INTRODUCED MAMMALS AND ISLANDS: PRIORITIES FOR CONSERVATION AND RESEARCH

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With so much of New Zealand's land surface transformed during the past 120 years, many small off-shore and outlying islands are now unique samples of the relatively undisturbed environment. But the very characteristics that have protected and isolated them in nearly primitive condition also make them extremely vulnerable to further disturbance. Many have already been drastically modified by introduced mammals such as goats, pigs, rabbits, cats and rats, or through exploitation by man. On some, these animals were introduced long ago and their populations now approach equilibrium with the modified environment. On others, populations of introduced mammals are declining naturally, often where a dominant and increasing vegetation is making the

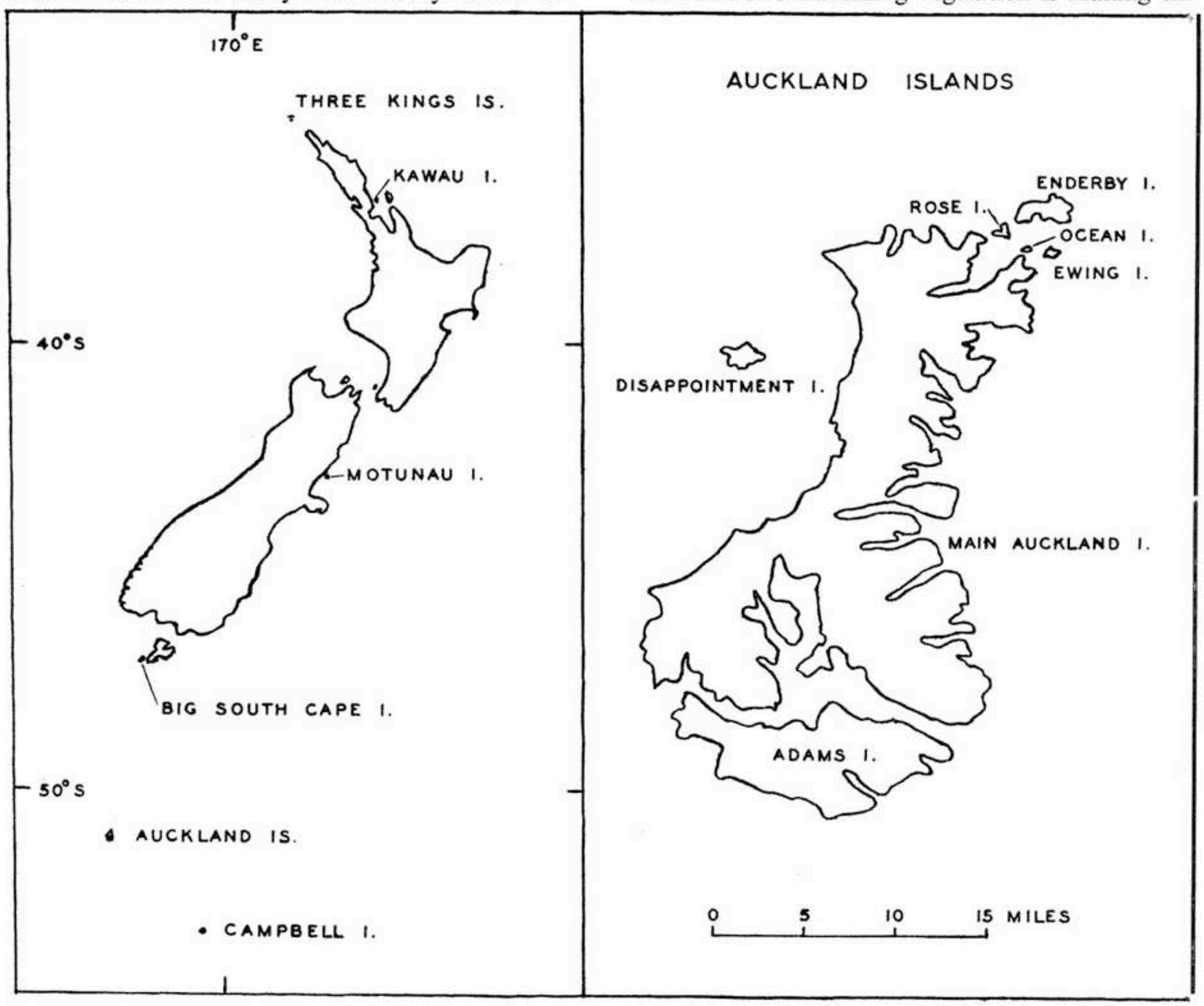

FIGURE 1. *Location of the islands mentioned in the text, with detail of the Auckland Island group.*

environment progressively less favourable for them. On a few other islands, especially where introduced animals have only recently become established, the original flora and fauna is being modified rapidly.

These distinctions must be recognised for planned conservation, and the islands managed accordingly. The best management policy for one island — for example, the immediate removal of introduced browsing mammals — may be much less worthwhile on another, and indeed may lead to unexpected and even undesirable results.

Two main priorities must always remain uppermost: (i) the vigorous protection of all islands still in a primitive state, and (ii) the control or extermination of introduced animals on unstable, actively degrading islands. But animal control on modified islands with apparently balanced ecosystems, or on nearly stable islands with declining mammal populations, has no priority as far as conservation is concerned and should not be attempted blindly just because the animals are there. It is necessary to carefully consider the objectives, the need for eradication, the likelihood of achieving it, and the probable ecological repercussions. Research is usually necessary beforehand so that the right decisions may be made. These principles are best illustrated by the contrasting situations on specific islands:

The Auckland Islands

The Auckland Islands are an uninhabited subantarctic group consisting of two large and four smaller islands, and numerous small islets (Fig. 1).

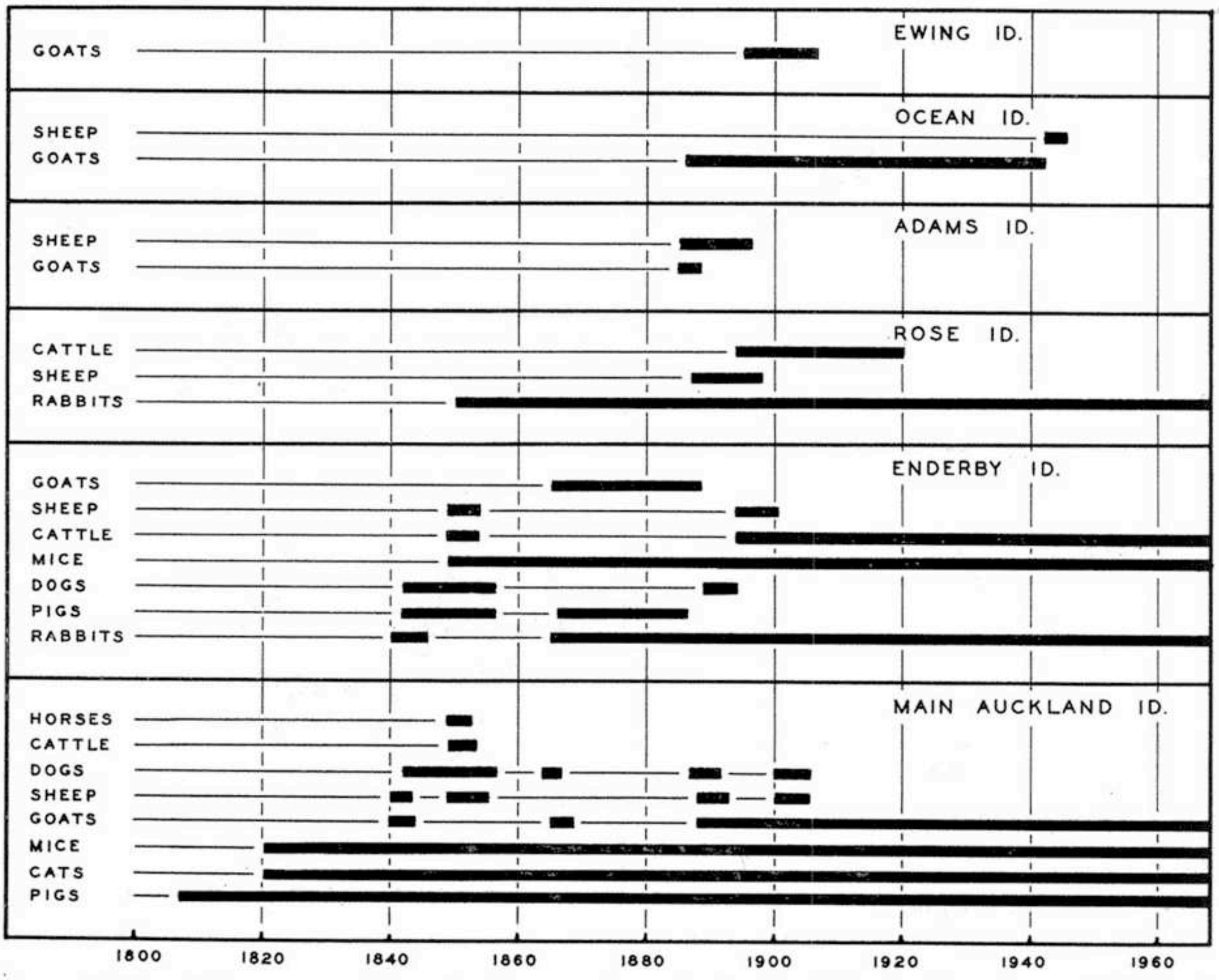

FIGURE 2. *Historical summary of introduced mammals on the Auckland Islands. (Based on published and unpublished references filed at Animal Ecology Division, D.S.I.R.)*

Since their discovery in 1806, a variety of mammals has been introduced, at first by sealers, or as food for castaways and later, during attempts at farming (Fig. 2). Today, pigs, cattle, goats, rabbits, cats and mice exist in various combinations on most of the larger islands; but fortunately the few sheep and goats liberated on Adams Island in the 1880s and 1890s did not survive for more than a few years and this, the second largest island, has remained in its primitive state. Thus, this group presents a unique opportunity for studying the effects of introduced mammals and man on the native plants and wildlife.

Enderby and Rose Islands have much in common, but modification of the original vegetation by fire and animals has been markedly different on each. Cattle, rabbits and mice are the only introduced mammals still present; rabbits are on both, but cattle and mice are confined to Enderby (Taylor, unpubl.).

Considerable changes have taken place in the vegetation of Enderby Island in the 160 years since the group was discovered. Dr M'Cormick of the *Erebus* and *Terror* Expedition landed at Sandy Bay in 1840 and described it as follows: "Above the centre of the beach is a hollow, filled with long grass, growing in a rich boggy soil in such rank luxuriance as to be up to the hips, and flanked by a sand-hill clad to the summit by the same kind of grass, having the whole skirted by a thicket of trees and bushes" (M'Cormick 1884). But today, a short sward, closely grazed by a few wild cattle and hundreds of rabbits, covers the entire open area behind the beach, including the high sand-hill. Further back this gives way to scrub and southern rata (*Metrosideros umbellata*) forest.

Likewise, early accounts and photographs of the north coast of Enderby show that it was covered by tall tussock where today there is only close-cropped turf. Indications of the previous vegetation may still be seen in remnants of *Poa litorosa* and plants of *Anisotome latifolia* existing on cliffs where they have survived fire and browsing.

On all parts of the island signs of induced changes in the vegetation are abundant. Old mounds show where tussock once flourished in areas now dominated by sward species, and long-dead rata trees stand at the original forest edge which was pushed back by burning many years ago. Although so common on Enderby today, the conspicuous yellow-flowered *Bulbinella rossii* is not mentioned in early botanical descriptions. Its spread has apparently been favoured by burning and grazing (Godley 1965).

About 70 years ago man ceased burning and introducing stock and the surviving mammals are now apparently in balance with the vegetation. This situation includes the rata forest as well as the sward and scrublands, for the forest is regenerating despite the presence of cattle. An old photograph taken on Enderby in 1888 (Fig. 3a) shortly before the cattle were introduced shows a previously-burnt area covered with low scrub and huts erected near a small wooden provision depot by

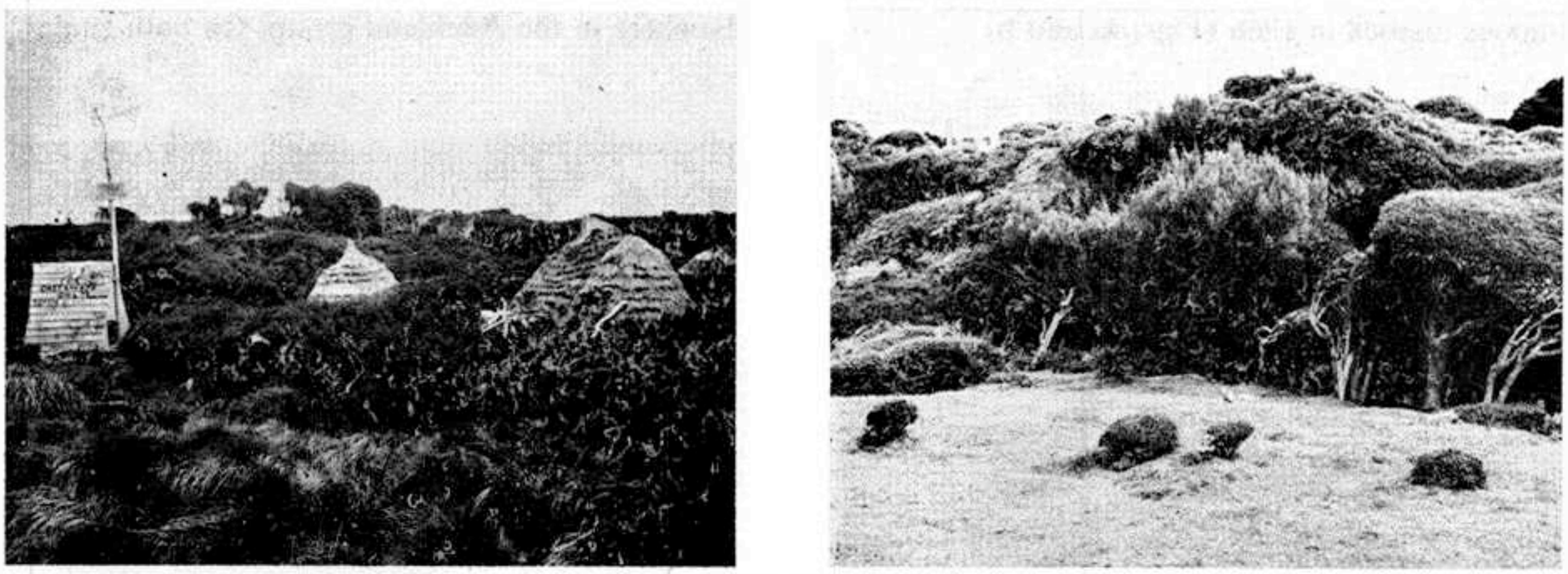

FIGURE 3. *Photographs taken at Sandy Bay, Enderby Island, showing changes in the vegetation over almost 80 years.*
(a) 1888. Vegetation near the huts built by survivors of the wreck of the Derry Castle. *Photo. Dominion Museum.*
(b) The same 1966. Only the top of the pole on the small wooden depot is visible above the canopy.

survivors of the wreck of the *Derry Castle*. Almost eighty years later, in 1966, this depot was completely overgrown with tall *Myrsine divaricata* and *Metrosideros umbellata* with the top of its roof three feet below the canopy (Fig. 3b). In 1966 there were no obvious differences between Enderby and Rose Islands in the health of the rata forests or in the amount of young rata regenerating, although cattle had been absent from Rose Island for over 40 years. A careful comparison of photographs taken during the second World War with those taken on expeditions of which I was a member in 1954 and 1966, shows that, despite the continued presence of cattle, rabbits and mice, the vegetation on Enderby Island has not changed noticeably in the last 25 years.

Rose Island has not been as drastically modified as Enderby and still has large areas of *Poa litorosa* tussock grassland (Godley 1965). However, signs of modified vegetation are abundant. The palatable *Poa foliosa* and *Anisotome latifolia* are confined to cliffs and ledges, there are large areas of closely grazed sward and there is widespread evidence of early burning of both tussock grassland and rata forest.

But unlike the now stable vegetation on Enderby, the vegetation on Rose Island is aggressive and increasing. Between 1954 and 1966 there was an obvious increase in plant cover with *Poa litorosa* tussocks invading areas previously under sward. Other places where scattered tussocks grew out of the sward in 1954 were covered with almost continuous tussock in 1966 (Figs. 4a and b).

What are the interactions between these two very different vegetations and the mammal populations remaining today? On Rose Island where the plant cover is increasing the rabbit population has markedly declined since 1954. Apparently, the disappearance of cattle about 1920 allowed the vegetation to increase and this has made conditions progressively less favourable for rabbits. Probably the rabbit population will continue to decline and may eventually die out. On Enderby Island the vegetation has remainded virtually unchanged for at least the last 25 years and is apparently in balance with mammal populations that have not changed in size in recent years.

As far as conservation is concerned, these two islands are important. Sandy Bay on Enderby Island is the main breeding ground and population centre of the southern sea-lion (*Otaria hookeri*), a species that breeds only on New Zealand's subantarctic islands (Falla 1965). And Enderby is the only breeding place in the Auckland Islands of the royal albatross (*Diomedea exulans*). Although recorded from Enderby in small numbers in 1840 (M'Cormick 1884) these birds were completely exterminated there by sealers, colonists, and castaways in the second half of last century (Ogilvie-Grant 1905); but, since being unmolested by man, they have recolonised and increased despite the presence of cattle and rabbits. Fifteen pairs of royal albatrosses were breeding on Enderby in 1966. Large numbers of yellow-eyed penguins (*Megadyptes antipodes*) also nest on Enderby and Rose Islands, apparently in greater densities than elsewhere in the Auckland group. On both Ender-

FIGURE 4. (*a*) *West end of Rose Island, 1954. An area of sward grassland at the margin of long-dead rata forest. Scattered tussocks of* Poa litorosa. *Photo. K. Wodzicki.*
(*b*) *The same 1966. The tussock has increased and invaded much of the sward.*

by and Rose, red-crowned parakeets (*Cyanoramphus novaezelandiae*) are common and spend much of their time feeding on the sward maintained by rabbits and cattle. This species is rare on the main Auckland Island, probably because of predation by cats.

These special features make Enderby Island unique among the islands of the group; and most importantly, these features are not threatened by the introduced mammals, but rather are in balance with them.

Thus, there are three clearly distinct situations within the Auckland group: Adams Island, now completely undisturbed, Enderby Island, where introduced mammals are apparently in balance with a stable but much modified environment, and Rose Island where modified vegetation is dominant and increasing and the rabbit population declining.

Big South Cape and Three Kings Islands

A fourth situation exists on some other New Zealand islands — that of an actively degrading flora and fauna. A good example is Big South Cape Island, off Stewart Island, where introduced rats (*Rattus rattus*) have recently wreaked havoc with populations of several rare native birds (Henderson 1965; Blackburn 1965). Also in this category would come islands where the last survivors of certain plant and animal species are threatened with extinction; as, for example, was the situation on the Three Kings Islands in 1946 (Turbott 1963).

Campbell Island

The situation on Campbell Island is in many ways comparable with that on Rose Island. Sheep were introduced in 1895, farmed for the next 36 years, and reached peak numbers of 8.500 around 1910. Since the shepherds left in 1931, the sheep have become feral.

Wilson and Orwin (1964) have shown that there were less than 1,000 sheep in 1961, and that their numbers have declined naturally at a steady rate of 5% per year because of the unfavourable environment. Early burning altered the vegetation in their favour but successive burning and overgrazing have changed the dominant tussock species from *Chionochloa antarctica* to the less palatable *Poa litorosa*. *Dracophyllum* scrub is now increasing on the lower levels of the island.

For some years now conservationists have considered exterminating the sheep (Westerskov 1959), but although it is clear that burning and stocking in earlier years greatly changed the vegetation, there are conflicting opinions, but little evidence, on the continuing effect of their present numbers on the flora and fauna (Wilson and Orwin 1964). As an alternative to slaughtering the entire population, Wilson and Orwin suggested erecting a fence $1\frac{1}{2}$ miles long across the island and shooting out the sheep from one half. There is much merit in this suggestion since the island has already been irretrievably modified and important comparisons of regeneration and its effects on the wildlife could be made between the two halves. Such objective studies are badly needed.

Motunau Island

Situated $\frac{3}{4}$ mile off the North Canterbury coast, 40 miles north from Christchurch. this small flat-topped island of about 9 acres is the breeding ground of thousands of sea birds. During the nesting season about 2,000 white-flippered penguins (*Eudyptula albosignata*), 20,000 fairy prions (*Pachyptilla turtur*), 1000 white-faced storm petrels (*Pelagodroma marina*), 200 sooty shearwaters (*Puffinus griseus*) and 200 black-backed gulls (*Larus dominicanus*) inhabit the island (Taylor 1967).

It has a long history of modification including occasional burning, and a population of rabbits had lived there for well over 100 years until exterminated as a conservation measure between 1958 and 1963.

Prior to rabbit control in 1958, the vegetation. particularly on the flat top, was mainly a lowland tussock formation with very few shrubby species. Since removal of the rabbits Motunau Island's vegetation has started to change from grassland towards more scrubby growth and it could ultimately become mainly covered with coastal forest species (Mason 1967). Whether the breeding birds will be better off then than now remains to be seen.

In the meantime, one immediate effect has been the vigorous invasion of boxthorn (*Lycium ferocissimum*). This shrub has sprung up all over the island and unless controlled is likely to menace the thousands of small petrels flying about at night (Fig. 5). Since the rabbits were destroyed, several scrub-cutting parties have been sent to the island to eradicate the boxthorn. But it is still springing up and re-shooting from the roots, so scrub-cutting has now become an annual event. Hundreds of starlings roost on the island and bring seeds across from the mainland.

FIGURE 5. *Boxthorn has invaded Motunau Island since the rabbits were removed. The photograph shows several small bushes and a fairy prion trapped in the thorns.*

THE NEED FOR ECOLOGICAL RESEARCH

The rabbits on Motunau were destroyed, not as part of a planned ecological experiment, but simply because they were felt to be a threat to the nesting sea-birds. However, before the decision was made no one went very deeply into how the rabbits' removal would help the birdlife, or what side effects it could have on the ecosystem. Unfortunately the widespread attitude persists that we cannot get rid of the introduced mammals from all these small islands quickly enough. I do not agree with this. Where introduced mammals have been present for many years the original ecosystem is usually disrupted and a new balance achieved.

It is usually easy enough to shoot the goats, wild cattle or sheep from small islands, but unfortunately this very often creates only fresh conservation problems. If it is just a problem of stopping rapid deterioration of the vegetation or preventing accelerated erosion then, of course, to get rid of the browsing animals is the obvious solution. But all situations should be studied first and the possible repercussions examined before poisoning or shooting starts. For example, before starting to shoot sheep on Campbell Island or wild cattle on Enderby Island, we must decide what long term changes we hope to achieve. Are we prepared to accept such consequential changes as fewer parakeets on Enderby or a reduced nesting area for royal albatrosses on Campbell, for these changes are likely to follow; or are these possible effects on the bird populations unimportant compared with the other values at stake?

Murphy (1964) illustrated the difficulty of trying to restore a disturbed ecosystem. The breeding islands of the rare Bermuda petrel were overrun with rats. These were poisoned, which permitted the return of tropic-birds to breed, but they occupied the burrows used by the rare petrels and prevented them from breeding. The problem was finally solved in a complicated way, by the fitting of wooden baffles to some of the burrow entrances so that only the small petrels could pass through.

If it is found necessary to eradicate introduced mammals, studies should be made of the modified environment and of all subsequent changes that may take place. Some of this work has been done in the past, but many opportunities have been overlooked. It is only by turning each animal control operation into an ecological experiment that the long term benefits for conservation can be assessed. However, the location and timing of such experiments need not always remain the prerogative of control authorities or be limited to islands with unstable ecosystems. There is no reason why introduced animals should not be removed from selected islands solely for the purposes of research into this aspect of conservation.

Finally, an important point often overlooked is the scientific interest of the introduced mammals themselves. Far too often island populations are exterminated before being studied, thus losing unique opportunities to shed light on zoological problems.

A particularly apt example of the dangers that over-hasty extermination of "noxious" animals on islands may lead to was brought to light by the re-discovery on Kawau Island, after shooting campaigns, of a thriving population of the introduced white-throated wallaby (*Macropus parma*) hitherto supposed extinct (Wodzicki and Flux 1967).

Where introduced animals have been isolated on islands for over 100 years there is the possibility of interesting changes, and the study and preservation of genetic diversity in animals such as sheep or cattle has economic as well as academic value.

Studies of the parasitic faunas of introduced mammals on islands may throw light on their ability to accompany hosts, or to persist without alternate hosts (Bull 1960). For example, were the present parasites of mainland goats originally

introduced with them or later, perhaps in sheep which may still provide the main source of infection? Studies of isolated island populations may help answer such questions, and it is important that they should be considered before the populations are destroyed.

The future management of present populations of introduced mammals on outlying islands should be soundly based on the results of ecological research, and not on a hit or miss policy of exterminating those species most easily exterminated. Certain carefully selected islands such as Enderby and Campbell would be best regarded as isolated natural laboratories (Knox 1965) where the interactions between introduced mammals and the environment may be studied to advance our understanding of important problems associated with these species on the mainland and elsewhere.

CONSERVATION PRIORITIES

So far as introduced mammals and the conservation of island environments are concerned, top priority must be given to the active and vigorous protection of all unmodified islands to ensure that exotic mammals never gain a foothold.

After visiting Big South Cape Island in 1945 Richdale (*c.* 1946) wrote: "We saw no evidence of vermin on this southern outpost . . . the island has in its isolation preserved its original and valuable species. It must be remembered, however, that this fortunate circumstance is not due to any vigilance on the part of this or past generations; their survival has been just a matter of sheer chance." After pointing out how easily the land birds would fall victims to rats and cats should they be introduced, Richdale concluded, " . . . it is the duty of the authorities to make sure that such a tragedy does not occur". Unfortunately no heed was paid to these remarks and the very tragedy of which Richdale warned occurred 20 years later when introduced rats devastated the bird population and exterminated several species from the island.

High priority should also be given to removing introduced mammals from unstable, actively degrading islands. But the control of introduced mammals on modified, stable islands with balanced ecosystems or on nearly stable islands with declining mammal populations should not be attempted solely as a conservation measure unless the need is confirmed by sufficient ecological research.

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REFERENCES

BLACKBURN, A., 1965. Mutton-bird islands diary. *Notornis* 12: 191–207.

BULL, P. C., 1960. Parasites of the European rabbit, *Oryctolagus cuniculus* (L.) on some subantarctic islands. *N.Z. J. Sci.* 3: 258–273.

FALLA, R. A., 1965. Birds and mammals of the subantarctic islands. *Proc. N.Z. Ecol. Soc.* 12: 63–68.

GODLEY, E. J., 1965. Notes on the vegetation of the Auckland Islands. *Proc. N.Z. Ecol. Soc.* 12: 57–63.

HENDERSON, L. E., 1965. The tragedy of the muttonbird islands. *Forest and Bird* 158: 6–8.

KNOX, G. A., 1965. The subantarctic islands: past, present and future. *Proc. N.Z. Ecol. Soc.* 12: 69–72.

MASON, R., 1967. Vegetation. *In* Motunau Island, Canterbury, New Zealand — an ecological survey. *N.Z. Dept. Sci. Industr. Res. Bull.* 178: 68–92.

M'CORMICK, R., 1884. *Voyages of discovery in the arctic and antarctic seas, and round the world.* Vol. I. Sampson Low, London.

MURPHY, R. C., 1964. Discussion: Conservation (p. 602). In *Antarctic biology*, Ed. R. Carrick *et al.* Herman, Paris.

OGILVIE-GRANT, W. R., 1905. On the birds procured by the Earl of Ranfurly in New Zealand and the adjacent islands. *Ibis* 8: 543–602.

RICHDALE, L. E. (*c.* 1946). *Vanishing New Zealand birds* Otago Daily Times and Witness Newspapers Co., Dunedin.

TAYLOR, R. H., 1967. Mammals and birds, with a note on lizards. *In* Motunau Island, Canterbury, New Zealand — an ecological survey. *N.Z. Dept. Sci. Industr. Res. Bull.* 178: 42–67.

TURBOTT, E. G., 1963. Three Kings Islands, New Zealand. A study in modification and regeneration. In *Pacific Basin biogeography*, Ed. J. L. Gressitt. Bishop Museum, Honolulu. 485–498.

WESTERSKOV, K., 1959. The nesting habitat of the royal albatross on Campbell Island. *Proc. N.Z. Ecol. Soc.* 6: 16–20.

WILSON, P. R., and ORWIN, D. F. G., 1964. The sheep population of Campbell Island. *N.Z. J. Sci.* 1: 460–490.

WODZICKI, K., and FLUX, J. E. C., 1967. Re-discovery of the white-throated wallaby, *Macropus parma* Waterhouse 1846, on Kawau Island, New Zealand. *Aust. J. Sci.* 29: 429–430.