

# The New Zealand Off-shore Islands

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## Introduction

New Zealand is an island archipelago and has been so throughout the greater part of its geological history. It stretches over 22 degrees of latitude or some 1,540 miles from the subtropical Kermadec Islands in the north to the subantarctic Campbell Island in the south (Fig. 1). Within this regions there are some 500 islands excluding the three main islands and innumerable nonvegetated stacks (Bell, 1963). They include island areas varying from stacks covering less than an acre to large islands such as Chatham Island (238,000 acres) and the main Auckland Island (128,000 acres). They also vary considerably in topography, vegetation, and climate.

Many of these islands are of unique scientific value being representative of ecosystems not found elsewhere and containing endemic species of plants and animals of considerable scientific importance. Some have suffered irreparable damage through the activities of man and the mammals he has introduced. Others fortunately have hitherto, wholly, or in part, escaped man-made changes. For these, and for the conservation of the irreplaceable endemic or rare species for which they are a last refuge New Zealand has a special responsibility. On some islands the removal of introduced mammals by officers of the Wildlife Branch, Department of Internal Affairs, has demonstrated that under certain conditions rehabilitation is possible.

In this review, nature conservation as it applies to the New Zealand islands is outlined, the conservation status of the various islands is assessed, an account is given of the present level of scientific research on the subantarctic islands and the future requirements for conservation in the New Zealand islands is considered.

## Nature Conservation Legislation in New Zealand

There is a multiplicity of Parliamentary Acts concerning nature conservation legislation in New Zealand coupled with a wide range of different types of reserves with varying degrees of protection. At present the following types of reserves are recognised.

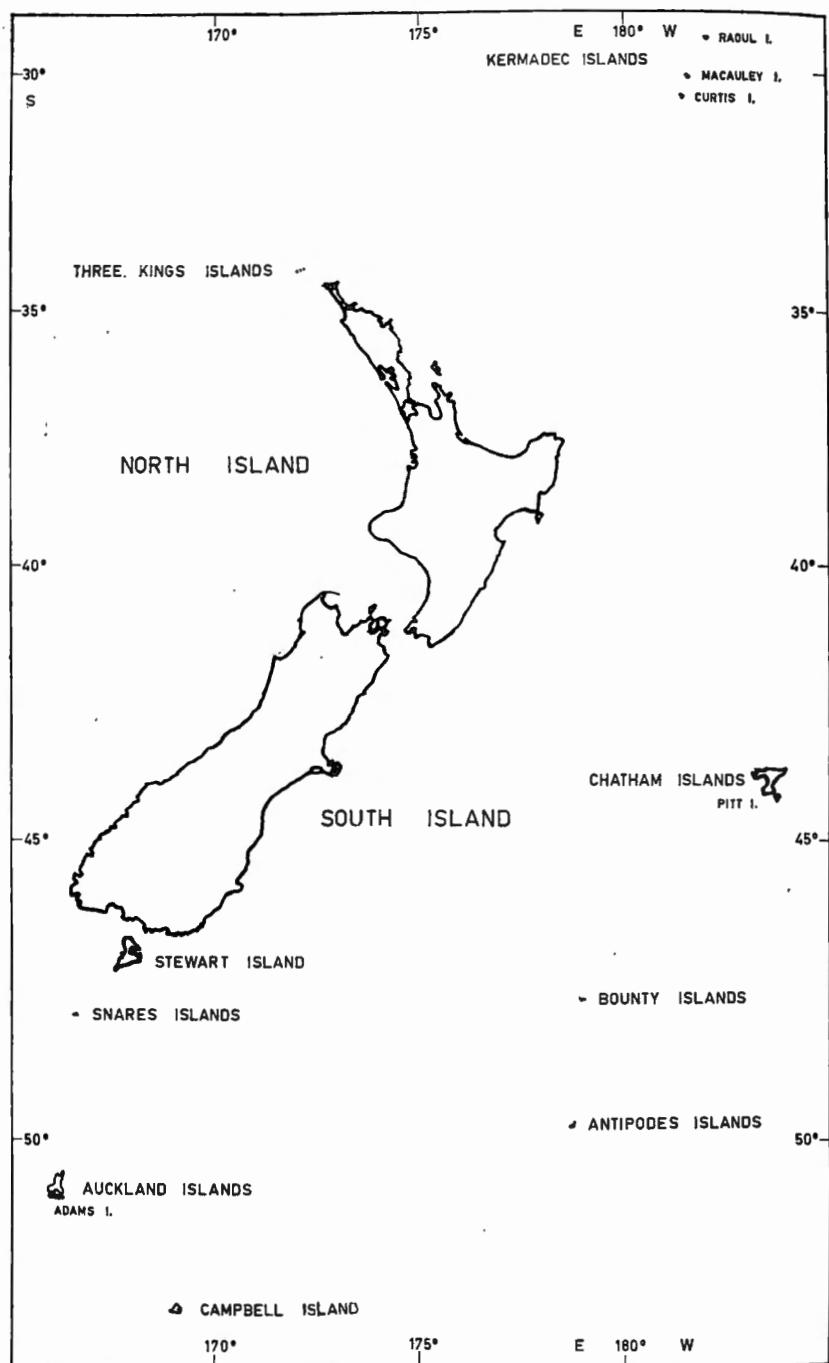


Fig. 1.

## (1) ADMINISTERED BY THE DEPARTMENT OF INTERNAL AFFAIRS

(a) *Wildlife Sanctuary*

The Wildlife Act of 1953 provides that the Governor General may by proclamation declare any area of land or water (providing the water does not belong to a sea or harbor) to be a *Wildlife Sanctuary*. The Act also allows for the inclusion of certain restrictions concerning rights of entry, hunting or killing, or taking wildlife or vegetation, rights of burning and clearing vegetation, prohibiting camping, lighting fires, usage of boats, prohibiting the disturbing of birds by aircraft, prohibiting the use of fire-arms and explosives, prohibiting taking or keeping animals or birds into or on a Sanctuary, prohibiting the depositing of rubbish, restricting the construction of roadways, etc. and may make any other prohibitional restriction which it is felt necessary to benefit the Wildlife found therein.

*Maori rights.* In many of the island areas the Maoris have traditional rights which are protected by legislation. Some Sanctuaries and Reserves have Maori right of access of these owners is provided for. In addition, they may under permit exercise traditional mutton-birding rights, taking the young of a number of species of petrel. Recently the introduction by mutton birders of rats onto Big South Cape Island off Stewart Island has resulted in the virtual extermination of some rare bird species.

(b) *Wildlife Refuge*

The Wildlife Act of 1953 empowers the Governor General from time to time by proclamation to declare an area of land or water (providing it is not a sea or harbor) to be a *Wildlife Refuge*. These Wildlife Refuges do not have the same strict provisions as above but the Act specifies certain restrictions—the keeping or bringing of domestic animals or fire-arms on the land, the discharging of fire-arms or explosives, and the killing or molesting of any wildlife or nest, eggs or spawn. Provision is also made for the prohibition or restriction of boats. The administration of Wildlife Refuges is delegated to the Acclimatization Societies within whose district they are situated.

At present there are 12 Wildlife Sanctuaries, 11 of which are islands, and approximately 200 Wildlife Refuges, seven of which are islands, throughout the New Zealand region.

(c) In addition there are Closed Game Areas and Wildlife Management Areas which do not apply to any of the island areas.

## (2) ADMINISTERED BY THE LANDS AND SURVEY DEPARTMENT

(a) *National Parks*

These are administered by the National Park Authority with each park having its own National Park Board. The National Park Act (1952) contains among its functions and powers the following: "administration, management and control of the Park—in such a manner as to secure to the public the fullest proper use and enjoyment of the Park consistent with the preservation of the natural features and

the protection and wellbeing of its native flora and fauna."

(b) *Wilderness Areas*

These are areas set aside within National Parks with a greater degree of protection from interference—no buildings are permitted, no vehicles are allowed, and only foot tracks may be constructed.

(c) *Reserves for the Preservation of Flora and Fauna*

These were originally set up under the Lands Act of 1947, which gave the Minister of Lands authority to set apart as a reserve any Crown Land for any purpose which in his opinion is desirable in the public interest. A number of Reserves for the Preservation of Flora and Fauna were set aside. The Reserves and Domains Act of 1953 restricts entry to such reserves except under permit. When permits are granted the Lands and Survey Department lays down such conditions as it sees fit. These include similar restrictions to those set out for Wildlife Sanctuaries.

(d) *Scenic Reserves*

Subject to the imposition of such conditions and restrictions as may be necessary for the preservation of the natural features of the reserves and their native flora and fauna the public have freedom of entry and right of access to such reserves.

The different categories of reserves listed above are classified in Table 1 according to the degree of protection.

The various island groups in the first four categories are listed below with the number of islands in each group. Those following Bell (1963) have arbitrarily been divided into three groups, large, medium, and small. In addition stacks which serve as nesting sites for sea birds are also listed.

Table 1. Types of reserves and degree of protection afforded

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*Maximum Protection*

1. Public Reserves for the Preservation of Flora and Fauna.
2. Wildlife Sanctuaries.

*Intermediate Protection*

3. Wildlife Refuges.
4. Wilderness Areas.

*Minimum Protection*

5. Scenic Reserves.
  6. National Parks.
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*Reserves for the Preservation of Flora and Fauna*

North Island West Coast

Kapiti, 1 large

Cuvier, 1 medium

North Island East Coast

Poor Knights, 2 medium and stacks

Hen and Chickens, 1 medium and 4 small

Little Barrier, 1 large

South Island East Coast

Chetwode, 3 medium and 5 stacks

Titi (Motungarara), 1 small

#### Foveaux Strait

Bench, 1 medium and 3 stacks

#### Outlying (Off-shore) Islands (Fig. 1)

Kermadec, 1 medium, 3 small

Chatham Is.

South East, 1 small

Little Mangere, 1 small

Antipodes, 1 large and stacks

Bounty,

Auckland Is. (Fig. 3)

Auckland, 1 large

Adams, 1 medium

Rose, 1 small

Enderby, 1 small

Ewing, 1 small

Disappointment, 1 small

Campbell, 1 large

Snares, 1 medium, 1 small, and stacks

#### *Wildlife Sanctuaries*

North Island East Coast

Mokohinau, 1 medium, 4 small

Aldermans, 4 small to medium and stack

Karewa, 1 small

Cook Strait

Trios, 3 small

Otamatou Rock, 1 stoack

Stephens, 1 medium

White Rock, 1 stack

Duffers Rock, 1 stack

Sentinel Rock, 1 stack

South Island East Coast

Motunau, 1 small

#### *Wildlife Refuges*

North Island West Coast

Three Kings, 1 medium, 3 small, and stacks

Sugar Loaves, 5 small

Mokopuna (Leper), 1 small

North Island East Coast

Mayor, 1 medium to large

South Island West Coast

Open Bay, 3 small

**South Island East Coast**  
**Cosgrove, 1 small**

**Wilderness Areas**

Secretary Island in the Fiordland National Park is the only island that has been declared a Wilderness Area.

At present the Department of Lands and Survey is undertaking a survey of the nature reserves under its jurisdiction with a view to their reclassification into the following categories:

- (a) *Scientific* These are reserves with important scientific value. The present Reserves for the Preservation of Flora and Fauna will probably be in this category.
- (b) *Scenic A* These are reserves with their greatest value as examples of natural systems; i.e. with high aesthetic value. In such reserves there will be restrictions as applying to present Scenic Reserves.
- (c) *Scenic B* These are reserves with an amenity value for public use as well as having scenic value.
- (d) *Conservation* These are reserves which have their greatest value in soil and water conservation.

**The Near-shore Islands**

Of the innumerable near-shore islands, excluding the Three Kings which will be dealt with later, either islands or groups of islands have the status of Reserves for the Preservation of Flora and Fauna, six islands in island groups and four stacks have been declared Wildlife Sanctuaries, and six islands in island groups are Wildlife Refuges (Fig. 2). The most urgent requirement as far as these are concerned is the completion of the projected conservation survey by the Conservation Section of the Wildlife Branch of the Department of Internal Affairs, although with the available manpower this is certain to take some considerable time. This survey will reveal additional islands and island groups that will merit special status as Scientific Reserves. Islands that on present knowledge would merit such protection are some of the islands round Stewart Island especially the Solanders.

**The Off-shore Islands**

These include the following islands or groups of islands—Three Kings, Kermadecs, Chathams, Antipodes, Bounty, Auckland, Campbell, and Snares. Each of these will be dealt with in turn under a series of headings.

**THE NORTHERN TROPICAL AND WARM-TEMPERATURE ISLANDS**

**1. *Three Kings Islands***

**No. and Size.** One medium, 875 acres (Great King Island); three small (North

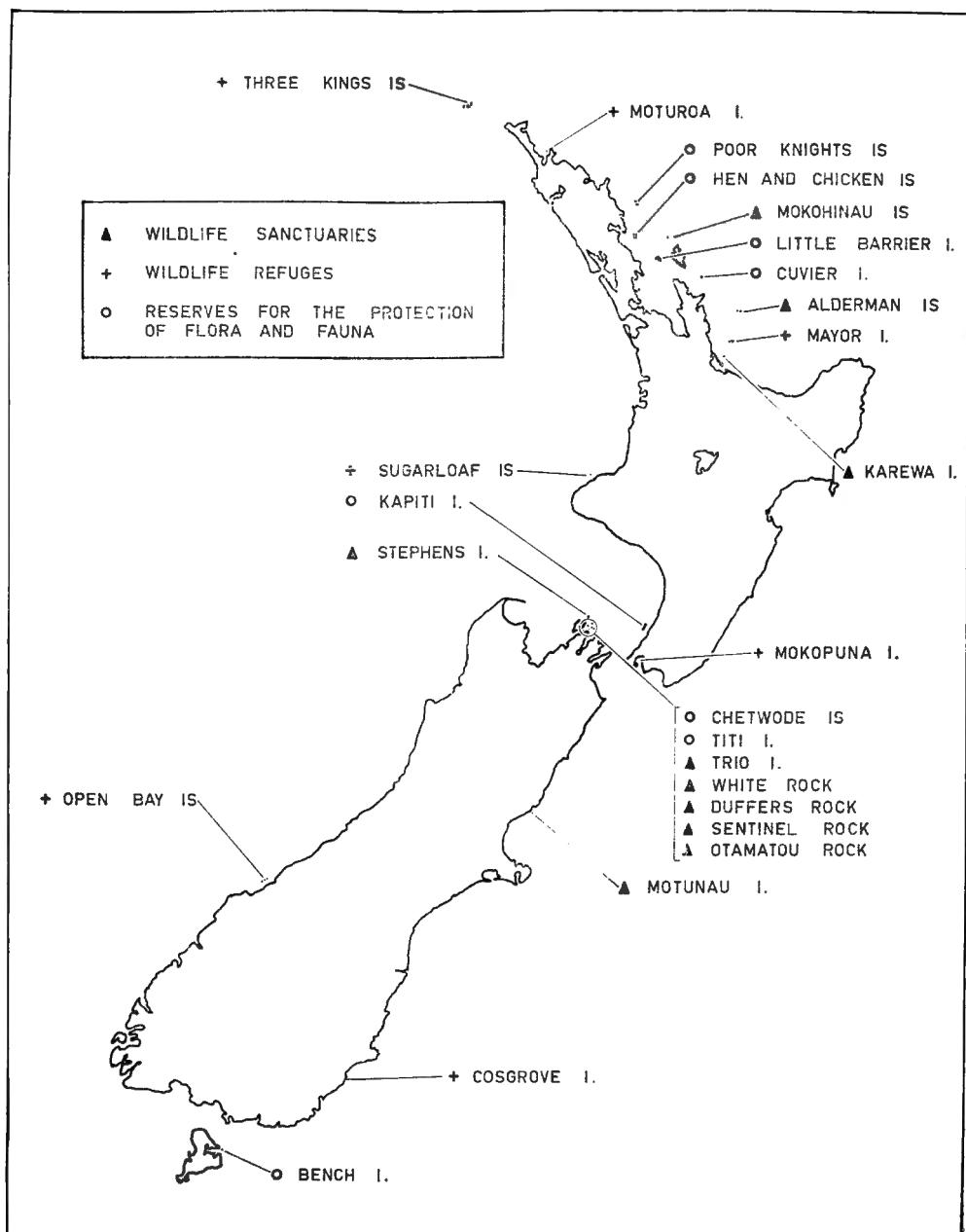


Fig. 2.

East Island, South West Island and West Island); stacks of varying size (one group forming the Princes Islands).

*Conservation Status. Wildlife Refuge*

*Scientific Importance.* There is a marked endemism in the flora and fauna. There are two endemics genera of plants both monotypic and 13 endemic species (Oliver, 1948, 1951; Baylis, 1948, 1951, 1958). Among the insects and the terrestrial molluscs in particular there are many interesting endemics. There is no endemism among the birds (Turbott and Buddle, 1948).

*Modification by Man.* Maoris lived in the islands until 1840 and had deforested North East Island, South West Island, and much of the Great King Island.

*Modification by Introduced Mammals.* Goats were placed on Great King Island in 1889 but may have been there before that date (Turbott, 1948, 1963, 1968). They were eradicated by hunters from the Wildlife Branch, Department of Internal Affairs in 1946, a total of 393 being killed. At that time they had reduced the vegetation to a reasonably uniform scrub or forest of kanuka (*Leptospermum ericoides*), a nonpalatable species. A high proportion (78 per cent) of the plant species had been greatly reduced, 19 species being down to the last few individuals, these included six species of trees or shrubs. Amongst the latter were two endemics of which only one individual could be found; one of these has proved to be hermaphrodite and self-fertile (*Tecomanthe*), but the other (*Plectormirtha*), though hermaphrodite is self-sterile. This last species is certain to become extinct.

*Research.* Since the removal of the goats the regeneration of the vegetation and changes in the bird fauna and terrestrial invertebrates have been followed by a team from the Auckland Museum and Otago University led by E. G. Turbott and G. T. S. Baylis. Considerable regeneration has taken place and the process has been well documented. Research is continuing and the results are a classic example of the changes which can take place on an island ecosystem after the removal of a destructive herbivore.

*Future Requirements.* Protection is adequate and continuing research should provide an adequate basis for the future management of the group. These islands should ultimately form a Scientific Reserve in the new classification.

## 2. Kermadec Islands

*No. and Size.* One large, Raoul (7,260 acres); outliers of Raoul, seven small known collectively as the Herald Islands (Meyer, Napier, Nugent, Daynell; North, South and East Chanter); one medium, Macauley (756 acres), one small, Hazard (17 acres), both 67 miles north-east of Raoul; two small Curtis (128 acres) and Cheeseman (12 acres), both 20 miles south of Macauley.

*Conservation Status. Part Reserve for the Preservation of Flora and Fauna.*

*Scientific Importance.* These islands are of considerable scientific importance being the only land area apart from Norfolk, Lord Howe, and Juan Fernandez at this latitude in the Pacific. The plants show Australian, New Zealand, and Polynesian relationships and include some 14 interesting endemics (Cheeseman,

1888; Oliver, 1910). There is little published work on the invertebrate fauna, but adequate collections are now being worked up. The birds are of great interest, the islands forming the breeding sites of a rich and interesting assemblage of seabirds including the following endemic species or subspecies; Kermadec allied shearwater, *Puffinus assimilis kermadecensis*; Sunday Island petrel, *Pterodroma externa cervicalis*; Kermadec petrel, *Pterodroma neglecta*; black-winged petrel, *Pterodroma hypoleuca nigripennis*; Kermadec storm petrel, *Pelagodroma marina albiclinis*; and grey ternlet, *Procelsterna cerulea albivitta*. Other Pacific seabirds breeding in large numbers on the islands include wedgetailed shearwater, *Puffinus pacificus pacificus*; Redtailed tropic bird, *Phaethon rubricanda roseotincta*; masked booby, *Sula dactylatra personata*; sooty tern, *Sterna fuscata*; white-capped noddy, *Anous tenuirostris minutus*; and the white tern, *Gygis alba royanus* (Oliver, 1912; Sorenson, 1964; Edgar, et. al. 1965). Endemic land birds include the spotless crake, *Porzana tabuensis plumbea* and the Kermadec parakeet, *Cyanoramphus novaezelandiae cyanurus*.

*Modification by Man.* Since the 1800's when the islands were visited by whalers there have been periods of intermittent settlement on Raoul with attempts to grow exotic fruits, especially oranges, for the New Zealand market. Raoul is now occupied by the staff of a small Meteorological Station and some farming is carried out. This occupation has resulted in the introduction and establishment of a large number of exotic plant species (Oliver, 1910; Sykes, 1965).

*Modification by Introduced Mammals.* Goats were introduced to Raoul and other islands in 1842, cats were found on Raoul in the 1860's, and Norway rats probably arrived much earlier in the whaling ships (Watson, 1956). The native rat, the kiore, is also present. Goats, cats, and rats are now numerous on Raoul and up to 1966 were abundant on Macauley. On the latter island some 3200 goats were destroyed by the Wildlife Branch, Department of Internal Affairs. Fortunately, none of these introduced mammals as yet occur on the other islands. On Raoul goats have so modified the vegetation that only the less palatable species alone are regenerating successfully apart from a few inaccessible sites. The endemic *Hebe* was not found in 1967 and is possibly now extinct (Sykes, 1965; Merton, 1968). In addition exotics such as the unpalatable aroid (*Alocasia macrorrhiza*) has almost completely replaced the tree ferns on the wetter sites.

The rats and cats have had a devastating effect on the bird life of Raoul (Merton, 1968; Soper, 1968). Oliver (1912) recorded that the Kermadec Island petrel nested in tens of thousands and the young of this species in the past were harvested in large numbers by the settlers—12,000 being taken in 1889 (Cheeseman, 1891). In 1967 only two nests of this species were found. Both the wedge-tailed shearwater and the blackwinged petrel are drastically reduced in numbers and the rare endemic Sunday Island petrel is almost extinct. The originally huge Denham Bay sooty tern colony has been reduced to a fraction of its original size. In 1967 some 25,000 chicks were hatched, but very few survived the rat and cat predation. The endemic parakeet has been exterminated on Raoul many years since. The

list could be extended and the story is a very depressing one. Fortunately, there is still an abundant birdlife on the Herald Islands and recolonization of Raoul could take place from these islands if the predators were eliminated.

*Scientific Research.* As Soper (1968) points out these islands have been curiously neglected as far as natural historians are concerned. The only formal expeditions have been those of T. F. Cheeseman in 1887, W. R. B. Oliver and T. Iredale in 1890, and the Ornithological Society of New Zealand 1967 Expedition. This ten-man expedition carried out studies on the birds, introduced mammals, invertebrates, and vegetation of Raoul and Meyer Islands (Merton, 1968). When worked up the results should add much to our knowledge of these islands and highlight the needs for future research.

*Future Requirements.* Goats which had completely changed the Macauley Island ecosystem have now been eliminated and the changes which take place should be followed as has been done on the Three Kings. There is an urgent need for research on the introduced mammals on Raoul and the implementation of measures for their control and eventual elimination. Continuing ecological research will be needed as a basis for the future management of these islands. The Kermadecs have a high priority as scientific reserves and should have the maximum degree of protection.

#### THE SUBANTARCTIC ISLANDS

##### 1. Chatham Islands

*No. and Size.* One large, Chatham (224,000 acres); one medium, Pitt (15,000 acres); five small, South West, (640 acres), Mangere, Little Mangere, Forty Fours, Sisters, numerous stacks.

*Conservation Status.* South East Island—Reserve for the Preservation of Flora and Fauna; Mangere—Reserve for the Preservation of Flora and Fauna.

*Scientific Importance.* These islands are not truly subantarctic lying on the northern fringe of the Subantarctic zone. The flora and fauna are a mixture of northern and southern elements. They are the most northerly breeding sites for a number of seabirds such as the Royal Albatross, with large colonies on the Sisters and Forty Fours. Of the 55 breeding birds, 13 are introduced and 18 species or subspecies are endemic to the group. The small South East Island now is the only refuge for three endemic species, the Chatham Island snipe, the Chatham Island petrel, and the shore plover. The latter species was once widely distributed throughout the New Zealand mainland and is now reduced to some 70 pairs (Fleming, 1939). Little Mangere now has the sole remaining populations of the Chatham Island yellow-crowned parakeet with about 100 individuals and the Chatham Island robin, estimated at 20 to 35 pairs in 1937.

*Modification by Man.* Polynesian ancestors of the original Moriori population reached the island possibly 1000 years ago, sealers and whalers, and Maoris arrived in the early 1800's and farming has been carried out continuously since their arrival. Farming has considerably modified the original vegetation on the

main Chatham and Pitt Islands.

*Modification by Introduced Mammals.* While the usual cats and rats are present on Chatham and Pitt the smaller outlying islands such as South East, Little Mangere, Sisters, and Forty Fours have fortunately remained free of these pests.

*Scientific Research.* Because of easy access numerous scientists have visited the islands for short periods, but detailed ecological research is still lacking. A team of entomologists from the Entomology Division, D.S.I.R., made the first extensive collections in 1967. This year a party from the Wildlife Branch, Department of Internal Affairs and the Lands and Survey Department carried out a survey to assess the effect of the recent development of an intensive crayfishing industry on the fauna and the present status of the bird fauna and of the reserves. Arising out of this survey recommendations may be made for the reservation of ecosystems not yet represented in the present reserves.

*Future Requirements.* Steps should be taken to secure the reservation of the Sisters and Forty Fours as Scientific Reserves. There is an urgent need for detailed work on the rare endemic bird species, especially on South East Island and of the ecosystems of which they are a part.

## 2. Antipodes Islands

*No. and Size.* One large, Antipodes (15,360 acres); one small, Bollons and a number of stacks.

*Conservation Status.* Reserve for the Preservation of Flora and Fauna.

*Scientific Importance.* Along with Adams Island in the Auckland group and the Snares Island the Antipodes are still largely in their natural state having escaped the ravages of human occupation and introduced mammals. Three species of penguins, three albatrosses, and at least ten species of petrels breed on the Antipodes, some of them in very large numbers (Table II). In addition, there are two endemic parakeet species. The vegetation contains representatives of many of the interesting subantarctic endemic plants. Because of their relatively undisturbed state as unique island ecosystems these islands are of great scientific importance.

*Interference by Man.* Although the scene of early sealing expeditions there is little sign of human interference.

*Interference by Introduced Mammals.* Nil.

*Scientific Research.* These are the least known of all the subantarctic islands, so scientist having spent more than a few days on the main island. The University of Canterbury has organized a comprehensive expedition to these islands to take place from January 6th to March 8th, 1969.

*Future Requirements.* The major requirement is for the primary survey planned for 1969. Further long-term research will be required but this will be dependent upon the provision of facilities.

## 3. Bounty Islands

*No. and Size.* A number of granite islets and stacks of varying sizes.

*Conservation Status.* Reserve for the Preservation of Flora and Fauna.

*Scientific Importance.* There is no terrestrial vegetation, but there are very large concentrations of a relatively few species of seabirds; nine species having been recorded from the group.

*Interference by Man.* While sealers almost exterminated the fur seal they had little effect on the bird life.

*Interference by Introduced Mammals.* Nil.

*Scientific Research.* Very little work has been carried out although a number of scientists have spent short periods ashore.

*Future Requirements.* There is a need for a primary survey.

#### 4. Auckland Islands

*No. and Size.* One large, Auckland (114,560 acres); one medium, Adams (22,720); five small, Enderby (1770 acres), Rose, Ocean, Ewing, and Disappointment (Fig. 3).

*Conservation Status.* Reserve for the Preservation of Flora and Fauna.

*Scientific Importance.* This is the largest land area in the Pacific subantarctic. Floristically these islands are the richest group with some 170 species including six endemics and other species confined to the subantarctic such as those of the genus *Pleurophyllum*. The endemic bird species include the Auckland Island rail, recently rediscovered on Adam Island and the Auckland Island flightless duck. Forty-nine bird species, including seventeen sea birds breed on the group (Table 2). The major breeding population, apart from a few pairs of the Southern sealion frequents a

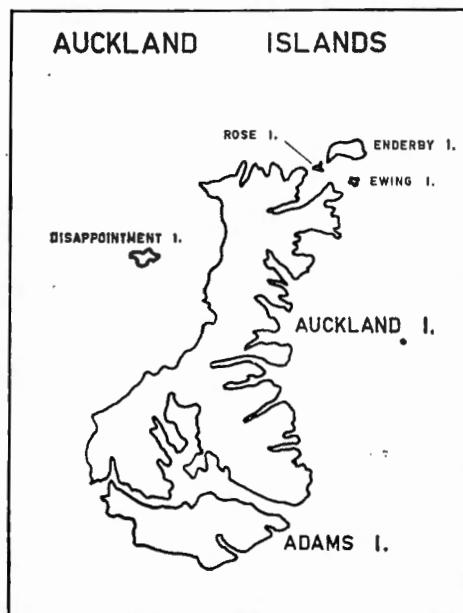


Fig. 3.

single beach on Enderby Island. The invertebrate fauna comprises probably more than 600 species with a high degree of endemism. Adams Island alone retains its virgin state and consequently is of extreme importance.

*Interference by Man.* Early attempts at settlement in the 1840's were abortive. Various attempts were made to farm sheep, but they had limited success. Enderby, Rose, and Ocean Islands have all been altered by burning in various degrees.

*Interference by Introduced Mammals.* The Auckland Islands have had more introductions than any other group (Falla, 1948, 1965; Taylor, 1968). Sheep were introduced in 1895, but conditions did not prove suitable and flocks of up to 2000 disappeared after being abandoned. Cattle were left on Enderby Island when pastoral attempts were abandoned and now number some 60 to 70 individuals. Goats still survive in small numbers on the northern end of the main island. A small herd on Ocean Island was exterminated in 1941 and replaced by sheep for the use of the wartime coast watchers. These were finally killed out in 1945. Wild pigs were introduced in the early 1800's and are now established throughout the main island where they have considerably modified the vegetation eliminating many of the palatable herbaceous species except from the more inaccessible places. They have also, along with cats, had a disastrous effect on burrowing petrels. Feral cats are widespread on the main island and while mice are common, rats do not appear to be present. Rabbits are present on Rose and Enderby Islands (Bull, 1960). Taylor (1968) has recently summarized the history of introductions on the Auckland Islands (see Fig. 4).

*Scientific Research.* Apart from Campbell Island more work has been carried out on the Auckland Islands than any other group. Many of the early southern expeditions visited the islands while the Philosophical Institute of Canterbury 1907 Expedition (Chilton, 1909) carried out the first intensive work. A small D.S.I.R. party visited Enderby and Rose Islands in 1958 to be followed by the two major combined expeditions in 1964 and 1966 (see above). As a result we now have adequate background information on the general distribution of the flora and fauna.

*Future Requirements.* The greatest need is for the establishment of longterm ecological research. In particular the modified Enderby Island ecosystem would repay intensive study.

##### 5. *Campbell Island*

*No. and Size.* One large (38,160 acres) plus a number of islets and stacks.

*Conservation Status.* Reserve for the Preservation of Flora and Fauna.

*Scientific Importance.* Next to the Auckland Islands, Campbell has the largest number of species of plants and animals of the truly subantarctic islands. The indigenous vascular plants number about 116 species and in addition there are at least 47 introduced species. There is a rich invertebrate fauna numbering in excess of 400 species. Fur seals, sea lions, and elephant seals all breed on the island.

*Interference by Man.* Campbell Island has had the largest continuous period of farming from 1895 to 1931. There has also been continuous occupation by the

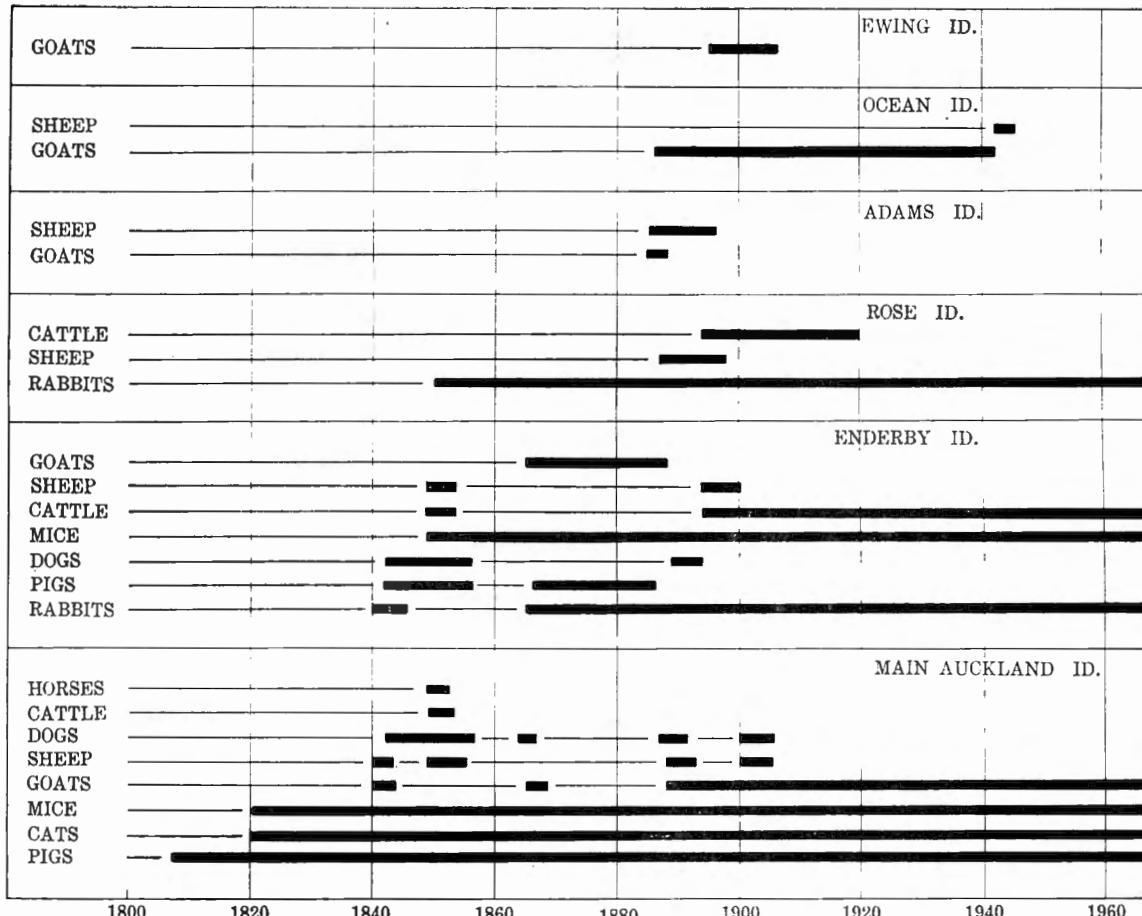


Fig. 4. Historical summary of introduced mammals on the Auckland Islands. (Based on published and unpublished references filed at Animal Ecology Division, D.S.I.R.)

coast watching parties 1941–45 and since that date by the staff of the Meteorological Station.

*Interference by Introduced Mammals.* The sheep have declined from an estimated 4000 in 1931 to about 2000 in 1941 and were down about 1000 in 1962 (Wilson and Orwin, 1964). Cattle have remained at a constant low level of 15–20 animals. Goats which were originally liberated have not survived. These grazing mammals and the extensive farming during the farming period have probably created conditions which are more favorable than formerly to the wandering albatrosses. Feral cats and Norway rats are widespread and have severely reduced the original petrel populations.

*Future Requirements.* Because of its accessibility and facilities Campbell Island should form a base for long-term work. Changes which take place as the sheep and cattle decline should be followed.

#### 6. Snares Islands

*No. and Size.* One small to medium, Main Snares Island (648 acres); one small, Broughton Island; and many stacks.

*Conservation Status.* Reserve for the Preservation of Flora and Fauna.

*Scientific Value.* These islands are of great importance as being the least disturbed of the subantarctic islands lacking the introduced mammals which are a feature of the other groups except the Antipodes. There are large breeding populations of sea birds (Warham, 1967) including the endemic Snares Island penguin, Buller's mollymawk, and the stoaty shearwater with a population of between 2 and 3 million. In addition there are three endemic land birds, the Snares Islands snipe, fernbird, and tomtit. The vascular flora is limited to less than 30 species (Fineran, 1964b).

The Snares Islands are the most accessible of the three remaining subantarctic islands which are as yet virtually undisturbed, the others being Adams Island in the Auckland group and the Antipodes Islands. Such sites, little modified by man and owing their productivity to natural selection, provide a valuable base against which to evaluate the effects of human activity on natural resources. Such places are being rapidly destroyed, modified or polluted and those few remaining need to be preserved and have to have their undisturbed ecosystems investigated while there is still time. The Snares Islands with their relatively large biomass and relatively simple ecosystem is especially suitable for such studies.

*Interference by Man.* Sealing and mutton birding in the last century appears to have had little effect except for the reduction of the seal populations (now on the increase).

*Interference by Introduced Mammals.* No introduced mammals have been recorded.

*Scientific Research.* Until recently visiting scientists had spent no more than a day ashore. In 1947 a group of ten sponsored by the Dominion Museum and the American Museum of Natural History were on the main island for a fortnight,

(Fleming, 1948). In 1948 L. E. Richdale spent several weeks studying the breeding behaviour of Bullers mollymawk. In 1961 the University of Canterbury established the biological station and carried out a preliminary survey of the vegetation, invertebrates, and birds (Fineran, 1964a). This was followed by a second expedition in 1967. A five-year research program as part of the New Zealand National Program for I.B.P. commences this summer (Royal Society of New Zealand, 1968).

*Future Requirements.* A vigorous protection policy should be pursued and the planned detailed studies should be carried to completion. These include studies of primary productivity, peat formation and succession on abandoned penguin colonies; the establishment of basic data for the biomass of key vertebrates and terrestrial invertebrates; the estimation of the utilization of primary production by organisms involved in the grazing and detritus food chains; investigations of the effects of sea-birds and seals in the environment including soils; sampling of the food of the seabirds, comparison with plankton abundance offshore, and the correlation of breeding success and variation in the local food supply.

### Research as a Basis for Future Conservation and Management Policies

The subantarctic islands have long attracted the interest of naturalists, and many of the early southern expeditions to the southern oceans visited these fascinating islands. In 1907-8 the Canterbury Philosophical Institute organized the first comprehensive expedition to all of the islands apart from the Chathams (Chilton, 1909a). During this expedition parties spent extended periods on the Auckland Island and on Campbell Island. Apart from occasional brief visits little work was done until the period of the 1939-45 War when volunteer coastwatching parties were established on Campbell Island and on the northern and southern shores of the Auckland Islands. These were largely composed of biologists. The collections made by these scientists were reported upon in a series of Cape Expedition reports published by the Dominion Museum, Wellington.

In recent years the tempo of work has increased and the following major expeditions have been carried out since 1954.

1954. Chatham Islands 1954 Expedition (Knox, 1957). While this was primarily marine entomological collections were made, and investigations were carried out on the marine birds, especially on the outlying islets.

1959. Department of Scientific and Industrial Research Expedition to Campbell Island covering marine botanical, entomological studies. The Bishop Museum, Honolulu collaborated on the entomological work, and entomologists from this museum spent an extended period on the island (Gressitt, 1964).

1961. First Snares Island Expedition from the University of Canterbury, Christchurch, resulting in the establishment of the Snares Islands Biological Station and the first detailed survey of the group (Fineran, 1964b).

1964. Department of Scientific and Industrial Research, Dominion Museum

and Canterbury University expedition to the northern Auckland Islands.

1966. Department of Scientific and Industrial Research, Dominion Museum and Canterbury University expedition to Adams Island and the southern Auckland Islands.

1967. Second University of Canterbury expedition to the Snares Islands.

1969. A comprehensive expedition has been organised by the University of Canterbury to the Antipodes Islands.

The University of Canterbury is engaged in a Five-Year Research Project in the Subantarctic Islands as part of the C. T. Section of the New Zealand I.B.P. Programme. The Antipodes Islands Expedition, and the intensive investigations on the Snares Islands which will commence this summer are part of this project.

Some idea of the increase in our knowledge of these islands is to be seen in the following table which lists estimates of the arthropod fauna by Gressitt and Weber (1959) compared with recent estimate by Gressitt (1964b) and Johns (*pers. comm.*) The latter estimates for the Snares Islands are based on the University of Canterbury expeditions in 1961 and 1967.

Table 2. The arthropod fauna of the subantarctic islands

	<i>Campbell Is.</i>	<i>Auckland Is.</i>	<i>Antipodes Is.</i>	<i>Bounty Is.</i>	<i>Snares Is.</i>
1959	107	151	20	8	18
1964	381	600	—	—	—
1967	—	—	—	—	165+
Probable nos.	400+	650+	250+	50+	200+

Thus in the space of a few years and in spite of the numerous collecting expeditions over a period of more than 100 years prior to 1959 the recorded number of species for some islands has been increased four to eight-fold. As mentioned above it is planned to fill in the conspicuous gap in the Antipodes Islands in the 1969 summer.

So far we only have adequate published accounts for the arthropod fauna of Campbell Island (Gressitt, 1964a; Gressitt, et. al., 1964) although accounts covering that of the Auckland and Snares Islands are in preparation. A high proportion of the arthropod species are endemic to one island group or are confined to the islands of the subantarctic. Gessitt (1964b) has estimated that 47% of the species and 7% of the anthropod genera are endemic to Campbell Island. Because of the larger size and popular appeal of plants and birds conservation interest in these islands has been focused on these groups, but it must not be forgotten that from the scientific viewpoint the preservation of the unique arthropods and their habitats is of equal importance. A study of these island species can contribute enormously to our understanding of evolutionary processes by the clear examples of speciation they afford and by demonstrating the effects of isolation and of strongly altered competitive and selective environments (Miller, 1967). We can see the events of extinction, supplanting and mixing which are often so complex on continents as

usually to defy interpretation. Island situations are akin to simplified laboratory tests and from these principles may be determined that are applicable to the evolutionary process as a whole. One of the interesting evolutionary phenomenon in these islands is the strong tendency towards reduced flying among insects, ability culminating in complete wing loss. Of the probable 170 species of normally winged insect groups, on Campbell Island 18, or 40% are flightless, having reduced wings or no wings at all (Gressitt, 1964b). Of the groups that are rarely wingless some of the examples are striking, or even previously unreported or unparalleled, as far as known. When it is realized that in the Hawaiian Islands one third of the insect fauna has disappeared due to deforestation and degradation of the habitat, as well as the introduction of many other insects which have destroyed or competed with them (Dorst, 1963) the great need for maintaining these unique island ecosystems is clear.

These subantarctic islands have always attracted the attention of ornithologists because of their interesting bird fauna, especially the large populations of breeding sea birds (Falla, 1965). Table III lists the recorded breeding birds in these islands. It can be seen that there are many endemic species or subspecies either confined to one island, an island group or to the subantarctic as a whole. Species which already have become extinct in European times include the merganser (*Mergus australis*) on the Auckland Islands and eight species on the Chathams, including the Chatham Island rail, *Rallus modestus*; Dieffenbach's rail, *R. dieffenbachi*; and the Chatham Island fern bird, *Bowdleria punctata rufescens* (Williams, 1962). Modification of the habitat and predation by introduced mammals have severely reduced or eliminated many species, especially burrowing petrels, on some islands, in particular on the main Auckland Island and Campbell Island. On the Antipodes where disturbance has never been severe the birds are undoubtedly denser than in any other New Zealand subantarctic island, except perhaps the Bounties. While we have a general picture of the distribution of the species and scattered observations on their behaviour and breeding patterns, detailed studies have been made of a few species only and a considerable amount of research will be needed before we acquire the necessary information upon which long term conservation plans can be based.

These islands also contain breeding populations of the southern fur seal (*Arc-tocephalus fosteri*) now actively increasing in range and numbers, the elephant seal (*Mirounga leonina*) breeding in small numbers on Campbell, Auckland, and the Antipodes and the southern sea-lion (*Otaria hookeri*) now almost entirely confined to Enderby Island in the Aucklands.

Information on the plants and their distribution is now reasonably adequate for all the groups apart from the Antipodes (Cheeseman, 1909; Cockayne, 1909; Oliver, 1910; Fineran, 1964; Godley, 1965). Thus for most of the islands we are now in a position to move beyond the reconnaissance stage and commence detailed studies of the autecology of selected key species and of the dynamics of the island systems as ecological units. Such ecosystem studies are starting this summer in

the Snares Islands.

*Introduced Mammals* Many of the islands have already been drastically modified by introduced mammals such as goats, pigs, rabbits, cats, or through exploitation by man. On the Chathams only a few outliers such as the Sisters and the Forty Fours have escaped such modification. Fig. 4 taken from Taylor (1968) depicts diagrammatically the history of introduced mammals on the Auckland Islands. These six islands form a series with Adams alone remaining in its primitive state. Enderby Island is of great interest. Induced changes in the vegetation have been considerable with large areas formerly in tussock now dominated by the conspicuous yellow-flowered *Bulbinella rossii* which was not mentioned in the early accounts of the vegetation. Since the cessation of burning and introductions some 70 years ago the surviving mammals and the vegetation have achieved a state of balance forming a modified ecosystem of great interest. The southern rata (*Metrosideros umbellata*) forest is actively regenerating, and the changes have benefited a number of species such as the southern skuas and the red-crowned parakeets, the latter species feeding in large numbers on the sward maintained by the rabbits and cattle. On Rose Island on the other hand a modified vegetation is dominant and increasing as the rabbit populations decline with the change in habitat.

Rather than exterminate the mammals on Enderby Island it should best be regarded as an isolated natural laboratory where the interactions between mammals and the environment can be studied to advance our understanding of ecosystem dynamics (Knox, 1965).

Removal of introduced mammals from an island may not achieve the desired end. Taylor, (1968) cites the example of Motunau Island off the South Island east coast. Rabbits were removed from this island not as a planned ecological experiment, but because they were felt to be a threat to the large population of seabirds, especially petrels. An immediate effect of the removal of the rabbits has been a vigorous invasion of boxthorn which unless controlled will be of considerable danger to small nightflying petrels.

As Taylor (1968, p. 65) points out "the future management of present populations of introduced mammals on outlying islands should be shoundly based on the results of ecological research and not on a hit and miss policy of exterminating those species most easily exterminated".

When it is found necessary to eradicate introduced mammals studies should be made of the modified environment and of the subsequent changes as have been carried out in the Three Kings. Such work must be long-term if useful results are to accrue.

Taylor has outlined the conservation priorities for islands as far as introduced mammals are concerned. These are:

- (i) the active vigorous protection of all unmodified islands to ensure that exotic mammals never gain a foothold;
- (ii) the control or extermination of introduced mammals from unstable, actively degrading islands;

Table 3. Breeding or probably breeding birds on the New Zealand subantarctic islands  
 (+ = present; 1 = endemic to the group, 2 = endemic to the N.Z. Subantarctic Islands; \* = introduced species)

Species List	Chatham Is.	Antipodes Is.	Bounty Is.	Auckland Is.	Campbell I.	Snares Is.
Yellow-eyed penguin ( <i>Megadyptes antipodes</i> )				+	+	
Southern blue penguin ( <i>Eudyptula minor minor</i> )	+					
Rockhopper penguin ( <i>Eudyptes crestatus cretatus</i> )		+	+	+	+	
Snares crested penguin ( <i>Eudyptes pachyrhynchus atratus</i> )						+ 1
Erect crested penguin ( <i>Eudyptes pachyrhynchus sclateri</i> )		+ 2	+ 2	+ 2	+ 2	
Wandering albatross ( <i>Diomedea exulans exulans</i> )				+	+	
Southern royal albatross ( <i>Diomedea epomophora epomophora</i> )				+ 2	+ 2	
Northern royal albatross ( <i>Diomedea epomophora sanfordi</i> )	+					
N.Z. black-browed mollymawk ( <i>Diomedea melanophris impavida</i> )		+ 2			+ 2	
Grey-headed mollymawk ( <i>Diomedea chrysostoma</i> )		?		+		
Buller's mollymawk ( <i>Diomedea bulleri</i> )	+					+
Shy mollymawk ( <i>Diomedea cauta cauta</i> )				+		
Salvin's mollymawk ( <i>Diomedea cauta salvini</i> )			+ 2			+ 2
Chatham Island mollymawk ( <i>Diomedea cauta eremita</i> )	+ 1					
Light-mantled sooty albatross ( <i>Phoebetria palpebrata</i> )		+		+	+	
Northern giant petrel ( <i>Macronectes giganteus halli</i> )	+	+		+	+	+
Cape pigeon ( <i>Daption capensis australis</i> )		+	+	+	+	+
Broad-billed prion ( <i>Pachyptila vittata vittata</i> )	+					+
Auckland Island prion ( <i>Pachyptila desolata alter</i> )				+	?	
Fairy prion ( <i>Pachyptila turtur</i> )	+	+				+
Fulmar prion ( <i>Pachyptila crassirostris crassirostris</i> )			+ 1			
Chatham fulmar prion ( <i>Pachyptila crassirostris pyramidalis</i> )	+ 1					
Sooty shearwater ( <i>Puffinus griseus</i> )	+	+		+	+	+
Subantarctic allied shearwater ( <i>Puffinus assimilis elegans</i> )	+			?		
White-chinned petrel ( <i>Procellaria aequinoctialis steadi</i> )		+		+	+	
Grey petrel ( <i>Procellaria cinerea</i> )		+			+	
White-headed petrel ( <i>Pterodroma lessoni</i> )		+		+	?	
Mottled petrel ( <i>Pterodroma inexpectata</i> )	?	?		?		+
Chatham Island petrel ( <i>Pterodroma hypoleuca axillaris</i> )	+ 1					
Grey-backed storm petrel ( <i>Garrodia nereis</i> )	+	+		+	?	
Black-bellied storm petrel ( <i>Fregetta tropica</i> )		+	+	+	?	

White-faced storm petrel ( <i>Pelagodroma marina maoriana</i> )	+		+			
Southern diving petrel ( <i>Pelecanoides urinatrix chathamensis</i> )	+		+			+
Subantarctic diving petrel ( <i>Pelecanoides urinatrix exsul</i> )		+	+		?	
South Georgian diving petrel ( <i>Pelecanoides georgicus</i> )			+			
Black shag ( <i>Phalacrocorax carbo novaehollandiae</i> )	+					
Chatham Island shag ( <i>Phalacrocorax carunculatus onslowi</i> )	+ 1					
Bounty Island shag ( <i>Phalacrocorax carunculatus ranfurlyi</i> )		+ 1				
Auckland Island shag ( <i>Phalacrocorax campbelli colensoi</i> )			+ 1			
Campbell Island shag ( <i>Phalacrocorax campbelli campbelli</i> )					+ 1	
Pitt Island shag ( <i>Stictocarbo punctatus featherstoni</i> )	+ 1					
* Black swan ( <i>Cygnus atratus</i> )	+					
Auckland Island flightless duck ( <i>Anas aucklandica aucklandica</i> )			+ 1			
Grey duck ( <i>Anas superciliosa superciliosa</i> )	+		+			
* Mallard ( <i>Anas platyrhynchos platyrhynchos</i> )	+		+			
N.Z. shoveler ( <i>Anas rhynchotis variegata</i> )	+		+			
Auckland Island merganser ( <i>Mergus australis</i> )			Extinct ?			
Australian harrier ( <i>Circus approximans gouldi</i> )			+			
N.Z. falcon ( <i>Falco novaeseelandiae</i> )			+			
Auckland Island rail ( <i>Rallus pectoralis muelleri</i> )			+ 1			
* South Island weka ( <i>Gallirallus australis hectori</i> )	+					
Banded dotterel ( <i>Charadrius bicinctus</i> )	+		/			
N.Z. shore plover ( <i>Thinornis novaeseelandiae</i> )	+ 1					
Chatham Island oystercatcher ( <i>Haemotopus chathamensis</i> )	+ 1					
Auckland Island snipe ( <i>Coenocorypha aucklandica aucklandica</i> )			+ 1			
Antipodes Island snipe ( <i>Coenocorypha aucklandica meinertzhagenae</i> )		+ 1				
Snares Island snipe ( <i>Coenocorypha aucklandica huegeli</i> )					+ 1	
Chatham Island snipe ( <i>Coenocorypha aucklandica pusilla</i> )	+ 1					
Pied stilt ( <i>Himantopus himantopus leucocephalus</i> )	+					
Southern skua ( <i>Catharacta skua lonnbergi</i> )	+	+	+	+	+	+
Southern black-backed gull ( <i>Larus dominicanus</i> )	+	+	+	+	+	?
Red-billed gull ( <i>Larus novaehollandiae scopulinus</i> )	+	+	+	+	+	+
Antarctic tern ( <i>Sterna vittata bethunei</i> )	+	+	+	+	+	+
White-fronted tern ( <i>Sterna striata</i> )	+		+	+	+	
Chatham Island pigeon ( <i>Hemiphaga novaeseelandiae chathamensis</i> )	+ 1					
Red-crowned parakeet ( <i>Cyanoramphus novaeseelandiae novaeseelandiae</i> )			+			

Species List	Chatham Is.	Antipodes Is.	Bounty Is.	Auckland Is.	Campbell I.	Snares Is.
Chatham Island red-crowned parakeet ( <i>Cyanoramphus novaeseelandiae chathamensis</i> )	+ 1					
Antipodes Island red-crowned parakeet ( <i>Cyanoramphus novaeseelandiae hochstetteri</i> )		+ 1				
Antipodes Island parakeet ( <i>Cyanoramphus unicolor</i> )		+ 1				
Yellow-crowned parakeet ( <i>Cyanoramphus auriceps auriceps</i> )				+ 1		
Chatham Island yellow-crowned parakeet ( <i>Cyanoramphus auriceps forbesi</i> )	+ 1					
Shining cuckoo ( <i>Chalcites lucidus lucidus</i> )	+ 1					
* Skylark ( <i>Alauda arvensis</i> )	+ 1		+ 1		?	
Chatham Island fantail ( <i>Rhipidura fuliginosa penitus</i> )	+ 1					
Chatham Island tomtit ( <i>Petroica macrocephala chathamensis</i> )	+ 1					
Auckland Island tomtit ( <i>Petroica macrocephala marrineri</i> )			+ 1			
Snares Island tomtit ( <i>Petroica macrocephala dannefaerdi</i> )					+ 1	
Chatham Island robin ( <i>Petroica (Miro) traversi</i> )	+ 1					
Chatham Island fernbird ( <i>Bowdleria punctata rufescens</i> )	+ 1					
Snares Island fernbird ( <i>Bowdleria punctata caudata</i> )					+ 1	
Chatham Island warbler ( <i>Gerygone albofrontata</i> )	+ 1					
* Song thrush ( <i>Turdus philomelos</i> )	+ 1		+ 1	+ 1	+ 1	
* Blackbird ( <i>Turdus merula</i> )	+ 1	+ 1	+ 1	+ 1	+ 1	
* British hedge sparrow ( <i>Prunella modularis occidentalis</i> )				+ 1	+ 1	
N.Z. pipit ( <i>Anthus novaeseelandiae novaeseelandiae</i> )	+ 1	+ 1	+ 1	+ 1	+ 1	?
Bellbird ( <i>Anthonis melanura melanura</i> )				+ 1		
Chatham Island bellbird ( <i>Anthonis melanura melanocephala</i> )	+ 1			+ 1		
Tui ( <i>Prosthemadera novaeseelandiae novaeseelandiae</i> )	+ 1		+ 1			
Chatham Island tui ( <i>Prosthemadera novaeseelandiae chathamensis</i> )	+ 1					
Silvereye ( <i>Zosterops lateralis</i> )	+ 1		+ 1	+ 1	+ 1	
* British goldfinch ( <i>Carduelis carduelis britannica</i> )	+ 1	+ 1	+ 1	+ 1	+ 1	
* Redpoll ( <i>Carduelis flammea</i> )	+ 1		+ 1	+ 1	+ 1	
* British chaffinch ( <i>Fringilla coelebs gentilis</i> )	+ 1		+ 1	+ 1	+ 1	
* Yellowhammer ( <i>Emberiza citrinella citrinella</i> )	+ 1				?	
* House sparrow ( <i>Passer domesticus</i> )	+ 1		+ 1	+ 1	+ 1	
* Starling ( <i>Sturnus vulgaris</i> )	+ 1		+ 1	+ 1	+ 1	
	55	24	10	49	31	26

Nomenclature in the above list follows the Ornithological Society of New Zealand "Checklist of New Zealand Birds".

- (iii) control of introduced mammals on modified, stable islands with balanced ecosystems, or on nearby stable islands with declining mammal populations, should not be attempted solely as a conservation measure unless the need is confirmed by ecological research. In such cases it is necessary to carefully consider the objectives, the need for eradication, the likelihood of achieving it and the probable ecological consequences.

Officers of the Wildlife Branch, New Zealand Department of Internal Affairs have had considerable success in the elimination of goats from island ecosystems. The key to this success has been the employment of experienced shooters, the use of .22 rifles with high velocity ammunition and persistent hunting to get the last animal.

*Research needs* Apart from the Antipodes and Bounties we now have carried out adequate primary surveys and are beginning a second or ecological phase of investigation. It is only long-term ecological studies that will provide an adequate basis for the future management of these unique natural resources. Such studies will require permanent facilities such as those now provided on the Snares Islands.

*Requirements for the Future* As already emphasised island ecosystems are particularly vulnerable to competition from introduced species. Much of New Zealand's interesting bird fauna has disappeared from the mainland and now is found only on the offlying islands. Other species of plants and animals are in a precarious position. For the relatively undisturbed island ecosystems that remain New Zealand has a special responsibility, but it is not enough simply to reserve such areas and then leave them alone. It is necessary to keep a constant watch on their status, and, as has been stressed, to carry out the necessary research upon which future plans for their sound management can be established. We tend to think of these islands as being relatively static and unchanging. However, as my experience of them accumulates I am impressed by the rapidity with which changes are occurring. In the short space of six years there have been some striking changes in the vegetation of the Snares Islands. In many localities the shrubby *Hebe elliptica* has aggressively invaded areas of tussock grassland and there has also been a marked increase in the abundance of the interesting endemic *Stilborcarpa robusta*.

While as scientists and conservationists we may be impatient at the rate of progress concerning our knowledge of the New Zealand off-shore islands a great deal has been accomplished. This is the more remarkable considering the early lack of co-ordination of research and the logistic difficulties involved in research on remote islands. At present a wide variety of research institutions are interested in various aspects of island problems. The Wildlife Branch, Department of Internal Affairs has an active programme in progress of evaluation of the status of the New Zealand islands and of the investigation of island conservation problems. The Lands and Survey Department has established an expert committee to advise on problems concerning the subantarctic islands under its jurisdiction. A long-term program of research on the Subantarctic Islands forms part of the New Zealand National I.B.P. Programme (Royal Society of New Zealand, 1967). A Working Group has been set up to co-ordinate this research. Most of the important islands

areas have a special status as reserves of various kinds.

New Zealand has a special obligation to world science for the conservation of these unique island exosystems and it is a responsibility that is increasingly being recognized not only by New Zealand scientists but by government administrators.

In order to ensure the future management of these islands as reserves of considerable scientific importance containing representatives of unique ecosystems the following recommendations need to be implemented:

1. The active encouragement, continuation and co-ordination of the research activities in progress and contemplated.
2. The completion of the survey and evaluation of the status of the fauna of all the New Zealand off-shore islands and the extension of this to cover surveys of the flora. There is an urgent need for more botanical work, especially ecological.
3. The transfer of the management of these island reserves to an organization with adequately trained staff responsible for their scientific management. At present a Commission on the Organization of Wildlife Research and Management is studying the requirements on the whole wildlife field. It is anticipated that a new Wildlife organization will be set up amalgamating present scattered activities and it is hoped that it will recommend such a transfer.
4. The promotion of research on the introduced mammals as outlined in the previous section with a view to their control and elimination where desirable. One of the most urgent requirements is the need for research on rats as these are one of the most serious problems on a wide range of islands. On Big South Cape Island off Stewart Island the introduction of rats by mutton-birders has eliminated the endemic snipe subspecies and the bush wren while the rare South Island saddleback has only been saved by transfer to other, as yet rat-free, islands (Henderson, 1965; Blackburn, 1965). Research on rat ecology with a view to developing a successful means of exterminating them from the islands where they are a threat to wildlife is an urgent requirement.
5. The extension of facilities for research workers on key islands. A biological station has been established on the Snares Islands (see above) while the coast watching station established in 1941 at Ranui Cove on the north of Auckland Island has been renovated by the 1964 and 1966 Auckland Island expeditions. Meteorological stations are established on Raoul and Campbell and further facilities for biologists could be established in association with these stations.
6. For the long-term future management of these areas it will be necessary to station wardens with adequate scientific training on certain key islands. While many of the personnel of the Meteorological Stations on Raoul and Campbell have been keen naturalists there is a lack of continuity and scientific background. The most urgent requirement is for a warden on Raoul to carry out plans for the rehabilitation of this island.

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