petrel (*Procellaria westlandica*). *Fauna Survey Unit Report* No. 3. New Zealand Wildlife Service, Department of Internal Affairs, Wellington.

—— 1976. Distribution of breeding sites of the Westland black petrel (*Procellaria westlandica*). *Notornis* 23: 233-242.

Blezard, R. H. & Burgess, J. 1999. Observer reports from squid-jigging vessels off the New Zealand coast 1999. *Conservation Advisory Science Notes* No. 255, Department of Conservation, Wellington.

Booth, A. M. 1995. The little shearwater in the 1994 breeding season on Lady Alice Island: breeding success, and timing and causes of breeding failure. *Conservation Advisory Science Notes* No. 115, Department of Conservation, Wellington.

—— 1996. *The breeding ecology of the North Island little shearwater.* Unpublished M.Sc. thesis, Massey University, Palmerston North.

Booth, A. M., Minot, E. O., Fordham, R. A. & Innes, J. G. 1996. Kiore (*Rattus exulans*) predation on the eggs of the little shearwater (*Puffinus assimilis haurakiensis*). *Notornis* 43: 147-153.

Booth, A. M., Minot, E. O., Fordham, R. A. & Imber, M. J. (in press). Coordinated food provisioning in the little shearwater *Puffinus assimilis haurakiensis*; a previously undescribed foraging strategy in the Procellaridae. *Ibis*

Booth, A. M. & Schmechel, F.A. (in prep.). Fulmar prion (*Pachyptila crassirostris*) census, Bounty Islands, 1997. Unpublished internal report, Department of Conservation, Southland Conservancy.

Bourne, W. R. P. 1967. Subfossil petrel bones from the Chatham Islands. *Ibis* 109: 1-7.

Bourne, W. R. P. & Imber, M. J. 1982. Plastic pellets collected by a prion on Gough Island, central South Atlantic Ocean. *Marine Pollution Bulletin* 13: 20-21.

Brager, S. & Stanley, S. 1999. Near-shore distribution and seasonal abundance of white-flippered penguins (*Eudyptula minor albosignata*) at Banks Peninsula, New Zealand. *Notornis* 46: 365-372.

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. 1991. Albatross mortality and associated bait loss in the Japanese longline fishery in the Southern Ocean. *Biological Conservation* 55: 255-268.

Brothers, N., Gales, R. & Reid, T. 1998. Seabird interactions with longline fishing in the AFZ: 1996 seabird mortality estimates and 1988-1996 trends. Unpublished Wildlife Report 98/1, Parks and Wildlife Service, Tasmania. (Presented at CCSBT - ERS working group 3, Document 9806/18. Tokyo, Japan.)

Brothers, N., Gales, R. & Reid, T. 1999. The influence of environmental variables and mitigation measures on seabird catch rates in the Japanese tuna longline fishery within the Australian Fishing Zone, 1991-1995. *Biological Conservation* 88: 85-101.

Buckingham, R., Elliott, G. & Walker, K. 1991. Bird and mammal observations on Adams Island and southern Auckland Island 1989. *Science & Research Internal Report* No. 105, Department of Conservation, Wellington.

Buller, W .L. 1888. *A history of the birds of New Zealand*, 2nd edn. The author, London.

Challies, C. N. 1998. *Eudyptula minor albosignata*. In: *Penguin conservation assessment and management plan* (Report from workshop held 8-9 September 1996, Cape Town, South Africa). Ellis, S., Croxall, J. P. & Cooper, J. (eds), IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, USA, pp 86-88.

Chambers, G. K. & Coddington, S. J. 1998. Molecular systematics of New Zealand fairy tern (*Sterna nereis davisae*) based on mitochondrial DNA sequences. *Conservation Advisory Science Notes* No. 182, Department of Conservation, Wellington.

Cherel, Y. & Klages, N. 1998. A review of the food of albatrosses. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 113-136.

Cherel, Y., Waugh, S. M., Hanchet, S. & Weimerskirch, H. (in press). Albatross predation of juvenile southern blue whiting *Micromesistius australis* on the Campbell Plateau. *New Zealand Journal of Marine and Freshwater Research*

Clark, G. & Robertson, C. J. R. 1996. New Zealand white-capped mollymawks *(Diomedea cauta steadi*) breeding with black-browed mollymawks (*D. melanophrys melanophrys*) at Antipodes Islands, New Zealand. *Notornis* 43: 1-6.

Clark, G., Amey, J. & McAllister, G. 1995. Unexpectedly large number of wandering albatrosses (*Diomedea exulans*) breeding on Antipodes Island, New Zealand. *Notornis* 42: 42-46.

Clark, G., Booth, A. & Amey, J. 1998. The 'Totorore' expedition to the Bounty Islands, New Zealand, October 1997 to January 1998. Unpublished report, Department of Conservation, Invercargill.

Collar, N.J., Crosby, M. J. & Stattersfield, A. J. 1994. Birds to watch 2, The world list of threatened birds. *Birdlife Conservation Series* No. 4. Page Bros (Norwich) Ltd, Great Britain.

Cooper, J. & Klages, N.T.W. 1995. The diets and dietary segregation of sooty albatrosses (*Phoebetria* spp.) at subantarctic Marion Island. *Antarctic Science* 7: 15-23.

Cooper, J., Brown, C. R., Gales, R. P., Hindell, M.A., Klages, N.T.W., Moors, P. J., Pemberton, D., Ridoux, V., Thompson, K. R. & van Heezik, Y. M. 1990. Diets and dietary segregation of crested penguins (*Eudyptes*). In: *Penguin biology*. Davis, L. S., Darby, J.T. (eds), Academic Press, San Diego, pp 131-156.

—— 1991. Birds of Centre Island. *Notornis* 38: 103-109.

—— 1992. Rockhopper penguins at the Auckland Islands. *Notornis* 39: 66-67.

Cooper, W. & McClelland, P. 1992. The birds of Omaui and Pig Islands, Foveaux Strait. *Notornis* 39: 316-318.

Cooper, W. J., Miskelly, C. M., Morrison, K. & Peacock, R. J. 1986. Birds of the Solander Islands. *Notornis* 33: 77-89.

Cossee, R. O. 1995. New Zealand-banded sooty tern (*Sterna fuscata*) breeds in the Seychelles. *Notornis* 43: 280.

Cox, J. E., Taylor, R. H. & Mason, R. 1967. Motunau Island, Canterbury, New Zealand, an ecological survey. *New Zealand Department of Scientific and Industrial Research Bulletin* No. 178. Government Printer, Wellington.

Crocker, T. & Habraken, T. 1998. Banded gulls. *OSNZ News* 86: 2-3.

Crockett, D.E. 1994. Rediscovery of Chatham Island taiko *Pterodroma magentae. Notornis* (*Supplement*) 41: 49-60.

Croxall, J. P. 1998. *Eudyptes chrysocome filholi.* In: *Penguin conservation assessment and management plan*. (Report from workshop held 8-9 September 1996, Cape Town, South Africa.) Ellis, S., Croxall, J. P. & Cooper, J. (eds), IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, USA, pp 48-51.

Croxall, J. P. & Gales, R. 1998. An assessment of the conservation status of albatrosses. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 46-65.

Croxall, J. P., Prince, P. A., Rothery, P. & Wood, A. G. 1998. Population changes in albatrosses at South Georgia. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 69-83.

Cunningham, D. M. & Moors, P. J. 1994. The decline of rockhopper penguins *Eudyptes chrysocome* at Campbell Island, Southern Ocean and the influence of rising sea temperatures. *Emu* 94: 27-36.

Darby, J.T. & Seddon, P. J. 1990. Breeding biology of yellow-eyed penguins (*Megadyptes antipodes*). In: *Penguin biology*. Davis, L. S., Darby, J.T. (eds), Academic Press, San Diego, pp 45-62.

de Lisle, G.W., Stanislawek, W. L. & Moors, P. J. 1990. *Pasteurella multocida* infections in rockhopper penguins (*Eudyptes chrysocome*) from Campbell Island, New Zealand. *Journal of Wildlife Diseases* 26: 283-285.

del Hoyo, J., Elliot, A. & Sargatal, J. (eds), 1992. *Handbook of the birds of the world*. Vol. 1. Ostrich to Ducks. Lynx Edicions, Barcelona.

—— 1996. *Handbook of the birds of the world*. Vol. 3. Hoatzin to Auks. Lynx Edicions, Barcelona.

Dennis, A. 1999. Helping the penguins. *Forest & Bird* 291: 36-39.

Department of Conservation. 1991. Yellow-eyed penguin species conservation strategy. Unpublished Recovery Plan, The Department, Dunedin.

—— 1998. *Restoring the dawn chorus; Department of Conservation Strategic Business Plan 1998-2002*. The Department, Wellington.

Dilks, P. J. 1979. Observations of the food of feral cats on Campbell Island. *New Zealand Journal of Ecology* 2: 64-66.

Dilks, P. J. & Grindell, J. M. 1983. Visit to Campbell Island by P.J. Dilks and J.M. Grindell, 11 January - 23 February 1983. Unpublished report, Ecology Division, Department of Scientific and Industrial Research, Lower Hutt.

—— 1990. Yellow-eyed penguins on Banks Peninsula - a preliminary report. *Science & Research Internal Report* No. 67, Department of Conservation, Wellington.

Dilks, P. J. & Wilson, P. R. 1979. Feral sheep and cattle and royal albatrosses on Campbell Island; population trends and habitat changes. *New Zealand Journal of Zoology* 6: 127-139.

Dunnet, G. M. 1985. Pycroft's petrel in the breeding season at Hen and Chickens Islands. *Notornis* 32: 5-21.

Edge, K-A. 1996. Parental investment in penguins: a phylogenetic and experimental approach. Unpublished Ph.D thesis, University of Otago, Dunedin.

Edge, K-A., Jamieson, I. G. & Darby, J. T. 1999. Parental investment and the management of an endangered penguin. *Biological Conservation* 88: 367-378.

Efford, M. & Spencer, N. 1996. Population studies of yellow-eyed penguins. *Landcare Research Contract Report* LC9697/014, Manaaki Whenua - Landcare Research New Zealand, Dunedin.

Efford, M. J., Darby, J.T. & Spencer, N. J. 1994a. Population studies of yellow-eyed penguins. *Landcare Research Contract Report* LC9495/39, Department of Conservation, Wellington.

Efford, M.J., Spencer, N. J. & Darby, J.T. 1994b. A relational database for yellow-eyed penguin banding and breeding records. *Landcare Research Contract Report* LC9495/38, Department of Conservation, Wellington.

Efford, M., Darby, J. & Spencer, N. 1996. Population studies of yellow-eyed penguins, 1993-94 progress report. *Science for Conservation* 22, Department of Conservation, Wellington.

Ell, G. 1999. Summer holiday victims. *Forest & Bird* 294: 20-23.

Elliott, G. P., Walker, K. J., Nicholls, D. G. & Murray, M. D. 1995. Foraging patterns of wandering albatross from the Auckland Islands. In: *Abstracts from first international conference on the biology and conservation of albatrosses, Hobart (Tasmania), 28 August - 1 September, 1995*, p 19.

Evans, R. M. 1970. Parental recognition and the 'mew call' in black-billed gulls (*Larus bulleri*). *Auk* 87: 503-513.

—— 1982a. Efficient use of food patches at different distances from a breeding colony in black-billed gulls. *Behaviour* 79: 28-38.

—— 1982b. Colony desertion and reproductive synchrony of black-billed gulls *Larus bulleri*. *Ibis* 124: 491-501.

Fallis, A. M., Bisset, S.A. & Allison, F. R. 1976. *Leucocytozoon tawaki* n.sp. (Eucoccida: Leucocytozoidae) from the penguin *Eudyptes pachyrhynchus*, and preliminary observations on its development in *Austrosimulium* spp. (Diptera: Simuliidae). *New Zealand Journal of Zoology* 3: 11-16.

Fleming, C.A. 1939. Birds of the Chatham Islands. *Emu* 38: 380-413, 492-509.

Fraser, W. R. 1994. Workshop on researcher-seabird interactions, July 15-17, 1993. Monticello, Minnesota, USA. Unpublished report, Office of Polar Programs, National Science Foundation, Washington, DC.

Freeman, A. N. D. 1997. The influence of hoki fishing vessels on Westland petrel (*Procellaria westlandica*) distribution at sea. *Notornis* 44: 159-164.

—— 1998. Diet of Westland petrels *Procellaria westlandica*: the importance of fisheries waste during chick-rearing. *Emu* 98: 36-43.

Freeman, A. & Wilson, K-J. 1997. Results of the Westland petrel satellite tracking programme 1995 season. *Conservation Advisory Science Notes* No. 160, Department of Conservation, Wellington.

Gales, R. 1993. *Co-operative mechanisms for the conservation of albatross*. (Commissioned by Australian Nature Conservation Agency.) Division of Parks and Wildlife, Tasmania. Tasmanian Government Printer.

Gales, R. 1998. Albatross populations: status and threats. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 20-45.

Gill, J. M. & Darby, J.T. 1993. Deaths in yellow-eyed penguins (*Megadyptes antipodes*) on the Otago Peninsula during the summer of 1990. *New Zealand Veterinary Journal* 41: 39-42.

Gould, P., Ostrom, P. & Walker, W. 1998. Foods of Buller's shearwaters (*Puffinus bulleri*) associated with driftnet fisheries in the central North Pacific Ocean. *Notornis* 45: 81-93.

Graczyk, T. K., Cockrem, J. F., Cranfield, M. R., Darby, J.T. & Moore, P. 1995. Avian malaria seroprevalence in wild New Zealand penguins. *Parasite* 2: 401-405.

Grant, A. 1994. Chatham Island taiko recovery plan 1994-2000. Unpublished Draft Plan 4, Department of Conservation, Christchurch.

Haase, B. 1994. A Chatham Island mollymawk off the Peruvian coast. *Notornis* 41: 50.

Habraken, T. 1997. Auckland black-billed gulls. *OSNZ News* 82: 6-7.

Hall, A. J. 1987. The breeding biology of the white-chinned petrel *Procellaria aequinoctialis* at South Georgia. *Journal of Zoology, London* 212: 605-617.

Halse, S. A. & Halse, N. J. 1988. Seabirds and shorebirds at Ningaloo in winter, with comments on Hutton's shearwaters. *Western Australian Naturalist* 17: 97-106.

Harper, P. C. 1983. Biology of the Buller's shearwater (*Puffinus bulleri*) at the Poor Knights Islands, New Zealand. *Notornis* 30: 299-318.

—— 1986. Biology of Buller's shearwater (*Puffinus bulleri*) at the Poor Knights Islands, New Zealand. In: The offshore islands of Northern New Zealand. Wright, A. E & Beever, R. E. (eds), *Information Series* No. 16. Department of Lands and Survey, Wellington, p 243.

Harper, P. C. & Fowler, J. A. 1987. Plastic pellets in New Zealand storm-killed prions (*Pachyptila* spp.) 1958-1977. *Notornis* 34: 65-70.

Harrison, P. 1983. *Seabirds - an identification guide*. Croom Helm Ltd, Kent.

Harrow, G. 1965. Preliminary report on discovery of nesting site of Hutton's shearwater. *Notornis* 12: 59-65.

—— 1976. Some observations of Hutton's shearwater. *Notornis* 23: 269-288.

Hawkins, J. M. & Heinekamp, H. F. 1992. Relocation of pied shag colony in Nelson city. *Notornis* 39: 95-98.

Heather, B. & Sagar, P. 1982. Black-fronted tern inquiry. *OSNZ News* 24: 2-3.

Hendriks, W. H., O'Connor, S., Thomas, D. V., Rutherfurd, S. M., Taylor, G. A. & Guilford, W. G. 2000. Nutrient composition of the crop contents of growing and adult grey-faced petrels (*Pterodroma macroptera*). *Journal of the Royal Society of New Zealand* 30(1):105-111.

Higgins, P. J. & Davies, S. J. J. F. 1996. *Handbook of Australian, New Zealand, and Antarctic birds*, Vol 3. Snipe to Pigeons. Oxford University Press, Melbourne.

Hill, S. & Hill, J. 1987. Richard Henry of Resolution Island. John McIndoe Ltd, Dunedin.

Holdaway, R. N. 1989. New Zealand's pre-human avifauna and its vulnerability. *New Zealand Journal of Ecology* (*Supplement*) 12: 11-25.

Holdaway, R. N. & Worthy, T. H. 1994. A new fossil species of shearwater *Puffinus* from the late Quaternary of the South Island, New Zealand, and notes on the biogeography and evolution of the *Puffinus gavia* superspecies. *Emu* 94: 201-215.

Honnor, L. 1997. Fairy tern recovery programme. *OSNZ News* 84: 5-6.

Horning, D. S. & Horning, C. J. 1974. Bird records of the 1971-1973 Snares Islands, New Zealand, Expedition. *Notornis* 21: 13-24.

Howell, S. N. G., Ainley, D. G., Webb, S., Hardesty, B. D. & Spear, L. B. 1996. New information on the distribution of three species of Southern Ocean gadfly petrels (*Pterodroma* spp.). *Notornis* 43: 71-78.

Hughey, K. & Warren, A. 1997. Habitat restoration for wildlife nesting on degraded braided riverbeds in New Zealand. In: *Conservation outside nature reserves*. Hale, P. & Lamb, D. (eds), Centre for Conservation Biology, The University of Queensland, pp 334-343.

Hull, C. L., Hindell, M. A., Gales, R. P., Meggs, R. A., Moyle, D.I . & Brothers, N. P. 1998. The efficacy of translocating little penguins *Eudyptula minor* during an oil spill. *Biological Conservation* 86: 393-400.

Imber, M. 1997. Vintage year for taiko. *OSNZ News* 83: 1.

Imber, M.J. 1976. Comparison of prey of the black *Procellaria* petrels of New Zealand. *New Zealand Journal of Marine and Freshwater Research* 10: 119-130.

—— 1983. The lesser petrels of Antipodes Islands, with notes from Prince Edward and Gough Islands. *Notornis* 30: 283-298.

—— 1984a. Exploitation by rats *Rattus* of eggs neglected by gadfly petrels *Pterodroma*. *Cormorant* 12: 82-93.

—— 1984b. Migration of white-faced storm-petrels *Pelagodroma marina* in the South Pacific and the status of the Kermadec subspecies. *Emu* 84: 32-35.

—— 1985a. Cook's petrel. In: *Complete book of New Zealand birds*. Robertson, C. J. R. (ed), Reader's Digest, Sydney, pp 80-81.

—— 1985b. Origins, phylogeny and taxonomy of the gadfly petrels *Pterodroma* spp. *Ibis* 127: 197-229.

—— 1987. Breeding ecology and conservation of the black petrel (*Procellaria parkinsoni*). *Notornis* 34: 19-39.

—— 1991. Feeding ecology of Antarctic and sub-Antarctic birds. Acta XX *Congressus Internationalis Ornithologici* 3: 1402-1412.

—— 1992. Cephalopods eaten by wandering albatrosses (Diomedea exulans L.) breeding at six circumpolar localities. *Journal of Royal Society of New Zealand* 22: 243-263.

—— 1994. Seabirds recorded at the Chatham Islands, 1960 to May 1993. *Notornis* (*Supplement*), 41: 97-108.

—— 1996. The food of Cook's petrel *Pterodroma cookii* during its breeding season on Little Barrier Island, New Zealand. *Emu* 96: 189-194.

—— 1999. Diet and feeding ecology of the royal albatross *Diomedea epomophora* – king of the shelf break and inner slope. *Emu* 99: 200-211.

Imber, M. J. & Russ, R. 1975. Some foods of the wandering albatross (*Diomedea exulans*). *Notornis* 22: 27-36.

Imber, M .J., Crockett, D. E., Gordon, A. H., Best, H. A., Douglas, M. E. & Cotter, R. N. 1994a. Finding the burrows of Chatham Island taiko *Pterodroma magentae* by radio telemetry. *Notornis* (*Supplement*) 41: 69-96.

Imber, M. J., Taylor, G. A., Grant, A. D. & Munn, A. 1994b. Chatham Island taiko *Pterodroma magentae* management and research, 1987-1993: predator control, productivity, and breeding biology. *Notornis* (*Supplement*) 41: 61-68.

Imber, M. J., Tennyson, A. J. D., Taylor, G. A. & Johnston, P. 1998. A second intact specimen of the Chatham Island taiko (*Pterodroma magentae*). *Notornis* 45: 247-254.

Innes, J. & Taylor, G. 1984. Sulphur Bay - a thermally heated wildlife area. *Forest & Bird* 232: 19-21.

IUCN, 1994. *IUCN red list categories*. Prepared by IUCN Species Survival Commission. IUCN, Cland, Switzerland.

Jackson, R. 1958. The Westland petrel. *Notornis* 7: 230-233.

James, P. C. & Robertson, H.A. 1986. How useful are vocalizations in petrel systematics? *Emu* 86: 186-189.

Jenkins, J. A. F. 1974. Local distribution and feeding habits of Buller's shearwater (*Puffinus bulleri*). *Notornis* 21: 109-120.

—— 1988. The distribution of Buller's shearwater (*Puffinus bulleri*) in New Zealand coastal waters and in the Tasman Sea. *Notornis* 35: 203-215.

Jones, P. 1999. Organochlorine contaminants in albatross from the South Pacific Ocean. *Conservation Advisory Science Notes* No. 226, Department of Conservation, Wellington.

Jouventin, P. 1990. Shy albatross *Diomedea cauta salvini* breeding on Penguin Island, Crozet Archipelago, Indian Ocean. *Ibis* 132: 126.

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

Kerr, I. S. 1976. *Campbell Island - a history*. A.H. & A.W. Reed, Wellington.

Kerr, I. S. & Judd, N. 1978. *Marlborough Whalers at Campbell Island 1909-1916*. Department of Lands and Survey, Wellington.

King, C. M. (ed) 1990. *The handbook of New Zealand mammals*. Oxford University Press, Auckland.

King, W. B. 1984. Incidental mortality of seabirds in gillnets in the North Pacific. In: Status and conservation of the world's seabirds. Croxall, J. P., Evans, P. G. H. & Schreiber, R.W. (eds), *ICBP Technical Publication* No. 2, pp 709-715.

Kinsky, F. C. & Falla, R. A. 1976. A subspecific revision of the Australasian blue penguin (*Eudyptula minor*) in the New Zealand area. *Records of the National Musuem of New Zealand* 1 (No. 7): 105-126.

Klaer, N. & Polacheck, T. 1997. By-catch of albatrosses and other seabirds by Japanese longline fishing vessels in the Australian Fishing Zone from April 1992 to March 1995. *Emu* 97: 150-167.

Lalas, C. 1977. Food and feeding behaviour of the black-fronted tern, *Chlidonias hybrida albostriatus*. Unpublished M.Sc. thesis, University of Otago, Dunedin.

—— 1979a. Seasonal movements of black-fronted terns. *Notornis* 26: 69-72.

—— 1979b. Double breeding season in pied shags on Stewart Island, from records by Roy Traill. *Notornis* 26: 94-95.

—— 1983. Comparative feeding ecology of New Zealand marine shags (*Phalacrocoracidae*). Unpublished PhD thesis, University of Otago, Dunedin.

—— 1993. Status and monitoring of marine shags in Otago Conservancy, with recommendations on research needs. *Conservation Advisory Science Notes* No. 13, Department of Conservation, Wellington.

Lalas, C. & Heather, B. D. 1980. The morphology, moult and taxonomic status of the black-fronted tern. *Notornis* 27: 45-68.

Lalas, C. & Brown, D. 1998. The diet of New Zealand king shags (*Leucocarbo carunculatus*) in Pelorus Sound. *Notornis* 45: 129-139.

Lamey, T. C. 1990. Snares crested penguin in the Falkland Islands. *Notornis* 37: 78.

—— 1992. Egg-size differences, hatch asynchrony and obligate brood reduction in crested penguins. Unpublished Ph.D. thesis, University of Oklahoma, Norman, Oklahoma, USA.

Langlands, P.A. 1991. Buller's shearwaters foraging around fishing vessels. *Notornis* 38: 266.

Latham, P. C. M. 1981. Black-fronted terns wintering in the Bay of Plenty. *Notornis* 28: 221-239.

Ludwig, J .P.; Summer, C. L.; Auman, H. J.; Gauger, V.; Bromley, D.; Giesy, J. P.; Rolland, R. & Colborn, T. 1998. The roles of organochloride contaminants and fisheries bycatch in recent population changes of black-footed and Laysan albatrosses in the North Pacific Ocean. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 225-238.

Maloney, R. F. 1999. Bird populations in nine braided rivers of the Upper Waitaki Basin, South Island, New Zealand: changes after 30 years. *Notornis* 46: 243-256.

Maloney, R., Wells, N., Elkington, S. & Chadderton, L. 1993. Survey of Fiordland crested penguins on Codfish Island. *Notornis* 40: 223-225.

Maloney, R. F., Rebergen, A. L., Nilsson, R. J. & Wells, N. J. 1997. Bird density and diversity in braided river beds in the Upper Waitaki Basin, South Island, New Zealand. *Notornis* 44: 219-232.

Maloney, R. F., Keedwell, R. J., Wells, N. J., Rebergen, A. L. & Nilsson, R. J. 1999. Effect of willow removal on habitat use by five birds of braided rivers, MacKenzie Basin, New Zealand. *New Zealand Journal of Ecology* 23: 53-60.

Marchant, S. & Higgins, P. J. (Co-ordinators) 1990. *Handbook of Australian, New Zealand and Antarctic birds.* Vol 1: Ratites to Ducks, Part A - Ratites to Petrels, Part B - Australian Pelican to Ducks. Oxford University Press, Melbourne.

McCallum, J., Brook, F. & Francis, M. 1985. Buller's mollymawks on Rosemary Rock, Three Kings Islands, in 1985. *Notornis* 32: 257-259.

McFadden, I. 1993. Petrels prospecting in the Hunua Ranges. *Notornis* 40: 188.

McHalick, O. 1999. Translocation database summary. *Threatened Species Occasional Publication* No. 14, Department of Conservation, Wellington.

McKinlay, B., Elbers, A., Ratz, H. & Nelson, D. 1997. Protection of yellow-eyed penguins from predators. In: *National predator management workshop 1997*. Sim, J. & Saunders, A. (eds), Department of Conservation, Wellington, pp 31-35.

McKinlay, B. 1998. *Megadyptes antipodes.* In: *Penguin conservation assessment and management plan*. (Report from workshop held 8-9 September 1996, Cape Town, South Africa.) Ellis, S., Croxall, J. P. & Cooper, J. (eds), IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, USA, pp 89-94.

McLean, I. G. 1990. Chick expulsion by a Fiordland crested penguin. *Notornis* 37: 181-182.

McLean, I. G. & Russ, R. B. 1991. The Fiordland crested penguin survey, Stage 1: Doubtful to Milford Sounds. *Notornis* 38: 183-190.

McLean, I. G., Studholme, B. J. S. & Russ, R. B. 1993. The Fiordland crested penguin survey, Stage III: Breaksea Island, Chalky and Preservation Inlets. *Notornis* 40: 85-94.

McLean, I G., Abel, M., Challies, C. N., Heppelthwaite, S., Lyall, J. & Russ, R. B. 1997. The Fiordland crested penguin (*Eudyptes pachyrhynchus*) survey, stage V: mainland coastline, Bruce Bay to Yates Point. *Notornis* 44: 37-47.

Mead, A. D. & Medway, D. 1960. Old and recent nesting records of petrels in Taranaki. *Notornis* 9: 105-106.

Meredith, M. A. M. & Sin, F. Y. T. 1988a. Genetic variation of four populations of the little blue penguin, *Eudyptula minor. Heredity* 60: 69-76.

—— 1988b. Morphometrical analysis of four populations of the little blue penguin, *Eudyptula minor. Journal of Natural History* 22: 801-809.

Merton, D. V. 1970. Kermadec Islands expedition reports: a general account of birdlife. *Notornis* 17: 147-199.

Meurk, C. D. 1977. Alien plants in Campbell Island's changing vegetation. *Mauri Ora* 5: 93-118.

——— 1982. Regeneration of subantarctic plants on Campbell Island following exclusion of sheep. *New Zealand Journal of Ecology* 5: 51-58.

Millener, P. R. 1972. The biology of the New Zealand pied cormorant. Unpublished M.Sc. thesis, University of Auckland, New Zealand.

Mills, J.A. & Shaw, P.W. 1980. The influence of age on laying date, clurch size, and egg size of the white-fronted tern, *Sterna striata. New Zealand Journal of Zoology* 7: 147-153.

Ministry for the Environment 1997. *New Zealand's state of the environment report 1997.* The Ministry, Wellington.

Miskelly, C. M. 1984. Birds of the Western Chain, Snares Islands, 1983-84. *Notornis* 31: 209-223.

——— 1997. Biological notes on the Western Chain, Snares Islands, 1984/85 and 1985/86. *Conservation Advisory Science Notes* No. 144, Department of Conservation, Wellington.

Miskelly, C. M. Pollard, S. & Carey, P. W. 1990. Antipodes Island report. Unpublished University of Canterbury Expedition Report, Department of Conservation, Southland.

Molloy, J. & Davis, A. 1992. *Setting priorities for the conservation of New Zealand's threatened plants and animals.* Department of Conservation, Wellington.

Moore, J. L. 1999. Norfolk Island bird notes, 1977 to 1997. *Notornis* 46: 354-364.

Moore, P. 1997. Cats on Campbell Island: rare or extinct. *Rare Bits* 25: 40.

——— 1998. Yellow-eyed penguin: a study of foraging habits. Science Poster 4, Department of Conservation, Wellington.

Moore, P. J. 1990. Population survey of yellow-eyed penguins on the Auckland Islands, Nov-Dec 1989. *Science & Research Internal Report* No. 73, Department of Conservation, Wellington.

——— (Compiler) 1991. Yellow-eyed penguin research and monitoring studies 1990-1991. *Science & Research Internal Report* No. 110, Department of Conservation, Wellington.

——— 1992. Population estimates of yellow-eyed penguin (*Megadyptes antipodes*) on Campbell and Auckland Islands 1987-90. *Notornis* 39: 1-15.

——— 1994. What is a bad season for yellow-eyed penguins? *Conservation Advisory Science Notes* No. 103, Department of Conservation, Wellington.

——— 1995. Status and decline of mollymawks on Campbell Island. In: *Abstracts from first international conference on the biology and conservation of albatrosses, Hobart (Tasmania), 28 August - 1 September, 1995*, p 7.

——— 1996. Light-mantled sooty albatross on Campbell Island, 1995-96: a pilot investigation. *Science for Conservation* 41, Department of Conservation, Wellington.

——— 1999. Counting mollymawks on Campbell Island - a guide to techniques and field procedures. *Department of Conservation* 16, The Department, Wellington.

——— (in press). Foraging range of the yellow-eyed penguin *Megadyptes antipodes. Marine Ornithology* 27.

Moore, P. J. & McClelland, P. J. 1990. Notes on birds of the Auckland Islands, November-December 1989. *Science & Research Internal Report* No. 93, Department of Conservation, Wellington.

Moore, P. J. & Moffat, R. D. 1990a. Research and management projects on Campbell Island 1987-88. *Science & Research Internal Report* No. 57, Department of Conservation, Wellington.

——— 1990b. Yellow-eyed penguin on Campbell Island. *Science & Research Internal Report* No. 58, Department of Conservation, Wellington.

——— 1990c. Mollymawks on Campbell Island. *Science & Research Internal Report* No. 59, Department of Conservation, Wellington.

Moore, P. J. & Wakelin, M. D. 1997. Diet of the yellow-eyed penguin *Megadyptes antipodes*, South Island, New Zealand 1991-1993. *Marine Ornithology* 25: 17-29.

Moore, P. J. & Blezard, R. 1999a. Photographs of Campbell Island mollymawk colonies: a guide to photopoints, historical comparisons and counting mollymawks. *Department of Conservation Technical Series* 17, The Department, Wellington.

—— 1999b. Counting Campbell Island mollymawk colonies from photographs – data supplements. *Science & Research Internal Report* No. 169, Department of Conservation, Wellington.

Moore, P. J., Douglas, M. E., Mills, J. A., McKinlay, B., Nelson, D. & Murphy, B. 1991. Results of a pilot study (1990-91): marine-based activities of yellow-eyed penguin. In: Yellow-eyed penguin research and monitoring studies 1990-1991. Moore, P. J. (ed), *Science & Research Internal Report* No. 110, Department of Conservation, Wellington.

Moore, P. J., Wakelin, M., Douglas, M. E., McKinlay, B., Nelson, D. & Murphy, B. 1995. Yellow-eyed penguin foraging study, south-eastern New Zealand, 1991-1993. *Science & Research Series* No. 83, Department of Conservation, Wellington.

Moore, P. J., Scott, J. J., Joyce, L. J. & Peart, M. 1997a. Southern royal albatross *Diomedea epomophora epomophora* census on Campbell Island, 4 January-6 February 1996, and a review of population figures. *Science & Research Series* No. 101, Department of Conservation, Wellington.

Moore, P. J., Taylor, G. A. & Amey, J. M. 1997b. Interbreeding of black-browed albatross *Diomedea m. melanophris* and and New Zealand black-browed albatross *D. m. impavida* on Campbell Island. *Emu* 97: 322-324.

Moore, P. J., Waugh, S. M., West, C. & Mitchell, G. 1997c. Preliminary results of a southern royal albatross *Diomedea epomophora epomophora* census, Campbell Island, 12 January-10 February 1995. *Science & Research Series* No. 100, Department of Conservation, Wellington.

Moors, P. J. 1980. Southern great skuas on Antipodes Island, New Zealand: observations on foods, breeding, and growth of chicks. *Notornis* 27: 133-146.

—— 1986. Decline in numbers of rockhopper penguins at Campbell Island. *Polar Record* 23: 69-73.

Morrison, K. 1980. Bird and stoat encounters in Fiordland. *Notornis* 27: 324.

Murie, J. O., Davis, L. S. & McLean, I. G. 1991. Identifying the sex of Fiordland crested penguins by morphometric characters. *Notornis* 38: 233-238.

Murphy, E. 1984. A report on the 1983/1984 summer rodent project in the Marlborough Sounds Maritime Park. Unpublished report, Ecology Division, Department of Scientific and Industrial Research, Nelson.

Murray, T. E., Bartle, J. A., Kalish, S. R. & Taylor, P. R. 1993. Incidental capture of seabirds by Japanese southern bluefin tuna longline vessels in New Zealand waters, 1988-1992. *Bird Conservation International* 3: 181-210.

Nelson, A. 1971. King shags in the Marlborough Sounds. *Notornis* 18: 30-37.

Nelson, J. B. 1978. *The Sulidae*. Oxford University Press, England.

Nicholls, D. G., Murray, M. D. & Robertson, C. J. R. 1994. Oceanic flights of the northern royal albatross *Diomedea epomophora sanfordi* using satellite telemetry. *Corella* 18: 50-52.

Nicholls, D. G., Murray, M. D., Elliott, G. P. & Walker, K. J. 1996. Satellite tracking of a wandering albatross from the Antipodes Islands, New Zealand, to South America. *Corella* 20: 28.

Nunn, G. B., Cooper, J., Jouventin, P., Robertson, C. J. R. & Robertson, G. G. 1996. Evolutionary relationships among extant albatrosses (Procellariiformes: Diomedeidae) established from complete cytochrome-*b* gene sequences. *Auk* 113: 784-801.

O'Brien, J. 1966. Macauley Island expedition. Unpublished report to Controller, New Zealand Wildlife Service, Wellington. Department of Internal Affairs file 46/29/9 (New Zealand Archives).

O'Brien, R. M. & Davies, J. 1990. A new subspecies of masked booby *Sula dactylatra* from Lord Howe, Norfolk and Kermadec Islands. *Marine Ornithology* 18: 1-7.

O'Donnell, C. F. J. 1992. Birdlife of the Ashburton River, Canterbury, New Zealand. *Department of Conservation Technical Report* No. 1, The Department, Christchurch.

O'Donnell, C. F. J. & Moore, S. G. M. 1983. The wildlife and conservation of braided river systems in Canterbury. *Fauna Survey Unit Report* No. 33. New Zealand Wildlife Service, Christchurch.

Ogi, H. 1984. Seabird mortality incidental to the Japanese salmon gill-net fishery. In: Status and conservation of the world's seabirds. Croxall, J. P., Evans, P. G. H. & Schreiber, R.W. (eds), *ICBP Technical Publication* No. 2, pp 717-721.

Oliver, W. R. B. 1955. *New Zealand birds*. 2nd edn. Reed, Wellington.

Parrish, G. R. & Pulham, G.A. 1995a. Observations on the breeding of the New Zealand fairy tern. *Tane* 35: 161-173.

—— 1995b. Population size, productivity and post-breeding movements of the New Zealand fairy tern. *Tane* 35: 175-181.

Parrish, R & Honnor, L. 1997. New Zealand Fairy Tern (Tara-iti) *Sterna nereis davisae* recovery plan 1997-2002. *Threatened Species Recovery Plan* No. 23, Department of Conservation, Wellington.

Peacock, L. 1995. Investigations into climatic effects on yellow-eyed penguins (Megadyptes antipodes). Unpublished M.Sc. thesis, University of Otago, Dunedin.

Petyt, C. 1996. Seabirds on Campbell Shelf. *OSNZ News* 81: 5-6.

Pierce, R. 1998a. Kiore: their impact on two small seabird species in the Hen & Chicken Islands. Science Poster 16, Department of Conservation, Wellington.

—— 1998b. The impact of kiore *Rattus exulans* on two small seabird species on New Zealand islands. In: Proceedings of 22nd International Ornithogical Congress, Durban. Adams, N. J. & Slotow, R. H. (eds), *Ostrich* 69: 446.

Pitman, R. L. & Ballance, L.T. 1992. Parkinson's petrel distribution and foraging ecology in the Eastern Pacific: aspects of an exclusive feeding relationship with dolphins. *Condor* 94: 825-835.

Podolsky, R. H. 1990. Effectiveness of social stimuli in attracting Laysan albatross to new potential nesting sites. *Auk* 107: 119-125.

Polacheck, T. & Tuck, G. 1995. Trends in tuna longline fisheries in the Southern Ocean and implications for seabird bycatch. Unpublished document prepared for the first meeting of the CCSBT ERS working group, 18-20 December 1995, Wellington, New Zealand.

Powlesland, R. 1998. Gull and tern survey. *OSNZ News* 88: 3-9.

Prince, P.A., Rothery, P., Croxall, J. P. & Wood, A. G. 1994. Population dynamics of black-browed and grey-headed albatrosses *Diomedea melanophris* and *D. chrysostoma* at Bird Island, South Georgia. *Ibis* 136: 50-71.

Prince, P.A., Croxall, J. P., Trathan, P. N. & Wood, A. G. 1998. The pelagic distribution of South Georgia albatrosses and their relationships with fisheries. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 137-167.

Pulham, G. 1997. Fairy terns nest early. *OSNZ News* 85: 5-6.

Pulham, G. & Dowding, J. 1996. Small terns, large dotterels. *OSNZ News* 79: 3-4.

Ratz, H. & Moller, H. 1997. Identification of predators of royal albatross chicks at Taiaroa Head in February 1994. *Conservation Advisory Science Notes* No. 138, Department of Conservation, Wellington.

Ratz, H. & Murphy, B. 1999. Effects of habitat and introduced mammalian predators on the breeding success of yellow-eyed penguins *Megadyptes antipodes*, South Island, New Zealand. *Pacific Conservation Biology* 5: 16-27.

Reid, D. & Reid, B. 1965. The Sulphur Point (Lake Rotorua) gull colony. *Notornis* 12: 138-157.

Reid, T. & James, D. 1997. The Chatham Island mollymawk (*Diomedea eremita*) in Australia. *Notornis* 44: 125-128.

Reese, P., Powlesland, R. & Cornick, D. 1996. Nesting of the pied shag (*Phalacrocorax varius*) at Makara Beach, Wellington. *Notornis* 43: 212-213.

Richdale, L.E. 1939. A royal albatross nesting on the Otago Peninsula, New Zealand. *Emu* 38: 467-488.

—— 1941a. A brief summary of the history of the yellow-eyed penguin. *Emu* 40: 265-287.

—— 1941b. The erect-crested penguin (*Eudyptes sclateri*) Buller. *Emu* 41: 25-53.

—— 1942. Supplementary notes on the royal albatross. *Emu* 41: 169-184 and 253-264.

—— 1945. Courtship and allied behaviour in penguins. *Emu* 44: 305-319 and 45: 37-54.

—— 1946. Pair-formation in penguins. *Emu* 46: 133-156 and 215-229.

—— 1947a. The pair bond in penguins and petrels; a banding study. *Bird-Banding* 18: 107-117.

—— 1947b. Seasonal fluctuations in weights of penguins and petrels. *Wilson Bulletin* 59: 160-171.

—— 1949a. The pre-egg stage in Buller's mollymawk. *Biological Monographs* 2. The author, Dunedin.

—— 1949b. Buller's albatross: incubation data. *Bird-banding* 20: 127-141.

—— 1950a. Further notes on the erect-crested penguin. *Emu* 49: 152-166.

—— 1950b. The pre-egg stage in the albatross family. *Biological Monographs* 3. The author, Dunedin.

—— 1951. *Sexual behaviour in penguins.* University of Kansas Press, Lawrence, Kansas.

—— 1952. Post-egg period in albatrosses. *Biological Monographs* 4. The author, Dunedin.

—— 1957. *A population study of penguins.* Clarendon Press, Oxford.

Richdale, L. E. & Warham, J. 1973. Survival, pair bond retention and nest-site tenacity in Buller's mollymawk. *Ibis* 115: 257-263.

Robertson, C. J. R. 1975. Report on the distribution, status and breeding biology of the royal albatross, wandering albatross and white-capped mollymawk on the Auckland Islands. In: Preliminary results of the Auckland Islands expedition 1972-1973. Yaldwin, J. C. (ed), *Reserves Series* No. 1975/3, Department of Lands and Survey, Wellington, pp 143-151.

—— 1980. Birds on Campbell Island. In: Preliminary reports of the Campbell Island expedition 1975-76. *Reserves Series* No. 7, Department of Lands and Survey, Wellington, pp 106-116.

—— 1991. Questions on the harvesting of Toroa in the Chatham Islands. *Science and Research Series* No. 35, Department of Conservation, Wellington.

—— 1993a. Survival and longevity of the northern royal albatross *Diomedea epomophora sanfordi* at Taiaroa Head 1937-1993. *Emu* 93: 269-276.

—— 1993b. Timing of egg laying in the royal albatross (*Diomedea epomophora*) at Taiaroa Head 1937-1992. *Conservation Advisory Science Notes* No. 50, Department of Conservation, Wellington.

—— 1998. Factors influencing the breeding performance of the northern royal albatross. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 99-104.

Robertson, C.J. R. & Kinsky, F. C. 1972. Dispersal movements of the royal albatross (*Diomedea epomophora*). *Notornis* 19: 289-301.

Robertson, C.J. R. & Wright, A. 1973. Successful hand-rearing of an abandoned royal albatross chick. *Notornis* 20: 49-58.

Robertson, C. J. R. & van Tets, G. F. 1982. The status of birds at the Bounty Islands. *Notornis* 29: 311-36.

Robertson, C. J. R. & Bell, B. D. 1984. Seabird status and conservation in the New Zealand region. In: Status and conservation of the world's seabirds. Croxall, J. P., Evans, P. G. H. & Schreiber, R. W. (eds), *ICBP Technical Publication* No. 2, pp 573-586.

Robertson, C. J. R. & Jenkins, J. 1986. Bird observations, Auckland Islands, February - June 1981. In: Preliminary reports of expeditions to the Auckland Islands Nature Reserve 1973-1984. Penniket, A., Garrick, A. & Breese, E. (eds), *Reserves Series*, Department of Lands and Survey, Wellington, pp 70-74.

Robertson, C. J. R. & Richdale, L. E. 1993. The breeding phenology of the royal albatross (*Diomedea epomophora sanfordi*) 1937-1974. *Conservation Advisory Science Notes* No. 48, Department of Conservation, Wellington.

Robertson, C. J. R. & Sawyer, S. 1994. Albatross research on (Motuhara) Forty-Fours islands: 6-15 December 1993. *Conservation Advisory Science Notes* No. 70, Department of Conservation, Wellington.

Robertson, C. J. R. & Nunn, G. B. 1998. Towards a new taxonomy for albatrosses. In*: Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 13-19.

Robertson, C. J. R. & Jones, P. D. 1998. Stress causing eggshell thinning: northern royal albatross. Science Poster 15, Department of Conservation, Wellington.

Robertson, C. J. R., O'Donnell, C. F. J. & Overmars, F. B. 1983. Habitat requirements of wetland birds in the Ahuriri River catchment, New Zealand. *New Zealand Wildlife Service Occasional Publication* No. 3. Department of Internal Affairs, Wellington.

Robertson, C. J. R., Law, E., de Hamel, R. J. B., Wakelin, D. J. & Courtney, S. P. 1984. Habitat requirements of wetland birds in the lower Waitaki River catchment, New Zealand. *New Zealand Wildlife Service Occasional Publication* No. 6. Department of Internal Affairs, Wellington.

Robertson, C.J.R., Robertson, G. G. & Bell, D. 1997. White-capped albatross (*Thalassarche steadi*) breeding at Chatham Islands. *Notornis* 44: 156-158.

Robertson, G. & Page, R. 1992. Notes on the albatrosses of The Pyramid and Fourty-Fours, Chatham Islands, NZ. Unpublished report, Department of Conservation, Wellington.

Russ, R. B., McLean, I. G. & Studholme, B. J. S. 1992. The Fiordland crested penguin survey, Stage II: Dusky and Breaksea Sounds. *Notornis* 39: 113-118.

Ryan , P. G. 1987a. The incidence and characteristics of plastic particles ingested by seabirds. *Marine Environment Research* 23: 175-206.

—— 1987b. The effects of ingested plastic on seabirds: correlations between plastic load and body condition. *Environmental Pollution* 46: 119-125.

—— 1988. Intra-specific variation in plastic ingestion by seabirds and the flux of plastic through seabird populations. *Condor* 90: 446-452.

—— 1991. The impact of the commercial lobster fishery on seabirds at the Tristan da Cunha Islands, South Atlantic Ocean. *Biological Conservation* 57: 339-350.

Ryan, P. G. & Boix-Hinzen, C. 1999. Consistent male-biased seabird mortality in the Patagonian toothfish long-line fishery. *Auk* 116: 851-854.

Sadleir, R. M. F. S., Taylor, R. H. & Taylor, G.A. 1986. Breeding of Antarctic terns (*Sterna vittata bethunei*). *Notornis* 33: 264-265.

Sagar, P. M. 1977. Birds of the Western Chain, Snares Islands, New Zealand. *Notornis* 24: 178-183.

—— 1978. Breeding of Antarctic terns at the Snares Islands, New Zealand. *Notornis* 25: 59-70.

Sagar, P. & Heather, B. 1981. Black-fronted tern survey. *OSNZ News* 20: 7.

—— 1982. Colour banded black-fronted terns. *OSNZ News* 25: 1.

Sagar, P. M. & Sagar, J. L. 1989. The effects of wind and sea on the feeding of Antarctic terns at the Snares Islands, New Zealand. *Notornis* 36: 171-182.

Sagar, P. M. & Warham, J. 1993. A long-lived southern Buller's mollymawk (*Diomedea bulleri bulleri*) with a small egg. *Notornis* 40: 303-304.

Sagar, P. M., Molloy, J., Tennyson, A. J. D. & Butler, D. 1994. Numbers of Buller's mollymawks breeding at the Snares Islands. *Notornis* 41: 85-92.

Sagar, P. M. & Weimerskirch, H. 1996. Satellite tracking of southern Buller's albatrosses from The Snares, New Zealand. *Condor* 98: 649-652.

Sagar, P. M. & Warham, J. 1998. Breeding biology of southern Buller's albatrosses at The Snares, New Zealand. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 92-98.

Sagar, P. M., Stahl, J. C. & Molloy, J. 1998. Sex determination and natal philopatry of southern Buller's mollymawks (*Diomedea bulleri bulleri*). *Notornis* 45: 271-278.

Sagar, P. M., Stahl, J. C., Molloy, J., Taylor, G. A. & Tennyson, A. J. D. 1999. Population size and trends within the two populations of southern Buller's albatross *Diomedea bulleri bulleri*. *Biological Conservation* 89: 11-19.

Sanders, M. D. 1997. Video monitoring of banded dotterel nests in braided rivers. In: *National predator management workshop 1997*. Sim, J. & Saunders, A. (eds), Department of Conservation, Wellington, pp 93-97.

Scofield, P. 1990. Response of Cook's and black petrels to artificial sounds. *Notornis* 37: 129-130.

—— 1990. The status of Cook's petrel on Great Barrier Island. *Notornis* 37: 130.

Scofield, R.P. 1989. The black petrel on Great Barrier Island. Unpublished M.Sc. thesis, University of Auckland, New Zealand.

Schuckard, R. 1994. New Zealand shag (*Leucocarbo carunculatus*) on Duffers Reef, Marlborough Sounds. *Notornis* 41: 93-108.

Seddon, P. J. 1988. Patterns of behaviour and nest site selection in the yellow-eyed penguin (*Megadyptes antipodes*). Unpublished Ph.D thesis, University of Otago, New Zealand.

—— 1989. Patterns of nest relief during incubation, and incubation period variability in the yellow-eyed penguin (*Megadyptes antipodes*). *New Zealand Journal of Zoology* 16: 393-400.

Seddon, P. J. & van Heezik, Y. 1990. Diving depths of yellow-eyed penguin *Megadyptes antipodes*. *Emu* 90: 53-57.

Sharp, B. E. 1996. Post-release survival of oiled, cleaned seabirds in North America. *Ibis* 138: 222-228.

Sherley, G. 1992. Monitoring Hutton's shearwater 1986-1989. *Notornis* 39: 249-261.

Siegel-Causey, D. 1988. Phylogeny of the Phalacrocoracidae. *Condor* 90: 885-905.

Smith, M. & Bentley, N. 1997. Underwater setting methods to minimise the accidental and incidental capture of seabirds by surface longliners. Report on a prototype device developed by MS Engineeering. *Science for Conservation* 67, Department of Conservation, Wellington.

Sorensen, J. H. 1950a. The royal albatross. *Cape Expedition Series Bulletin* 2: 1-39. Department of Scientific and Industrial Research, Wellington.

—— 1950b. The light-mantled sooty albatross at Campbell Island. *Cape Expedition Series Bulletin* 8. Department of Scientific and Industrial Research, Wellington, New Zealand.

Spear, L. B., Ainley, D. G. & Webb, S. W. 1995. Distribution, abundance and behaviour of Buller's, Chatham Island, and Salvin's albatrosses off Chile and Peru: potential interaction with longliners. In: *Abstracts from first international conference on the biology and conservation of albatrosses, Hobart* (*Tasmania*)*, 28 August - 1 September, 1995*, p 25.

Stahl, J. C., Bartle, J. A., Cheshire, N. G., Petyt, C. & Sagar, P. M. 1998. Distribution and movements of Buller's albatross (*Diomedea bulleri*) in Australasian seas. *New Zealand Journal of Zoology* 25: 109-137.

St. Clair, C. 1990. Mechanisms of brood reduction in Fiordland crested penguins (*Eudyptes pachyrhynchus*). Unpublished M.Sc. thesis, University of Canterbury.

——— 1992. Incubation behaviour, brood patch formation and obligate brood reduction in Fiordland crested penguins. Behavioral Ecology and Sociobiology 31: 409-416.

——— 1998. *Eudyptes pachyrhynchus*. In: Penguin conservation assessment and management plan. (Report from workshop held 8-9 September 1996, Cape Town, South Africa). Ellis, S., Croxall, J. P. & Cooper, J. (eds), IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, USA, pp 69-72.

St. Clair, C. C. & St. Clair, R. C. 1992. Weka predation on eggs and chicks of Fiordland crested penguins. *Notornis* 39: 60-63.

Stonehouse, B. 1967. Feeding behaviour and diving rhythms of some New Zealand shags. *Ibis* 109: 600-605.

Studholme, B. J. S. 1994. Parent-offspring recognition in the Fiordland crested penguin (*Eudyptes pachyrhynchus*). *New Zealand Natural Sciences* 21: 27-36.

Studholme, B. J. S., Russ, R. B. & McLean, I. G. 1994. The Fiordland crested penguin survey: Stage IV, Stewart and offshore islands and Solander Island. *Notornis* 41: 133-143.

Sutherland, F. 1999. After the fire. *Forest & Bird* 294: 18-19.

Tarburton, M. K. 1981. Notes and measurements of Hutton's and fluttering shearwaters found drowned at Kaikoura Peninsula. *Notornis* 28: 9-10.

Taylor, G. A. 1986. The ecology of Norway rats on Campbell Island. Unpublished report, Ecology Division, DSIR, Nelson.

——— 1988. Report to the Department of Conservation on an expedition to the Auckland Islands National Reserve, February 1988. Unpublished report, Department of Conservation, Invercargill.

——— 1991. Report on the Chatham Island taiko and Chatham Island petrel recovery programmes (1990/91). *Threatened Species Occasional Publication* No. 2, Department of Conservation, Wellington.

——— 1996. Seabirds found dead on New Zealand beaches in 1994. *Notornis* 43: 187-196.

——— 1997. Seabirds found dead on New Zealand beaches in 1995. *Notornis* 44: 201-212.

Taylor, G.A. & Tennyson, A.J. 1988. Report to the Department of Conservation on a trip to the Southern Kermadec Islands, September 1988. Unpublished Report, Department of Conservation, Auckland.

Taylor, G. A. & Parrish, G. R. 1991. Classified Summarised Notes, North Island 1 July 1989 to 30 June 1990. *Notornis* 38: 267-314.

Taylor, R. H. 1971. Influence of man on vegetation and wildlife of Enderby and Rose Islands, Auckland Islands. *New Zealand Journal of Botany* 9: 225-268.

——— 1979. Predation on sooty terns at Raoul Island by rats and cats. *Notornis* 26: 199-202.

Taylor, R. H. & Taylor, G. A. 1989. Re-assessment of the status of southern elephant seals (*Mirounga leonina*) in New Zealand. *New Zealand Journal of Marine and Freshwater Research* 23: 201-213.

Taylor, R. H., Bell, B. D. & Wilson, P. R. 1970. Royal albatrosses, feral sheep and cattle on Campbell Island. *New Zealand Journal of Science* 13:78-88.

Tennyson, A. 1990. Seabirds in strife. *Forest & Bird* 258: 23-30.

Tennyson, A. & Taylor, G. 1990a. Curtis Island. *OSNZ News* 57: 10.

Tennyson, A. & Pierce, R. 1995. The presence of Pycroft's petrel (*Pterodroma pycrofti*) and other petrels on Mauitaha Island, New Zealand. *Notornis* 42: 212-214.

Tennyson, A., Taylor, G. & Scofield, P. 1989. Another visit to Macauley Island. *OSNZ News* 52: 4-5.

Tennyson, A., Imber, M. & Taylor, R. 1998. Numbers of black-browed mollymawks (*Diomedea m. melanophrys*) and white-capped mollymawks (*D. cauta steadi*) at the Antipodes Islands in 1994-95 and their population trends in the New Zealand region. *Notornis* 45: 157-166.

Tennyson, A. J. D. 1991. The black-winged petrel on Mangere Island, Chatham Islands. *Notornis* 38: 111-116.

Tennyson, A. J. D. & Taylor, G.A. 1990b. Behaviour of *Pterodroma* petrels in response to "war-whoops". *Notornis* 37: 121-128.

Tennyson, A. J. D., Mayhill, R. C. & Clark, G. S. 1993. A visit to The Pyramid and the Murumurus, Chatham Islands. *Tane* 34: 171-179.

Tennyson, A. J. D. & Millener, P. R. 1994. Bird extinctions and fossil bones from Mangere Island, Chatham Islands. *Notornis* (*Supplement*) 41: 165-178.

Thompson, K. R. 1992. Quantitative analysis of the use of discards from squid trawlers by black-browed albatrosses *Diomedea melanophris* in the vicinity of the Falkland Islands. *Ibis* 134: 11-21.

Threatened Species Unit 1993. Diseases of avian wildlife in New Zealand. (Notes from lectures and presentations for a workshop held at School of Veterinary Sciences, Massey University, New Zealand, 13-14 August 1992.) Unpublished report, Department of Conservation, Wellington.

Tickell, W. L. N. & Pinder, R. 1975. Breeding biology of the black-browed albatross *Diomedea melanophris* and grey-headed albatross *D. chrysostoma* at Bird Island, South Georgia. *Ibis* 117: 433-451.

Tisdall, C. (Collator) 1994. *Setting priorities for the conservation of New Zealand's threatened plants and animals*. 2nd edn. Department of Conservation, Wellington.

Treadgold, S. 1998. A first for fairy terns. *OSNZ News* 87: 9-10.

Triggs, S. & Darby, J. 1989. Genetics and conservation of yellow-eyed penguin: an interim report. *Science & Research Internal Report* No. 43, Department of Conservation, Wellington.

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

Underhill, L. G., Bartlett, P.A., Baumann, L., Crawford, R. J. M., Dyer, B. M., Gildenhuys, A., Nel, D. C., Oatley, T. B., Thornton, M., Upfold, L., Williams, A. J., Whittington, P.A. & Wolfaardt, A. C. 1999. Mortality and survival of African penguins *Spheniscus demersus* involved in the *Apollo Sea* oil spill: an evaluation of rehabilitation efforts. *Ibis* 141: 29-37.

Uozumi, Y. 1998. Review of Japanese RTMP observer program in the high seas waters in 1996-1997 fishing years. Unpublished report, CCSBT - ERS working group 3, Document 9806/07. Tokyo, Japan.

van Heezik, Y. 1988. The growth and diet of the yellow-eyed penguin *Megadyptes antipodes*. Unpublished Ph.D thesis, University of Otago, Dunedin.

—— 1989. Diet of the Fiordland crested penguin during the post-guard phase of chick growth. *Notornis* 36: 151-156.

—— 1990. Seasonal, geographical, and age-related variations in the diet of the yellow-eyed penguin (*Megadyptes antipodes*). *New Zealand Journal of Zoology* 17: 201-212.

—— 1991. A comparison of yellow-eyed penguin growth rates across fifty years: Richdale revisited. *Notornis* 38: 117-123.

van Heezik, Y. & Davis, L. 1990. Effects of food variability on growth rates, fledging sizes and reproductive success in the yellow-eyed penguin *Megadyptes antipodes. Ibis* 132: 354-365.

van Tets, G. F. 1975. Observations on the Auckland Island shag, 1972-73. In: Preliminary results of the Auckland Islands Expedition 1972-1973. Yaldwin, J.C. (ed), *Reserves Series* No. 1975/3, Department of Lands and Survey, Wellington, pp 152-153.

—— 1980. The Campbell Island shag. In: Preliminary reports of the Campbell Island Expedition 1975-76. *Reserves Series* No. 7. Department of Lands and Survey, Wellington, pp 117-119.

Veitch, C. R. 1995. Habitat repair: a necessary prerequisite to translocation of threatened birds. In: *Reintroduction biology of Australian and New Zealand fauna*. Serena, M. (ed), Surrey Beatty & Sons, Australia, pp 97-104.

Veitch, C. R. & Bell, B. D. 1990. Eradication of introduced animals from the islands of New Zealand. In: Ecological restoration of New Zealand islands. Towns, D. R.; Daughterty, C. H. & Atkinson, I. A. E. (eds), *Conservation Sciences Publication* No. 2, Department of Conservation, Wellington, pp 137-146.

Waas, J. R. 1988a. Agonistic and sexual communication in the little blue penguins, *Eudyptula minor*. Unpublished Ph. D. thesis, Univeristy of Canterbury, Christchurch.

—— 1988b. Acoustic displays facilitate courtship in little blue penguins, *Eudyptula minor. Animal Behaviour* 36: 366-371.

—— 1990. Intraspecific variation in social repertoires: evidence from cave- and burrow-dwelling little blue penguins. *Behaviour* 115: 63-99.

—— 1995. Social stimulation and reproductive schedules: does the acoustic environment influence the egg-laying schedule in penguin colonies? In: *The penguins*. Dann, P., Norman, I. & Reilly, P. (eds), Surrey Beatty & Sons, Chipping Norton, pp 111-137.

Walker, K. & Elliott, G. 1999. Population changes and biology of the wandering albatross *Diomedea exulans gibsoni* at the Auckland Islands. *Emu* 99: 239-247.

Walker, K., Dilks, P., Elliott, G. & Stahl, J. C. 1991. Wandering albatross on Adams Island February 1991. *Science & Research Internal Report* No. 109, Department of Conservation, Wellington.

Walker, K., Elliot, G., Davis, A. & McClelland, P. 1995a. Wandering albatross on Adams Island: census, nesting data, and body measurements, February 1993. *Science & Research Series* No. 78, Department of Conservation, Wellington.

Walker, K., Elliott, G., Nicholls, D., Murray, D. & Dilks, P. 1995b. Satellite tracking of wandering albatross (*Diomedea exulans*) from the Auckland Islands: preliminary results. *Notornis* 42: 127-137.

Warham, J. 1963. The rockhopper penguin, *Eudyptes chrysocome*, at Macquarie Island. *Auk* 80: 229-256.

—— 1972a. Breeding seasons and sexual dimorphism in rockhopper penguins. *Auk* 89: 86-105.

—— 1972b. Aspects of the biology of the erect-crested penguin *Eudyptes sclateri. Ardea* 60: 145-184.

—— 1974a. The Fiordland crested penguin. *Ibis* 116: 1-27.

—— 1974b. The breeding biology and behaviour of the Snares crested penguin. *Journal of Royal Society, New Zealand* 4: 63.

—— 1975. The crested penguins. In: *The biology of penguins*. Stonehouse, B. (ed), Macmillan Press, pp 189-269.

—— 1981. Does Hutton's shearwater circumnavigate Australia? *Emu* 81: 44.

—— 1982. A distant recovery of a Buller's mollymawk. *Notornis* 29: 213-214.

—— 1988. Vocalisations of Procellaria petrels. *Notornis* 35: 169-183.

—— 1990. *The petrels their ecology and breeding systems*. Academic Press, London.

—— 1996. *The behaviour, population biology and physiology of the petrels*. Academic Press, London.

Warham, J. & Bell, B. D. 1979. The birds of Antipodes Island, New Zealand. *Notornis* 26: 121-169.

Warham, J. & Fitzsimons, C. H. 1987. The vocalisations of Buller's mollymawk, *Diomedea bulleri* (Aves: Diomedeidae), with some comparative data on other albatrosses. *New Zealand Journal of Zoology* 14: 65-79.

Warham, J. & Bennington, S. L. 1983. A census of Buller's albatross *Diomedea bulleri* at the Snares Islands, New Zealand. *Emu* 83: 112-114.

Watt, J. P. C. 1975. Notes on Whero Island and other roosting and breeding stations of the Stewart Island shag (*Leucocarbo carunculatus chalconotus*). *Notornis* 22: 265-272.

Waugh, S. M. 1998. Dye-marking of New Zealand black-browed and grey-headed albatrosses from Campbell Island. *New Zealand Journal of Marine and Freshwater Research* 32: 545-549.

Waugh, S. M., Moore, P. J. & Weimerskirch, H. 1995. Population dynamics of grey-headed mollymawks *Diomedea chrysostoma* and New Zealand black-browed mollymawks *D. melanophrys impavida* breeding at Campbell Island - a preliminary analysis. In: *Abstracts from first international conference on the biology and conservation of albatrosses, Hobart (Tasmania), 28 August - 1 September, 1995*, p 60.

Waugh, S. M., Sagar, P. M. & Paull, D. 1997. Laying dates, breeding success and annual breeding of southern royal albatrosses *Diomedea epomophora epomophora* at Campbell Island during 1964-69. *Emu* 97: 194-199.

Waugh, S. M., Sagar, P. M. & Cossee, R. O. 1999a. New Zealand black-browed albatross *Diomedea melanophrys impavida* and grey-headed albatross *D. chrysostoma* banded at Campbell Island: recoveries from the South Pacific region. *Emu 99: 29-35*.

Waugh, S. M., Weimerskirch, H., Moore, P. J. & Sagar, P. M. 1999b. Population dynamics of black-browed and grey-headed albatrosses *Diomedea melanophrys* and *D. chrysostoma* at Campbell Island, New Zealand, 1942-96. *Ibis* 141: 216-225.

Waugh, S. M., Weimerskirch, H., Cherel, Y. & Prince, P. A. (in press a). Contrasting strategies of provisioning and chick growth at Campbell Island, New Zealand. *Condor*.

Waugh, S. M., Weimerskirch, H., Cherel, Y., Shankar, U., Prince, P. A. & Sagar, P. M. (in press b). The exploitation of the marine environment by two sympatric albatrosses in the Pacific Southern Ocean. *Marine Ecology Progress Series*.

Waugh, S. M., Prince, P.A. & Weimerskirch, H. (in press c). Geographical variation in morphometry of black-browed and grey-headed albatrosses from four sites. *Polar Biology*.

Weimerskirch, H. & Jouventin, P. 1987. Population dynamics of the wandering albatross, *Diomedea exulans*, of the Crozet Islands: causes and consequences of the population decline. *Oikos* 49: 315-322.

—— 1998. Changes in population sizes and demographic parameters of six albatross species breeding on the French sub-antarctic islands. In: *Albatross biology and conservation*. Robertson, G. & Gales, R. (eds), Surrey Beatty & Sons, Chipping Norton, pp 84-91.

Weimerskirch, H. & Robertson, G. 1994. Satellite tracking of light-mantled sooty albatrosses. *Polar Biology* 14: 643-652.

Weimerskirch, H., Catard, A., Prince, P.A., Cherel, Y. & Croxall, J. P. 1999. Foraging white-chinned petrels *Procellaria aequinoctialis* at risk: from the tropics to Antarctic. *Biological Conservation* 87: 273-275.

West, J. A. 1990. Codfish Island petrel survey: 28 March – 9 April 1990. *Science & Research Internal Report* No. 85, Department of Conservation, Wellington.

—— 1994. Chatham petrel (*Pterodroma axillaris*) - an overview. *Notornis* (*Supplement*) 41: 19-26.

West, J. A. & Imber, M. J. 1986. Some foods of Buller's mollymawk *Diomedea bulleri*. *New Zealand Journal of Zoology* 13: 169-174.

West, J.A. & Nilsson, R. J. 1994. Habitat use and burrow densities of burrow-nesting seabirds on South East Island, Chatham Islands, New Zealand. *Notornis* (*Supplement*) 41: 27-37.

Westerskov, K. 1963. Ecological factors affecting distribution of a nesting royal albatross population. *The Proceedings X111th International Ornithological Congress*: 795-811.

Wilson, E. 1979. *Titi heritage, the story of the Muttonbird Islands*. Craig Printing Co. Ltd., Invercargill.

Woods, R.W. 1988. *Guide to birds of the Falkland Islands*. Anthony Nelson Ltd, England.

Worthy, T. H. 1998. Fossils indicate *Pelecanoides georgicus* had large colonies at Mason Bay, Stewart Island, New Zealand. *Notornis* 45: 229-246.

—— 1999. The role of climate change versus human impacts – avian extinction on South Island, New Zealand. In: Avian paleontology at the close of the 20th century. Proceedings of the 4th International Meeting of the Society of Avian Paleontology and Evolution, Washington D.C., 4-7 June 1996. Olson, S. L. (ed), *Smithsonian Contributions to Paleobiology* 89, pp 111-123.

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