Recovery Plans

This is one of a series of recovery plans published by the Department of Conservation. Recovery plans are statements of the Department's intentions for the conservation of particular plants and animals for a defined period. In focusing on goals and objectives for management, recovery plans serve to guide the Department in its allocation of resources and to promote discussion amongst a wider section of the interested public.

After preparing a technical report which was refined by botanists, scientists and managers both within and outside the Department, a draft of this plan was sent to the New Zealand Conservation Authority and relevant Conservation Boards for comment. After further refinement, this plan was formally approved by the Southern Regional General Manager in November 1998. A review of this plan is due after ten years (2009), or sooner if new information leads to proposals for a significant change in direction. This plan will remain operative until a reviewed plan is in place.

The Department acknowledges the need to take account of the views of the tangata whenua and the application of their values in the conservation of natural resources. while the expression of these values may vary, the recovery planning process provides opportunities for consultation between the Department and the tangata whenua. Departmental Conservancy Kaupapa Atawhai Managers are available to facilitate this dialigue.

A recovery group consisting of people with knowledge of coastal cresses (*Lepidium* and *Rorippa* species), and with an interest in their conservation has been established. The purpose of the Coastal Cress Recovery Group is to reveiw progress in the implementation of this plan and to recommend to the Department any changes which may be required as management proceeds. Comments and suggestions relating to the conservation of coastal cresses are welcome and should be directed to the recovery group via any office of the Department or to the Biodiversity Recovery Unit.

Coastal Cresses (Nau) Recovery Plan

THREATENED SPECIES RECOVERY PLAN NO. 26

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CONTENTS

Abstract

Six indigenous coastal species of *Lepidium* and *Rorippa divaricata* (Brassicaceae) are considered threatened with extinction and are covered by this recovery plan. These species are restricted to open, often disturbed, sites, and are usually present on higher fertility substrates. Current relictual populations exist round the New Zealand coast, and on some off-shore islands. All six species show a dependence on a range of other factors (e.g. high fertility and disturbed sites associated with animals, intact turf communities, etc.) and maintenance of these ecosystem linkages is essential for their conservation.

The decline of the coastal cresses (nau) has been the result of several factors. It seems clear that for several coastal cresses, seabirds and seals are a key factor in their ecology and the decline of these cress species can be linked to a decline in the associated animals. However, declines have also occurred at sites where associated animals are still abundant. In these cases, predation and herbivory by Brassicaceae pests (fungal and invertebrate), and competition with invasive plants, may be important agents of decline. A lack of awareness amongst conservation managers and the general public about the problems facing the coastal cresses, and especially the complex ecosystem linkages that appear important for sustaining these species in the wild, also threatens their long-term survival.

Based on the evidence of decline from the last 100–200 years it would seem likely that without active management, extinction of one or more coastal cresses is inevitable. This plan outlines ten objectives for the recovery of these species, with the conservation goal of this plan being to 'ensure that viable populations of all extant coastal cress species are restored and self-sustaining in the wild throughout the natural range of these species'.

1. Introduction

The New Zealand cresses (Brassicaceae) comprise eight indigenous and twelve naturalized species of *Lepidium* and two indigenous and four naturalized species of *Rorippa* (Webb et al. 1988, Garnock-Jones and Norton 1995). Of the indigenous *Lepidium* species, six are coastal, of which five are endemic to New Zealand (*Lepidium banksii*, *Lepidium oleraceum* agg., *Lepidium obtusatum*, *Lepidium tenuicaule*, *Lepidium naufragorum*), and one extends to Tasmania (*Lepidium flexicaule*; Hewson 1981). The other indigenous species occur inland in dry grasslands, rocky areas and on saline soils (Allen 1998). Of the two indigenous *Rorippa* species, one (*Rorippa divaricata*) occurs in coastal sites as well as some inland sites and is endemic to New Zealand. The other species (*Rorippa palustris*) is primarily a plant of wetlands and also occurs in northern temperate regions.

TABLE 1. COASTAL CRESSES AND THEIR CURRENT CONSERVATION STATUS BASED ON THE IUCN CATEGORIES USED BY CAMERON ET AL. (1995) AND THE DEPARTMENT OF CONSERVATION'S SPECIES PRIORITY RANKING SYSTEM (MOLLOY & DAVIS 1994).

SPECIES	IUCN	DOC SPRS
Lepidium banksii	Critical	A
Lepidium flexicaule	Endangered	B
Lepidium naufragorum	Rare	B
Lepidium obtusatum	Presumed Extinct	X
Lepidium oleraceum agg.	Endangered	B
Lepidium tenuicaule	Vulnerable	C
Rorippa divaricata	Endangered	B

The six indigenous coastal species of *Lepidium*, and *Rorippa divaricata* (Table 1), are referred to in this recovery plan as coastal cresses. They are treated collectively because they share many features of their ecology and are threatened by similar factors. However, there are also some differences between the species. For example, *Lepidium tenuicaule*, *Lepidium flexicaule* and some southern island populations of *Lepidium oleraceum* agg. are prostrate or procumbent plants, often growing in turf communities, a feature not normally found in the other *Lepidium* species, while *Rorippa divaricata* has been recorded historically from slips and other disturbed sites well away from the coastal zone. Despite these differences, there is enough in common between the species to warrant considering them collectively in this recovery plan, especially as many of the approaches to their conservation management are likely to be similar.

Maori names used in this recovery plan follow Turbott (1990) for birds and Beever (1991) for plants. Beever (1991) suggests nau as the Maori name for *Lepidium oleraceum* agg., but it is likely that nau was also applied to the other erect species of *Lepidium* (*Lepidium banksii*, *Lepidium obtusatum*, *Lepidium naufragorum*) as these are morphologically similar. We are unaware of any Maori names for *Lepidium flexicaule* or *Lepidium tenuicaule*. *Rorippa divaricata* is known as matangoa, although the name watakirihi (water cress) may also have been used. We use nau here to refer collectively to all coastal cresses, but for clarity we do not provide Maori names for the cresses when they are referred to using their scientific (Latin) names.

There has been considerable concern about the decline of the coastal cresses in New Zealand for some time, especially the *Lepidium* species (Kirk 1891, Cheeseman 1914, 1925, Given 1981, Ogle 1987, Wilson & Given 1989, Norton et al. 1997). *Lepidium oleraceum* agg. (Cook's scurvy grass) has entered New Zealand conservation folklore because of its apparent abundance during the voyages of James Cook in the eighteenth century, when it was used as an antiscorbutic. While Cook was reputably able to collect the plant by the boatload, few botanists have seen this species in recent years. Although the use of historical accounts to assess past species abundance presents some difficulties (de Lange & Norton 1996), it is clear that these species are now far less common than previously. *Lepidium obtusatum* is thought to be extinct, *Lepidium flexicaule* and *Lepidium tenuicaule* are probably extinct in the

North Island, while *Lepidium oleraceum* agg., *Lepidium banksii* and *Rorippa divaricata* appear to be far less abundant than previously and have experienced local extinction at many sites. Although there is no evidence for decline of *Lepidium naufragorum*, this species was described only in 1995 and there is no information to assess its abundance prior to this.

Because of these declines all the coastal cresses were listed by Cameron et al. (1995) in the New Zealand Botanical Society threatened plant list (Table 1) and included in the Department of Conservation's Species Priority Ranking System (Molloy & Davis 1994; Table 1). The primary goal of this recovery plan is to address this decline and to put in place management initiatives that will restore and sustain these distinctive plants within their natural coastal habitats.

2. Species description and significance

2.1 SPECIES DESCRIPTIONS

Recent descriptions of the coastal cresses can be found in Allan (1961), Webb et al. (1988), Garnock-Jones & Jonsell (1988) and Garnock-Jones & Norton (1995). Illustrations are included in Cheeseman (1914) for *Lepidium oleraceum* agg., Webb et al. (1988) for the fruit of the *Lepidium* species (except *Lepidium naufragorum*), and Garnock-Jones & Norton (1995) for *Lepidium naufragorum* and *Lepidium flexicaule*. Descriptions and illustrations can also be found in some Department of Conservation threatened plant field guides (e.g. Norton 1997, Sawyer et al. 1998). Summary descriptions and illustrations (figures 8–14) of the presently known species are given in Appendix 1. Garnock-Jones & Norton (1995) also provide a key to the coastal *Lepidium* species (Appendix 1), and Webb et al. (1988) to all New Zealand Brassicaceae genera. A synopsis of scientific names used for New Zealand coastal cresses is given in Appendix 2.

In summary, the coastal cresses are typically short-lived herbaceous plants with stout rootstocks. Coastal cresses vary from small rosette forming plants, through procumbent and prostrate plants, to tall upright plants, in some instances up to 1 m tall. Flowers are small and inconspicuous. The fruits in *Lepidium* are short but broad (usually no more than 5 x 5 mm) and flattened, while those in *Rorippa* are long but narrow (up to 30 x 2 mm) and rounded.

There are still some key unresolved taxonomic issues among the *Lepidium* species in the coastal cress group that have important implications for their conservation status and subsequent management priority. *Lepidium oleraceum* agg. is the most widespread of the coastal cresses and three varieties were listed by Allan (1961). While there is some uncertainty about the validity of some of these varieties (Garnock-Jones & Norton 1995), it is clear that there are a number of other distinct forms within the *Lepidium oleraceum* agg. that almost certainly warrant taxonomic recognition, probably at the specific level. Particularly distinctive forms are present on the Chatham Islands, Stewart Island and adjacent islands, and in the Subantarctic islands (e.g. plants from the Snares have two stamens while mainland and northern island populations have four, while procumbent forms are present on several islands). Plants previously placed in *Lepidium oleraceum* agg. on Lord Howe Island are now referred to *Lepidium nesophilum*. Resolution of these taxonomic questions is considered a matter of urgency in this recovery plan as there may be some presently undescribed taxa that are facing imminent extinction. Because of these uncertainties we treat *Lepidium oleraceum* agg. here as an unresolved species aggregate.

Garnock-Jones & Norton (1995) pointed out the many similarities between *Lepidium banksii* and *Lepidium obtusatum*, suggesting that the difference between these two species is no greater than that between the Wellington and Manukau populations of *Lepidium obtusatum*. They suggest that their status should be re-examined along with comparison with other New Zealand, Australian and South Pacific species.

2.2 CONSERVATION STATUS

At the time of writing, the only published assessments of the conservation status of the coastal cress species are those in Cameron et al. (1995) and Molloy & Davis (1994; Table 1). The following assessment of conservation status, based on the IUCN classification scheme used in Cameron et al. (1995), reports our current (1998) assessment of the status of the coastal cresses.

Lepidium banksii: 50–60 wild plants at two main sites in Abel Tasman National Park, both small and at risk of extinction, although plants have been established at six restoration sites. IUCN status: Critically Endangered (no change)

Lepidium flexicaule: Last recorded in North Island in 1934, but still present at 16 sites in northwestern South Island, although all sites contain small populations (c. 600 plants in total). IUCN status: Endangered (no change). Status of Tasmanian plants uncertain.

Lepidium naufragorum: Known from nine sites; abundant at two (Taumaka and Popotai, Open Bay Islands) but uncommon to very uncommon at the others (perhaps 5000 plants in total). IUCN status: Rare (no change).

Lepidium obtusatum: Not seen since 1917 (northern population) and 1938/39 (southern population) and now presumed extinct. Not known in cultivation. IUCN status: Extinct (no change).

Lepidium oleraceum agg.: Although known from many sites (90–100), most populations are small or very small (often < 20 plants) and there is evidence of ongoing decline at many sites. Much more common in the past. Perhaps c. 2000–5000 plants in total. IUCN status: Endangered (no change).

Lepidium tenuicaule: Still present at eleven sites in southern and southeastern South Island (5000–10 000 plants in total), but last recorded from North Island sites in 1930s. IUCN status: Vulnerable (no change).

Rorippa divaricata: Present or thought to be present at two mainland North Island sites and one mainland South Island site, and otherwise known from five off-shore islands, but all populations are very small (800–1000 plants in total). Much more common in the past. IUCN status: Critically Endangered (changed from Endangered).

3. Past distribution and abundance

The following discussion is an abridged version of that in Norton et al. (1997).

Very little is known about abundance or distribution of coastal cresses prior to, or during the period of, Maori settlement. The first European descriptions of New Zealand coastal cresses were made during the voyages of James Cook in 1769, 1773 and 1777, where *Lepidium oleraceum* agg. (scurvy grass) was commonly referred to in journals and was used as a food plant along with *Apium prostratum* (coastal celery, tuutae kooau). Other early visitors to New Zealand also collected or commented on scurvy grass including Jean-Francois-Marie de Surville in 1769, Dumont d'Urville in 1824, 1827 and 1837 and Allan Cunningham in 1826.

There are, however, some difficulties in assessing just how abundant scurvy grass and other coastal cresses were at this time. Interpretation of journals and other records from these early visits to New Zealand is not easy, as they are often sketchy and the use of vernacular plant names can be confusing (de Lange & Norton 1996). The vernacular 'scurvy grass' appears to have been predominantly applied to *Lepidium oleraceum* agg. but may also have been applied at times to other Brassicaceae. Unfortunately, apart from single records of *Lepidium flexicaule* and *Rorippa divaricata*, the other coastal cresses were not collected during the early visits, although it is possible that *Lepidium banksii* may have been included within the concept of scurvy grass as early as Cook's visits, as this species was first collected during the visits of d'Urville in the 1820s and 1830s and referred to *Lepidium oleraceum* agg. What emerges from these journals is a picture that suggests that *Lepidium oleraceum* agg. was widely distributed and could have been a locally abundant species. Certainly, in some localities, Cook and other early voyagers were able to collect scurvy grass and other herbs in large quantities to feed their crews. Furthermore, the sites visited by these early voyagers were mainly mainland sites, rather than off-shore islands, which are now the main refuges for scurvy grass.

The apparent abundance of *Lepidium oleraceum* agg., at least locally at the time of first European contact, is in stark contrast to the observations made by resident botanists towards the end of the nineteenth century. Both Kirk (1891) and Cheeseman (1914, 1925) commented on the rapid decline of this and other coastal cresses through until the start of the 20th century when these species had been lost from many of their earlier sites and were becoming very scarce at others. The general consensus amongst New Zealand botanists today is that this decline has continued through to the present (e.g. Given 1981, Ogle 1987, Webb et al. 1988, Wilson & Given 1989). For example, *Lepidium oleraceum* agg. is known only to remain at two of the 14 sites from which it was recorded during the eighteenth and early nineteenth centuries, while several of the coastal cress species are now absent from some of the sites where Cheeseman and Kirk recorded them. It is, however, difficult to quantify the decline as earlier observations (including journal notes and herbarium records) are sparse and information provided is often insufficient to confirm locations or collection dates, while there has been no long-term monitoring of individual wild coastal cress populations.

Assessment of changes in plant abundance based on herbarium records is also biased by the increasing number of collections in recent years and by the greater awareness and number of collections of uncommon species such as coastal cresses. For example, there have been more collections of *Lepidium oleraceum* agg. from northern New Zealand off-shore islands in the last 30 years, than in the preceding 100 years. However, it is clear that coastal cress species are far less common today than they were 100 years ago, and probably also than they were 200 years ago. For this reason, a key recommendation of this recovery plan is for increased monitoring of coastal cress populations.

4. Present distribution and abundance

The following is a summary of the known distribution of the coastal cresses. A list of all known or suspected sites for coastal cresses is given in Appendix 3.

4.1 *Lepidium banksii* (FIGURE 1)

This species has apparently always been confined to Tasman Bay–Marlborough Sounds where plants have been collected in three general areas:

1. Abel Tasman National Park; records from Astrolabe Harbour (1827) and Totaranui (1963 onwards). The Astrolabe Harbour records made on d'Urville's second voyage may have been from the same general site as the recent Totaranui records, where the species is still present (2 main populations).
2. Waimea Estuary/Boulder Bank; records are from small islands in Waimea Estuary (1946, 1992) and Boulder Bank (1908). One wild population was present on Nomans Island in Waimea Estuary until very recently, but all plants presently at the site have been planted. Restoration work has also been undertaken on one further island in the Waimea Estuary and two islands in the Moutere Estuary.
3. Marlborough Sounds; there are two nineteenth century records (with duplicates) from Pelorus Sound and Kenepuru.

4.2 *Lepidium flexicaule* (FIGURE 2)

Historically, *Lepidium flexicaule* has been recorded in the Auckland-Coromandel area of the North Island, on both east and west coasts and in major harbours (Manukau and Waitemata), and along the west coast of South Island from Cape Farewell to Greymouth. This species also appears to have been present in Wellington as Hooker refers to a Colenso record from 'Port Nicholson'. *Lepidium flexicaule* is also present in southern Tasmania where it appears to have a limited distribution, with only six vouchers at the Tasmanian Herbarium (and two duplicates at Canberra). The only early record (Rodway no date) is from the southeast coast (Bruny Island), while the other five records are from remote southwest coast sites and date between 1977 and 1986.

Lepidium flexicaule has been recorded from seven sites around Auckland; Mercury Bay (1769), Onehunga/Mangere Point (?1870s, 1880s), North Head Waitemata Harbour (?1870s), Rangitoto Island (1882), Waitakere (1885), Piako-Thames (?1880s, 1890s) and Bethells Beach (1934). There are no North Island records after 1934, and recent searching has as yet failed to relocate it at any of these sites. South Island records are more recent, with plants presently known from Point Elizabeth, Seal Island, Punakaiki, Tauranga Bay, the Kohaihai-Heaphy coastline, and at several sites along the Te Taitapu coastline near Kaihoka. Other sites from which the species has been recorded are Mokihinui (pre 1907), Cape Foulwind (pre 1907, 1913) and Westport including the Orowaiti Estuary (pre 1907, 1953).

4.3 *Lepidium naufragorum* (FIGURE 3)

Lepidium naufragorum is presently known from nine sites on the west coast of South Island from Cascade Point in the south to Cape Foulwind in the north. Because *Lepidium naufragorum* has only recently been described there is no information on its former distribution, with the only older herbarium records being from Open Bay Islands (where it had been identified as *Lepidium oleraceum* agg.). It is possible that it may be present at fur seal (kekeno, *Arctocephalus forsteri*) haulouts and on calcareous substrates both to the north and south of its present distribution (e.g. in Fiordland).

4.4 *Lepidium obtusatum* (FIGURE 4)

Lepidium obtusatum was first collected in the Wellington area prior to 1892, when Kirk described it, and near the Manukau Heads in 1870 (although it wasn't recognised as *Lepidium obtusatum* at that time). Further collections were made in 1914, 1917 and 1919, and a description of its Wellington habitat was published in 1921. The only other records (all from Seatoun, Wellington) are four herbarium vouchers from two collectors in 1938/39; this species now appears to be extinct at both sites despite searches for it in recent years.

4.5 *Lepidium oleraceum* agg. (FIGURE 5)

Lepidium oleraceum agg. has been widely distributed through the New Zealand botanical region from the Kermadecs in the north to Auckland Island in the south, but has declined dramatically at many sites, while many extant sites comprise only a few plants. This species has six main distribution centres: northern New Zealand including the Waikato coastline, southwestern North Island, northern South Island, Otago, Foveaux Strait-southern islands, and Chatham Islands. Interestingly, neither this species nor any other coastal cress has been recorded from Fiordland as yet.

Lepidium oleraceum agg. is known to be present at only two mainland sites in the North Island (Ngatutura Point, where only eight plants remained in 1994, and Cape Colville), but is present on several of the northern off-shore islands. At a few sites it appears to be quite common (e.g. Fanal/Motukino Island and Matapia Island), but most populations have only a few plants present (usually less than 20). *Lepidium oleraceum* agg. appears to be extinct on Raoul Island but is still present on Macauley Island in the Kermadecs, its current northern limit. Plants are still present on the Sugarloaf Islands/Nga Motu off New Plymouth, where some restoration work has also been undertaken. In the Wellington region, *Lepidium oleraceum* agg. appears to have been at least locally common up until the end of the 19th century but is now confined to two sites, Mana and Kapiti Islands.

There are several records from the Marlborough Sounds, praimarily on islands, dating back to Cook and d'Urville. *Lepidium oleraceum* agg. is still abundant on Stephens Island, but appears to be less common on other Cook Strait islands. There is also one recent record from the northwest coast of Nelson (Shannel Courtney pers. comm. 1998) where *Lepidium* plants were seen from a helicopter on two small islands near Kaihoka, although the identity of these

plants needs to be confirmed (they may be *Lepidium naufragorum*). There are a few early records from Banks Peninsula (1840–42 and 1921), but despite repeated searches it has not been found in recent years (Hugh Wilson, pers. comm. 1994). *Lepidium oleraceum* agg. is, however, still present along the Otago coast, both on the mainland and on adjacent islands, where it can be locally common. It is also present on both the northern and southern Muttonbird Islands adjacent to Stewart Island, although there are no records from Stewart Island itself.

Lepidium oleraceum agg. is present on the Antipodes, Snares and Solander Islands, although there are no recent records for the Auckland Islands. On the Chatham Islands it is known to be present at several sites on the main island, although all populations are small and most are on private land and appear directly threatened by grazing and erosion. *Lepidium oleraceum* agg. is also present on several of the outer islands, with large populations on Rangatira, Mangere and Little Mangere Islands, but appears to be uncommon at other sites.

4.6 *Lepidium tenuicaule* (FIGURE 6)

Lepidium tenuicaule has been recorded from eleven sites along the southeastern corner of the Otago-Southland coastline with several thousand plants present at two sites. In the Wellington area it has been recorded from two sites, Kapiti Island and Titahi Bay. The most recent record is 1912, although it may still be present on Kapiti Island.

4.7 *Rorippa divaricata* (FIGURE 7)

This species appears to have been most common historically from the northern North Island, although there is one record from Taranaki, one from Marlborough and one from Nelson (1998). *Rorippa divaricata* is today restricted to three mainland sites, two North Island and one South Island, and five northern offshore island sites and is very uncommon at all sites, with Fanal/Motukino and Aorangi Islands the only sites known to have more than 100 plants present. However, the distribution of this species is still poorly known.

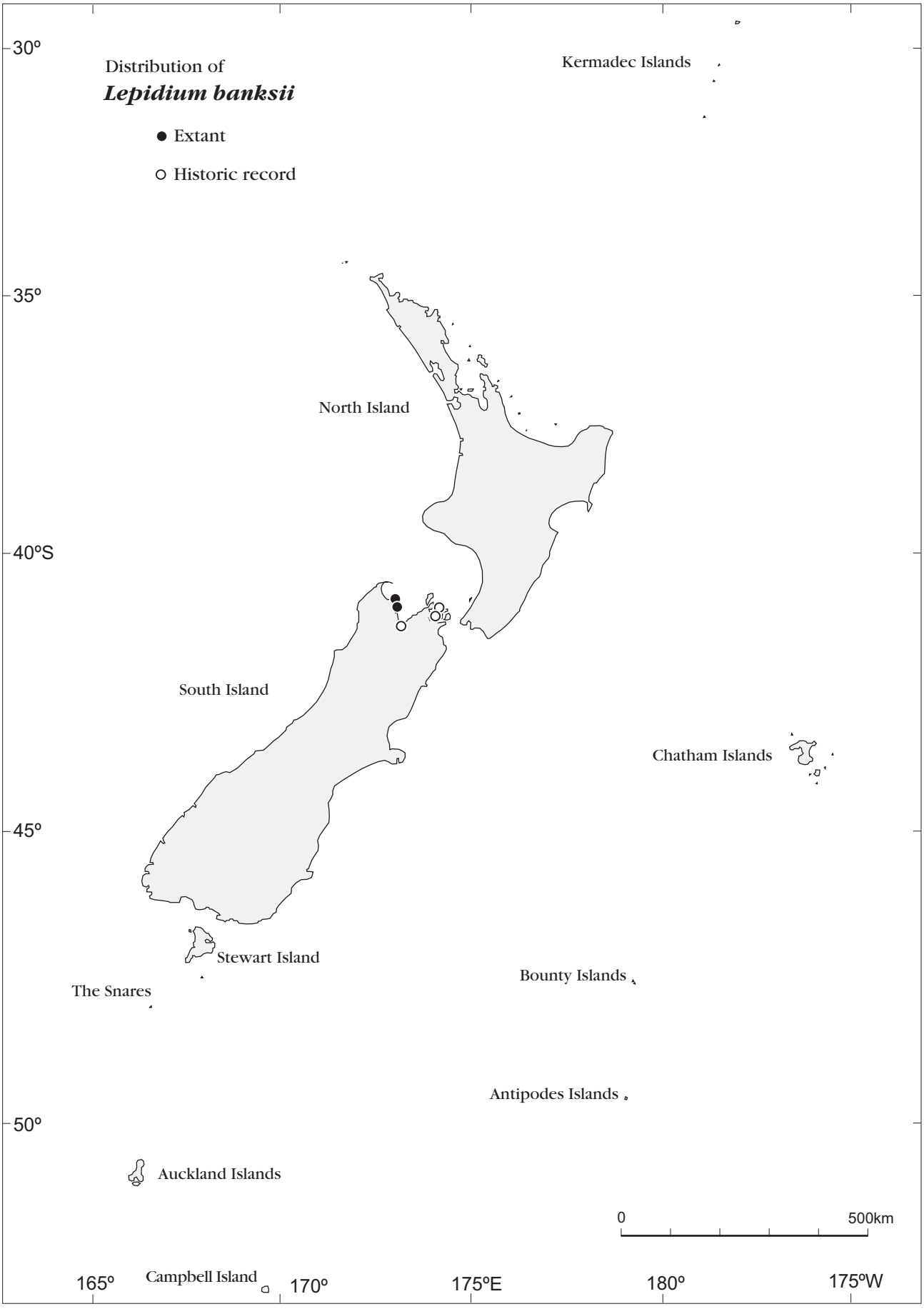

Figure 1. Current and historical distribution of *Lepidium banksii* (not all localities marked because of overlap and/or lack of specific details for location).

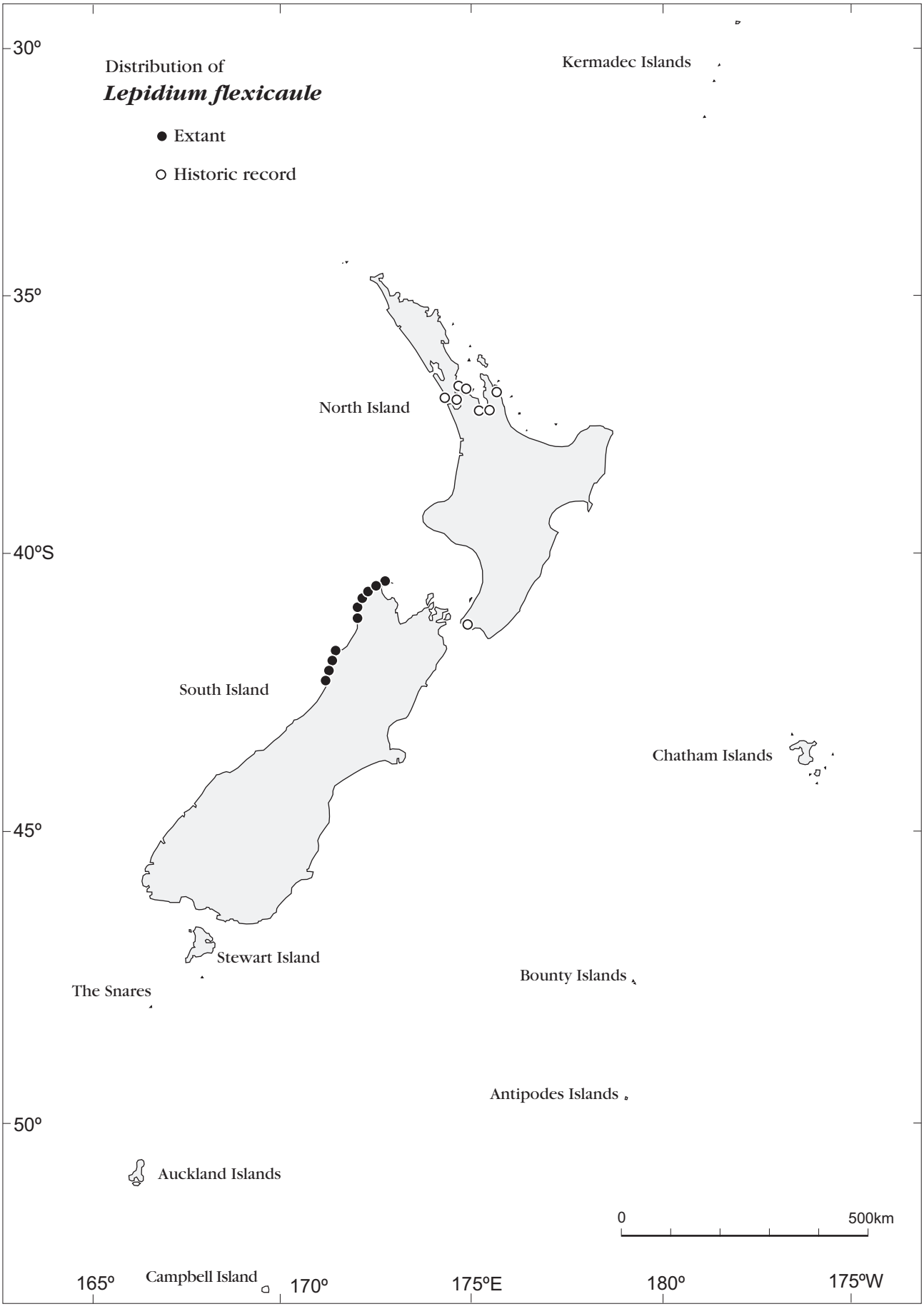

Figure 2. Current and historical distribution of *Lepidium flexicaule* (not all localities marked because of overlap and/or lack of specific details for location).

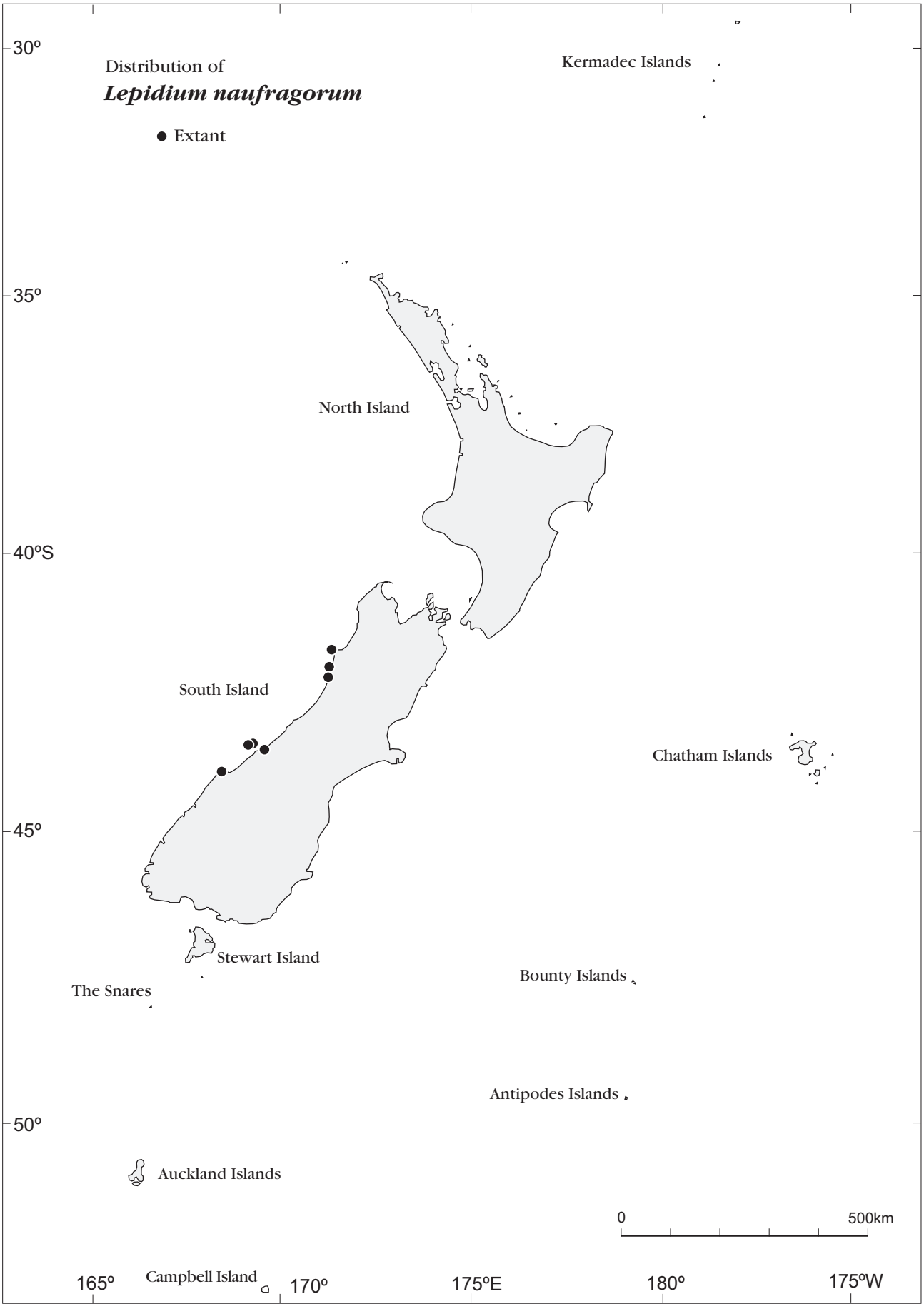

Figure 3. Current and historical distribution of *Lepidium naufragorum* (not all localities marked because of overlap and/or lack of specific details for location).

Figure 4. Current and historical distribution of *Lepidium obtusatum* (not all localities marked because of overlap and/or lack of specific details for location).

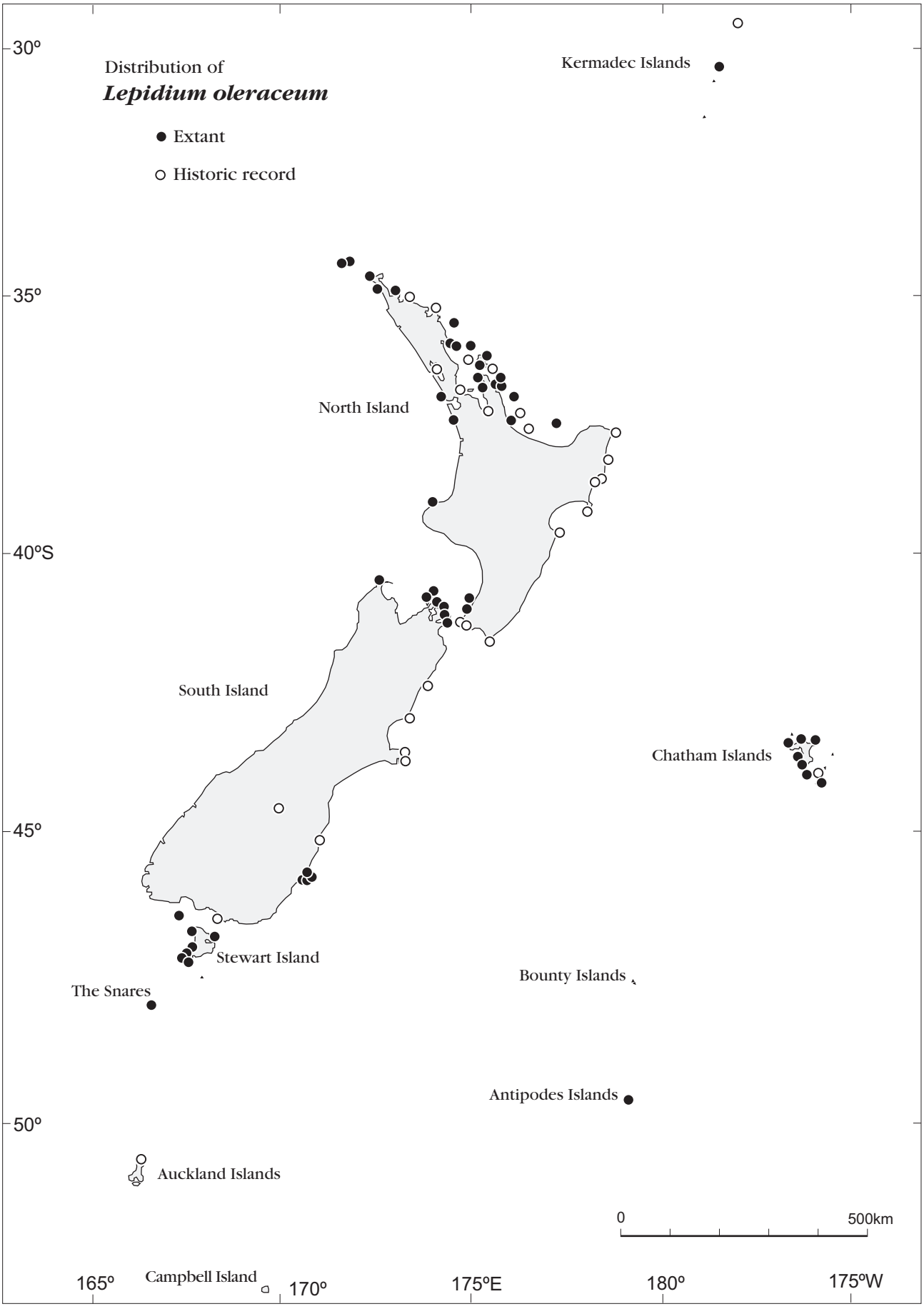

Figure 5. Current and historical distribution of *Lepidium oleraceum* agg. (not all localities marked because of overlap and/or lack of specific details for location).

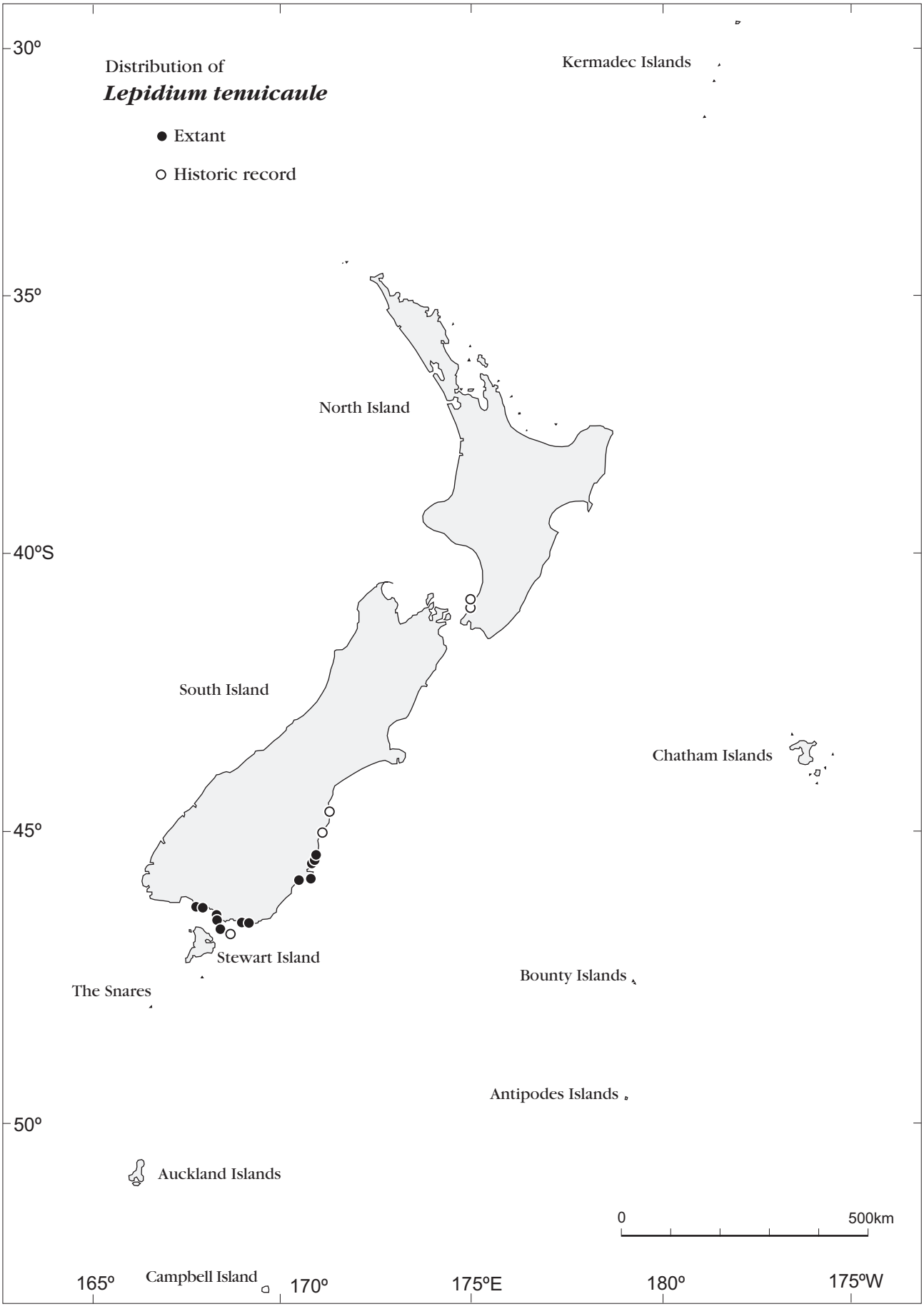

Figure 6. Current and historical distribution of *Lepidium tenuicaule* (not all localities marked because of overlap and/or lack of specific details for location).

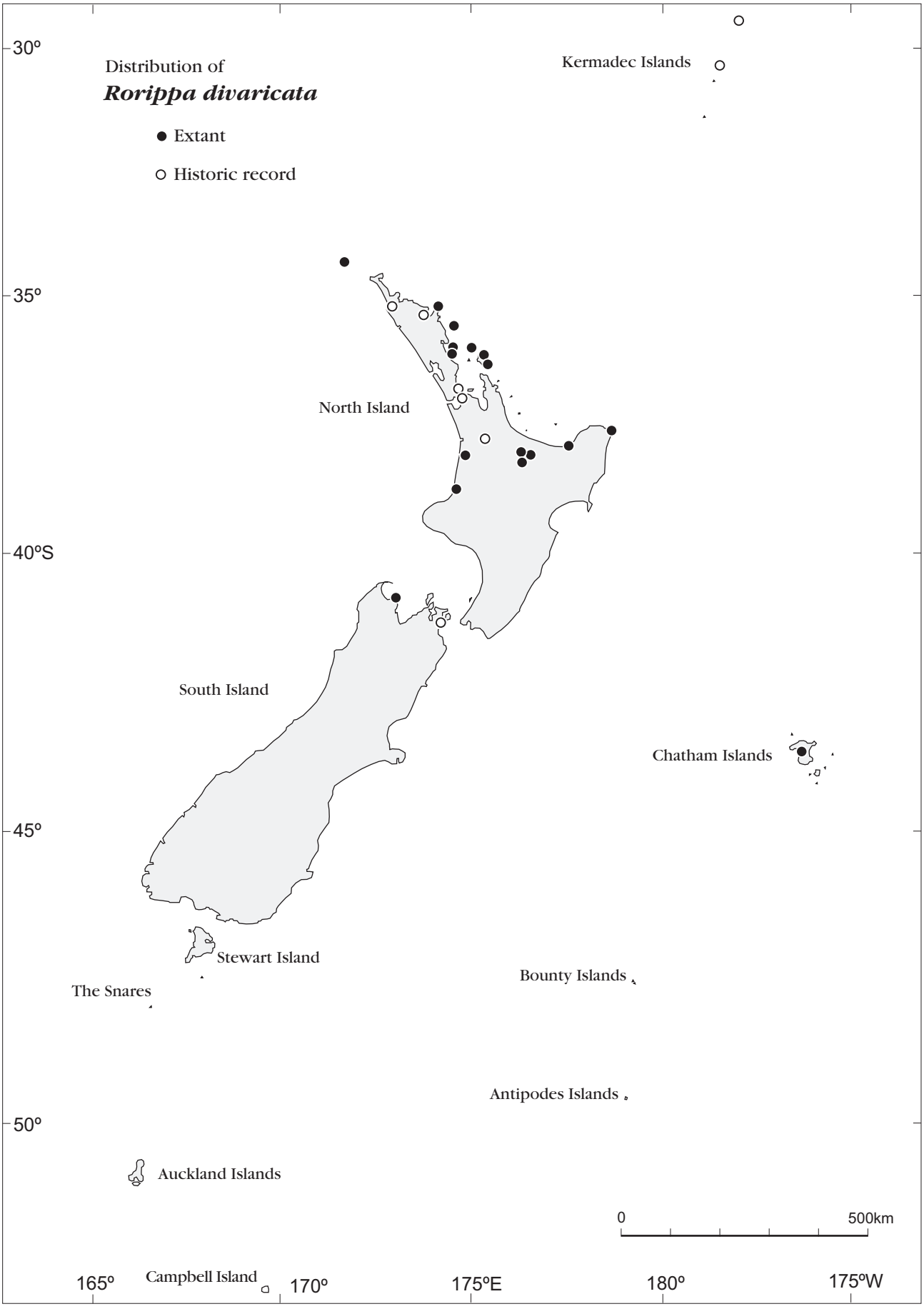

Figure 7. Current and historical distribution of *Rorippa divaricata* (not all localities marked because of overlap and/or lack of specific details for location).

5. Ecology

Ecologically, the coastal cresses have a number of similarities, especially in growth form, but also in habitat requirements and population dynamics. However, there are also some ecological differences between species. These similarities and differences are now discussed in more detail.

5.1 MORPHOLOGY, REPRODUCTIVE BIOLOGY AND POPULATION DYNAMICS

All coastal cresses are herbaceous perennials with stout rootstocks, and appear to be relatively short-lived. Cultivated plants of *Lepidium oleraceum* agg. live for a maximum of 5–10 years. Some species die back to a basal rosette (e.g. *Lepidium banksii*, *Lepidium flexicaule* and *Lepidium naufragorum*) while others have large woody bases from which they resprout (e.g. *Lepidium oleraceum* agg.). Some populations (e.g. in *Lepidium oleraceum* agg.) have long-lived trailing stems in which periods of stem elongation and stasis can be recognised by proximity of leaf-base scars.

Flowering appears to be regular and seed production copious. Seeds germinate readily in glasshouse and garden situations, and plants will flower in their first year. All coastal cresses are hermaphroditic. As with many other Brassicaceae, the coastal cresses have mucilage bodies in the cells of the outer epidermis of the seed and the small slightly sticky seeds appear well suited for vertebrate dispersal. There is no published information on seed viability in the wild, although stored seed remains viable for at least three years, and seed has been germinated from soil collected under *Lepidium oleraceum* agg. from Fanal/ Motukino Island (Steve Benham pers. comm. 1998).

The abundance of coastal cresses at a site appears to vary considerably through time, perhaps reflecting differences in climatic conditions between years. This variation may reflect differences in seed germination and seedling establishment, or could reflect differences in plants resprouting from persistent root stocks. Certainly, during the 1997–98 El Niño event, both *Lepidium oleraceum* agg. and *Rorippa divaricata* were far less abundant at sites in the Hauraki Gulf than they had been two years previously, perhaps due to the very dry conditions during this summer. Variation in the abundance of *Rorippa divaricata* through time has also been noted in Northland, where this species was abundant at a site in 1902 before disappearing, but reappeared within 100 m of the original site 18 years later.

5.2 HABITAT

The coastal cresses usually grow in the coastal zone close to the high tide mark. On many off-shore islands, coastal cresses are often found associated with bird colonies a considerable distance above the high tide mark. For example,

Lepidium oleraceum agg. regularly occurs several hundreds of metres from the high-tide mark on northern off-shore islands, usually among colonies of burrowing birds, while *Lepidium tenuicaule* has been recorded from near the summit of Kapiti Island. Some coastal cress species have also been recorded inland. *Rorippa divaricata* has been recorded from a number of sites in the central and northern North Island where it occurred on slips and other disturbed sites in lowland forest well away from the coast, and around the edges of lakes (e.g. in the Lake Rotorua area). *Lepidium oleraceum* agg. has also been recorded inland in the Waitaki Valley in Otago.

Coastal cresses are plants of open sites and can occur in rock crevices, on boulder or cobble beaches, in turf communities, amongst bird colonies (especially of burrowing birds), among fur seal haulouts, or on slips. *Lepidium flexicaule* and *Lepidium tenuicaule* have both been recorded from the edges of paths, roads, and other sites associated with human activities. *Rorippa divaricata* was recorded from newly cultivated land in Northland at the turn of the twentieth century. All species grow poorly under shade, although they can occasionally occur under open coastal shrubland/low forest (e.g. *Lepidium oleraceum* agg.). Some species (*Lepidium flexicaule* and *Lepidium tenuicaule*) occur in dense coastal turf communities. *Rorippa divaricata* is probably the most shade tolerant of the coastal cress species and has been recorded under coastal forest.

All of the coastal cresses apart from *Lepidium flexicaule* and *Lepidium tenuicaule* have been observed associated with coastal bird colonies, including blue penguin (koroa, *Eudyptula minor*); Fiordland crested penguin (tawaki, *Eudyptes pachyrhynchus*); yellow-eyed penguin (hoiho, *Megadyptes antipodes*); gannets (takapu, *Morus serrator*); terns (tara, taranui, tarapiroe; *Sterna* spp.); petrels (titi, korure, oi, taiko; *Pterodroma* spp.) and other burrowing seabird; gulls (karoro, tarapunga; *Larus* spp.); and shags (parekareka, *Stictocarbo punctatus*). *Lepidium oleraceum* agg. populations located at sea bird colonies are almost always bigger than those at sites lacking sea birds. Both *Lepidium flexicaule* and *Lepidium naufragorum* have been recorded from sites associated with haulouts of the New Zealand fur seal.

5.3 PESTS AND DISEASES

Coastal cresses are palatable and there is good documentation of browse by both domestic stock and feral mammals, although many coastal cresses occur in sites inaccessible to browsing mammals. Rooting by pigs (*Sus scrofa*) has caused a dramatic decline in the number of *Lepidium banksii* plants at one site at Abel Tasman National Park. A rapid response of *Lepidium oleraceum* agg. to rat (*Rattus* spp.) removal on some northern off-shore islands also suggests that rats may be important predators of both foliage and seeds.

Many pests of garden and crop Brassicaceae will attack *Lepidium oleraceum* agg. in cultivation; of these white rust (*Albugo candida*) is perhaps the most significant (Norton et al. 1997). The cosmopolitan white rust was first recorded in New Zealand in 1886 but no host was specified. It has subsequently been recorded from numerous Brassicaceae species introduced into New Zealand, but only from a limited number of indigenous Brassicaceae species. Because of

its prevalence on introduced species and its relative rarity on indigenous species until quite recently, white rust is not regarded as indigenous (Eric McKenzie pers. comm. 1995). White rust has been recorded from all New Zealand *Lepidium* species in cultivation, including on the Chatham Islands (Baker 1955, P.J. de Lange unpubl. data, A. Baird pers. comm. 1998) where it forms large white lesions on the foliage, inhibits seed development and can kill plants. White rust has been recorded from many *Lepidium oleraceum* agg. sites since c. 1950 including subantarctic islands (McKenzie & Foggo 1989), and is clearly a factor in the current decline of this species. It has also been recorded from *Lepidium banksii*, *Lepidium flexicaule*, *Lepidium naufragorum*, *Lepidium tenuicaule* and *Rorippa divaricata* in the wild (Garnock-Jones & Norton 1995, McKenzie & Dingley 1996, Shannel Courtney pers. comm. 1998).

Other pests of Brassicaceae that are known to affect coastal cresses include cabbage white butterfly (*Pieris repae*), the cabbage aphid (*Brevicoryne brassicae*), diamond-backed moth (*Plutella xylostella*), various leaf miners, and snails (*Helix aspersa*) and slugs (Esler 1975, Given 1981). All have been observed on cultivated *Lepidium*, and cabbage white butterfly, cabbage aphid and diamond-backed moth have been recorded from wild coastal cress sites. Cultivated coastal cress plants have also been observed to be affected by root aphids (species unknown: Steve Benham pers. com. 1998).

5.4 SUMMARY OF ECOLOGY

Coastal cresses are relatively fast growing, produce abundant seeds, and are short-lived perennials. They are typically poor competitors and vary considerably in abundance from year to year. Coastal cresses are usually restricted to open, often disturbed, sites, and are usually present on higher fertility substrates (e.g. bird colonies or among decomposing strandline material), although they can also occur in lower fertility sites. The coastal cresses can be divided into three groups ecologically: (i) *Lepidium oleraceum* agg. (except some southern populations), *Lepidium banksii*, *Lepidium obtusatum* and *Lepidium naufragorum*, which are tall, upright plants that show a strong association with animals in their coastal habitats; (ii) *Rorippa divaricata* which is also an upright herb, but has a wider distribution including disturbed open inland sites as well as coastal sites; and (iii) *Lepidium flexicaule*, *Lepidium tenuicaule* and some southern populations (Stewart, Snares, Antipodes and Chatham Islands) of *Lepidium oleraceum* agg. which are prostrate or procumbent plants often occurring in turf communities with or without animals. A key feature of coastal cresses is their dependence on a range of other factors (e.g. high fertility and disturbed sites associated with animals, intact turf communities, etc.) in their ecology. Maintenance of these ecosystem linkages is essential for the ongoing survival of coastal cress species.

6. Reasons for decline

Reasons for the decline of the coastal cresses are complex, but have been linked to browsing by introduced mammals. However, browsing is only one factor, with other important influences including herbivory and predation by invertebrate and fungal pests, overcollecting, coastal development, loss of associated animal species, competition with invasive plants, and infrequent but damaging natural events. It is likely that the factors involved in the decline of coastal cresses have changed through time and that some of the threats these species face today were not involved in their decline in the early period after first European settlement (Ogle 1987, Norton et al. 1997). The following discussion is adapted from Norton et al. (1997).

6.1 BROWSING

The decline of coastal cresses has been linked to browsing, either by domestic stock such as sheep (*Ovis aries*) and cattle (*Bos taurus*), or introduced wild mammals such as possums (*Trichosurus vulpecula*) (Given 1981). Coastal cress species are palatable and there is good documentation of their decline at sites with browsing animals (e.g. on the main Chatham Island) and their recovery once browsers have been removed (e.g. after rat eradication on some northern off-shore islands). However, because many of the present cress sites are inaccessible to many browsing animals (steep bluffs) and populations have still been lost from them, it has been suggested that it is overly simplistic to attribute their decline to browsing animals alone (Ogle 1987, Norton et al. 1997). Certainly, many domestic and wild browsing animals were not common in New Zealand prior to the mid-19th century, yet *Lepidium oleraceum* agg. and possibly other cress species were in decline prior to this. It seems clear that while browsing can be a key threat it is not the only threat to these plants.

6.2 HERBIVORY AND PREDATION BY PESTS OF BRASSICACEAE CROP PLANTS

The various pests of garden and crop Brassicaceae plants (white rust, cabbage white butterfly, cabbage aphid, diamond-backed moth, various leaf miners, and slugs, Limacidae, and snails appear to be having a significant impact on coastal cress populations in the wild today. White rust has been recorded from most *Lepidium oleraceum* agg. sites since c. 1950, as well as from some *Lepidium flexicaule*, *Lepidium banksii* and *Lepidium naufragorum* populations, and is clearly a factor in the current decline of these species. The other pest species have all been observed on cultivated *Lepidium*, and the cabbage white butterfly, cabbage aphid, and diamond-backed moth have been recorded from wild *Lepidium oleraceum* agg. sites. It is likely that these pests are a key factor in the current decline of coastal cresses, but it would seem unlikely that they were important in the decline of these species prior to the 20th century as they were either absent or very uncommon then (e.g. cabbage white butterfly was first recorded in new Zealand in 1929).

6.3 OVER-COLLECTING

Over-collecting by professional and amateur botanists, as well as horticulturalists, is an often overlooked factor in the decline of many uncommon plants (Norton et al. 1994). While over-collecting may not have been the dominant factor in the decline of coastal cresses, it does appear to have been important at some sites. The type locality of *Lepidium obtusatum* (near Wellington) was heavily collected (based on herbarium vouchers) with five botanists repeatedly gathering specimens from one, apparently small, localized population. Extensive collecting of other species has also occurred. For example, several botanists have repeatedly collected *Lepidium flexicaule* from three sites in northwestern South Island over the last 100 years. This species occurs in small populations of usually no more than a few dozen individuals and is now extinct at one of these collecting sites, and is very uncommon at a second.

6.4 COASTAL DEVELOPMENT, EROSION AND HABITAT DETERIORATION

Reclamation and coastal development in the Auckland area have destroyed most of the sites from which *Lepidium flexicaule* has been recorded and this species is now presumed extinct there. Similar problems may have occurred near Wellington, where the local city council initially had a gravel quarry and subsequently dumped rubbish at the only known site of *Lepidium obtusatum* (P.J. de Lange, unpubl. data). However, throughout the rest of New Zealand, coastal development is unlikely to have been a major factor.

Erosion and habitat deterioration as a result of farming may also have affected some *Lepidium* populations, for example on the Chatham Islands. The turf communities that are habitat for *Lepidium tenuicaule* in Otago and Southland also appear vulnerable to disturbance from domestic stock, especially cattle, although disturbed ground also creates opportunities for regeneration of this species. Erosion from over-grazing also appears to be a factor in the decline of *Lepidium oleraceum* agg. on Chatham Island.

6.5 LOSS OF ASSOCIATED ANIMAL SPECIES

The occurrence of a strong association between the distribution of *Lepidium oleraceum* agg. populations and seabird colonies has been commented on in several studies (e.g. Gillham 1960a,b, Atkinson 1964, Given 1981, Ogle 1987, Norton et al. 1997), and similar associations occur between *Lepidium banksii*, *Lepidium obtusatum*, *Lepidium naufragorum*, and *Rorippa divaricata* and coastal bird colonies and fur seal haulouts. In contrast, *Lepidium flexicaule* and *Lepidium tenuicaule* do not show as strong a relationship, reflecting their primary location in turf communities. However, even these sites are often frequented by coastal birds, including oystercatchers (torea, *Haematopus* spp.) and gulls, perhaps more so in the past than today.

Animals, especially birds, are likely to play an important role in the ecology of several coastal cress species by maintaining open sites through physical disturbance, including burrowing, through nutrient enrichment, and by dispersing seeds. These coastal cresses appear poor competitors and do best in open sites free of taller herbaceous and woody vegetation. Animal disturbance is important in preventing tall vegetation from dominating sites, thus allowing shorter stature herbaceous species such as the cresses to persist. Several of the coastal cresses are part of a guild of species characteristic of open sites in New Zealand coastal situations, and are especially prolific around seabird colonies. Removal of seabirds or fur seals results in an expansion of tall herbaceous vegetation and eventually woody plants, and a decrease in the opportunities for establishment of the coastal cresses.

The importance of seabirds for nutrient enrichment has been widely recognised and Ornduff (1965) coined the term 'ornithocoprophilous' to describe plant species that are associated with seabird guano deposits. Few studies have rigorously tested the importance of guano for plant survival, especially in New Zealand, although Ibell (1990) has presented data suggesting that *Leptinella featherstonii*, a Chatham Island endemic, may be dependent on guano for its survival. Ogle (1987) and Norton et al. (1997) list a number of New Zealand plants that may benefit from the nutrient enrichment associated with seabird colonies, in addition to the coastal cresses. Significantly, several of these taxa are also listed as nationally threatened. Loss of seabirds, and perhaps fur seals, may reduce nutrient enrichment and hence reduce the suitability for plants such as the coastal cresses, leading to their replacement by less specialized plants.

As the coastal cresses have sticky seeds well suited for vertebrate dispersal, seabirds are likely to be important for dispersing seed between sites. Shags have also been observed to transport *Lepidium* foliage (including inflorescences) for nest building, thus spreading plants to new sites (as has probably occurred with *Lepidium oleraceum* agg. establishing on an artificial breakwater near Dunedin). Reduction and loss of seabirds is likely to result in a reduction in seed dispersal and hence poor recolonisation of sites after local extinction.

The New Zealand seabird fauna has undergone dramatic declines with human settlement, with rats and cats being key predators (Towns et al. 1997). It would seem likely that in the first half of the 19th century Norway rats (*Rattus norvegicus*) devastated seabird colonies on the mainland, especially burrowing petrels, restricting most to off-shore islands (Graeme Taylor pers. comm. 1995). At the same time as seabird colonies were being devastated by rats, sealing gangs were rapidly depleting mainland and off-shore island fur seal populations. Between 1800 and 1830 the New Zealand fur seal population was decimated, although numbers are now gradually starting to recover at some sites. Both these changes must have had a dramatic influence on the nature of the New Zealand coastal environment and are likely to have had significant implications for the survival of plants dependent on these animals, such as the coastal cresses.

6.6 COMPETITION WITH INVASIVE PLANTS

As all coastal cresses are poor competitors, preferring open disturbed sites, they are particularly vulnerable to competition with invasive plants. There are several instances in which invasive plants have been observed competing with coastal cresses and this appears to be an increasing problem at several coastal cress sites. In Otago and Southland invasion of coastal turfs by introduced pasture grasses such as *Agrostis stolonifera* potentially threaten *Lepidium tenuicaule*, while along the Otago coast most *Lepidium oleraceum* agg. sites are being impacted by a variety of weed species. On Sugarloaf Island/Nga Motu boxthorn (*Lycium ferocissimum*) was spreading over *Lepidium oleraceum* agg. sites until it was removed. On Aorangi Island in the Poor Knights one of the largest remaining wild populations of *Rorippa divaricata* grows intermixed with pampas grass (*Cortaderia selloana*), and Mexican devil (*Ageratina adenophora*), two serious environmental weeds that threaten to displace this species.

Competition with invasive weeds may well have been a factor in the loss of coastal cresses at some mainland sites and as weeds spread onto more of the outer islands they could also impact there. However, weed control can also be a problem, especially if managers are not aware that threatened plants are present. Education is important to ensure that coastal cresses are not accidentally killed as part of weed control operations. Dieback of planted *Lepidium banksii* near Nelson as a result of grass control around the plants suggests that coastal cresses are vulnerable to some herbicides and care needs to be taken to ensure that appropriate herbicides are used.

6.7 INFREQUENT BUT DAMAGING NATURAL EVENTS

Coastal cresses appear to occur typically in small populations, often on recently disturbed sites, separated by a lack of suitable habitat. At some sites, coastal cress species would have been gradually replaced by taller indigenous vegetation as natural successional processes occurred, leading to their local extinction. Infrequent but damaging climatic events such as El Niño and severe storms are also likely to have resulted in local extinction. But in both situations, reestablishment would have occurred either on new disturbed sites or after climatic conditions improved. However, with the pronounced decline that has occurred in the abundance and distribution of coastal cresses in the last two hundred years, the chance of recolonisation of sites that experience local extinction is much less likely than previously. For species with very few wild populations such as *Lepidium banksii* and *Rorippa divaricata*, this could lead rapidly to species extinction at all sites. For these species in particular, restoration is essential to increase the number of wild populations.

7. Threats to long term survival

The decline of the coastal cresses has not been the result of one factor alone, and the relative importance of different factors in the decline of individual cress species is likely to have varied through time and between species. It seems clear that for several coastal cresses, seabirds and seals are a key factor in their ecology and the decline of these cress species can be linked to a decline in the associated animals. However, declines have also occurred at sites where associated animals are still abundant. In these cases, factors such as predation and herbivory by Brassicaceae pests, and competition with invasive plants, may be important agents of decline. Furthermore, infrequent but damaging natural events can affect coastal cress populations at any site, irrespective of the presence of other threats. Because of past habitat changes (e.g. loss of associated animals) some current sites may be suboptimal. Coastal cress populations at these sites may be particularly vulnerable to infrequent but damaging natural events (e.g. due to El Niño weather patterns). A lack of awareness amongst conservation managers and the general public about the problems facing the coastal cresses, and especially the complex ecosystem linkages that appear important for sustaining these species in the wild, also threatens their long-term survival. The rest of this plan seeks to put in place strategies to deal with these threats.

8. Recovery potential

Based on the evidence of decline from the last 100–200 years it would seem likely that without active management extinction of one or more coastal cresses is inevitable. *Lepidium banksii*, *Rorippa divaricata*, and some of the undescribed entities presently included within *Lepidium oleraceum* agg. appear the most vulnerable. Conversely, with management it would seem reasonable to expect that there will be some improvement in the condition of existing populations (e.g. number of plants) and in the medium to long term an increase in the total number of populations in the wild. However, some of the threats facing the coastal cresses present some real challenges for conservation management (e.g. controlling white rust and restoring mainland seabird colonies). These will be difficult to deal with in the short-term, but without attempting to deal with them now it might be too late in the future when new technologies are available (e.g. for predator control). Furthermore, the success of recent island predator eradication programmes and the increasing success in predator control at mainland island sites suggests that it should be possible to manage predators in order to enhance seabird populations and hence improve habitat for the coastal cresses.

9. Options for recovery

OPTION 1: DO NOTHING

This is not an acceptable option as the historical evidence suggests that all coastal cresses have declined and if there is not some management intervention then coastal cresses will continue to decline. Species extinction would seem likely for several cress species in the short to medium term (20–100 years).

OPTION 2: MANAGE ONLY IN CULTIVATION

Management in cultivation demands considerable financial and human resources and is unlikely to protect the full range of genetic diversity present in these species if used as the only management option. Relying solely on ex-situ management also ignores the fact that these species are part of larger natural ecosystems, and ignoring the threats these species face in the wild is also ignoring the threats to the other species in these coastal ecosystems, many of which cannot be conserved in ex-situ collections (e.g. seabirds). Ex-situ management also runs a number of risks associated with pests and disease, especially those associated with Brassicaceae crop plants (e.g. white rust which is present in many nurseries), while ex-situ collections may also be vulnerable to hybridisation. However, ex-situ management is still likely to be an important component in the management of coastal cresses.

OPTION 3: MANAGE AT A RANGE OF SITES THROUGHOUT NEW ZEALAND

The other option is to manage these plants throughout their natural range by dealing directly with the threats they face and putting in place management initiatives that will help to mitigate these threats. While this option will cost more than the 'do nothing' option, it should result in the long-term conservation of the coastal cresses. This is the option that is developed further here as the main focus of the coastal cress recovery, but also involving part of Option 2, through ex-situ collections.

10. Recovery strategy

10.1 GOALS AND OBJECTIVES

Management goal

To ensure that viable populations of all extant coastal cress species are restored and self-sustaining in the wild throughout the natural range of these species.

This goal will be realised when the IUCN threat status and the Department of Conservation priority status of each extant species has been improved by at least one category within 50 years.

Objectives

The following objectives are designed to meet the overall goal for the recovery of coastal cress species.

Objective 1. Promote iwi and public interest and involvement in the recovery of coastal cresses.

Objective 2. Consult with iwi over plan development and implementation.

Objective 3. Carry out or promote research on the use of coastal cress species by Maori and on the possibility that some or all coastal cresses may be Taonga.

Objective 4. Carry out or promote research that resolves the taxonomic position of coastal cresses, especially the entities within *Lepidium oleraceum* agg., and resolve relationships within *Lepidium obtusatum* and *Lepidium banksii*.

Objective 5. Survey all known or suspected coastal cress populations based on recent (< 50 years old) herbarium or anecdotal records or on ecological grounds to ascertain their current status.

Objective 6. Implement management of extant coastal cress populations to sustain them at their current sites with involvement by all interested parties including landowners and iwi.

Objective 7. Establish a detailed monitoring programme that assesses trends in population abundance through time for at least three representative populations of each extant coastal cress species, and for at least three representative populations within each of the six geographical areas that *Lepidium oleraceum* agg. occurs, including suspected undescribed taxa.

Objective 8. Carry out or promote research to better understand the ecology of coastal cresses and to develop methods to control the factors that threaten them.

Objective 9. Establish ex-situ collections of at least three representative populations of each extant coastal cress species, and for at least three representative populations within each of the six geographical areas that *Lepidium oleraceum* agg. occurs, including suspected undescribed taxa.

Objective 10. Establish restoration programmes for all species, where possible integrated with animal control programmes, to increase the number of wild populations and to better understand the factors that limit these species and to develop translocation protocols for restoration programmes.

10.2 WORK PLAN

To meet each objective and fulfil the management goal the following actions are required:

Objective 1. Promote iwi and public interest and involvement in the recovery of coastal cresses.

Explanation

Conservation of the coastal cresses cannot occur in isolation from iwi or the public. It is important that iwi and the public, including land owners, conservation groups and other interested parties, are aware of the problems facing the coastal cresses and have the opportunity to be involved in their recovery. The presence of coastal cresses on several iwi owned islands (e.g. Taumaka and the Titi Islands) highlights the importance of iwi involvement. The historical significance (e.g. the use of *Lepidium oleraceum* agg. (scurvy grass) by early European explorers) and potential Taonga status of these species (see Objective 3) highlight the role that iwi and the public can take in assisting in the location of new populations and monitoring existing ones. However, their involvement is dependent on the availability of appropriate identification material.

The success of the Tiritiri Matangi Island restoration in the Hauraki Gulf suggests that there is also considerable value in getting iwi and local community groups involved in some coastal cress restoration programmes, especially when they are accessible to major urban centres (e.g. on Rangitoto Island). These plants do have considerable potential in more general conservation education as illustrated by the Auckland Regional Botanical Gardens having developed school educational material based on *Lepidium oleraceum* agg.

There is also an important need to better educate senior conservation managers that threatened plant conservation is a key issue for biodiversity conservation in New Zealand and that the problems facing plants such as the coastal cresses are symptomatic of the problems facing coastal and other ecosystems more generally. The Southland Threatened Plant Garden has been used to train Department of Conservation field staff to identify coastal cresses and similar use needs to be made of all ex-situ collections (see Objective 9).

Plan

Promote the writing of articles for magazines such as New Zealand Geographic and Forest and Bird on the state of coastal cresses and the steps the Department is taking to address these.

Conservancy advocacy staff to utilise local papers to write further about implementation of the coastal cress recovery plan and the way that iwi and local community groups can become involved in coastal cress recovery.

Provide identification material including field guides, fact sheets, brochures and posters to facilitate Department of Conservation field staff, iwi and the general public in identifying these plants.

Work with iwi and the general public to assist them in better understanding the problems these plants are facing and the opportunities for their involvement in their recovery (e.g. through oral presentations and field trips with interested groups).

Develop a general information sheet to provide summary information to senior Department of Conservation managers on the importance of threatened plant conservation and of coastal cress conservation in particular and brief these senior managers on these issues.

Outcome

A better understanding by senior conservation managers and the general public of the problems facing coastal cresses and the steps the Department is taking to address these by (i) presentation of a briefing and information sheet to senior Department of Conservation managers within one year, (ii) preparation of identification material within two years and (iii) provision of ongoing talks and field trips and writing of articles for magazines and newspapers as appropriate.

Key personnel

Advocacy staff in Northland, Auckland, Waikato, Bay of Plenty, East Cape/ Hawkes Bay, Wanganui, Wellington, Nelson/Marlborough, West Coast, Otago and Southland Conservancies, Head Office advocacy staff, and Auckland Regional Botanical Gardens and Southland Threatened Plant Garden staff, with technical input from the Coastal Cresses (Nau) Recovery Group.

Objective 2. Consult with iwi over plan development and implementation.

Explanation

Because of Section 4 of the Conservation Act 1987, the terms of the Ngai Tahu settlement, the Wai 262 claim, the ownership of some coastal cress populations by iwi, and because it is likely that the coastal cresses are Taonga (Objective 3), it is essential that iwi are closely involved in the development and implementation of this recovery plan.

Plan

To closely involve iwi in all stages of plan preparation and implementation. This will be undertaken initially through the Department of Conservation Kaupapa Atawhai Managers network but could also involve briefings for any iwi who might be interested in more detailed information.

Outcome

Active involvement by iwi in all stages of plan development and implementation.

Key personnel

Kaupapa Atawhai Managers in all Conservancies and at Head Office.

Objective 3. **Carry out or promote research on the use of coastal cress species by Maori and on the possibility that some or all coastal cress species may be Taonga.**

Explanation

The Maori name for *Lepidium oleraceum* agg. is nau, a name that has linkages up through the Pacific to Hawai'i. It is reasonable to assume that Maori brought the name to New Zealand and were able to apply it to local cress species. Introduced species of cress (e.g. *Rorippa* and *Barbarea* species) are eaten by contemporary Maori and it may well be that at some stage in the past Maori used indigenous cress species with a subsequent cultural transfer to the introduced species. This possibly took place because the introduced species occurred at a wider range of sites (e.g. inland as well as coastal) and because they were more abundant than the declining indigenous coastal cresses. Because of this historic linkage with Maori it seems important to undertake research on the importance of these plants to Maori and on their possible status as Taonga.

Plan

To carry out or promote research on:

1. The historical use of coastal cresses by Maori.
2. The status of coastal cresses as Taonga.

Outcome

Within five years to obtain a better understanding of the historical use of coastal cresses by Maori and clarification of their status as Taonga.

Key personnel

Kaupapa Atawhai Managers in all Conservancies and at Head Office, and iwi, with technical input from the Coastal Cresses (Nau) Recovery Group as required.

Objective 4. **Carry out or promote research that resolves the taxonomic position of coastal cresses, especially the entities within *Lepidium oleraceum* agg., and resolve relationships within *Lepidium obtusatum* and *Lepidium banksii*.**

Explanation

In order to meet our international obligations under the Biodiversity Convention it is necessary that we have as full a knowledge of our biota as possible. There are still some important unresolved taxonomic issues in the coastal cresses, resolution of which will potentially increase the total number of species present in this group. It is likely that some presently undescribed taxa will be more threatened than the species they are presently included within. Without resolving the taxonomic position of these entities, it is difficult to prioritise their management and we may face the very real possibility that some of these undescribed taxa will become extinct, especially on the Chatham Islands. The key areas that require research are (i) the status of various forms within *Lepidium oleraceum* agg., especially on the Chatham Islands, on islands around Stewart Island and in Foveaux Strait, and on the subantarctic islands, and (ii) the status of *Lepidium obtusatum*, *Lepidium banksii* and related species from outside New Zealand (e.g. *Lepidium foliosum* and *Lepidium nesophilum*).

Plan

To support research on (in order of priority):

1. The status of various forms within *Lepidium oleraceum* agg. on the Chathams, on islands around Stewart Island and in Foveaux Strait, and on the subantarctic islands based on analysis of live collections and herbarium material.
2. The status of the existing named varieties within *Lepidium oleraceum* agg. (var. *frondosum*, var. *acutidentatum* and var. *serrulatum*), and of other variation within *Lepidium oleraceum* agg. based on analysis of live collections and herbarium material.
3. The status of *Lepidium banksii*, *Lepidium obtusatum, Lepidium nesophilum* and *Lepidium foliosum* based on herbarium material and where possible live plants.

Outcome

Resolution of the southern New Zealand *Lepidium oleraceum* agg. complex within three years, and of other variation within *Lepidium* within ten years, in order to better understand the biodiversity of New Zealand coastal cresses and to assist in priority setting for their conservation management.

Key personnel

University of Canterbury (David Norton), Science and Research (Peter de Lange), and Southland and Wellington (Chatham Islands) Conservancies.

Objective 5. Survey all known or suspected coastal cress populations based on recent (< 50 years old) herbarium or anecdotal records or on ecological grounds to ascertain their current status.

Explanation

While an attempt at documenting all known populations of coastal cresses has been made in Appendix 3, the status of many of these is now uncertain as they have not been checked in recent years. This has occurred because the sites are difficult to access, because they are under private ownership, or because no assessment on their abundance or condition has been made. An accurate assessment of the number and condition of all wild populations is an essential component in the recovery of these species and especially for setting priorities for active management work. There is a major funding and resourcing issue associated with undertaking this survey, but without good baseline information it is very difficult to prioritise management actions and hence successfully recover the coastal cresses. Iwi and the general public may be able to assist with survey, especially in situations where suspected or known coastal cress sites are located on private land (e.g. Titi islands). Some coastal cress sites may be Wahi Tapu and there will need to be liaison through Kaupapa Atawhai managers with regard to access to these sites.

Plan

Priority sites for survey should be those with records within the last 50 years or that are strongly suspected as having coastal cress species on ecological grounds. Historical sites (i.e. those older than 50 years) should also be surveyed,

but these can be done as an when the opportunity arises. Each Conservancy with coastal cress species should undertake surveys of all known and suspected coastal cress sites within two years. Visits should be made by staff familiar with these plants and when plants are present a threatened plant survey form (Appendix 4) should be completed with sufficient detail to allow relocation of the site and information on the abundance and health of plants to be assessed. This information should then be summarised for each Conservancy and submitted to the Coastal Cresses (Nau) Recovery Group.

Conservancies involved and cress species present are (species with historical records in brackets):

Northland: *Lepidium oleraceum* agg. and *Rorippa divaricata.*

Auckland: *Lepidium oleraceum* agg. and *Rorippa divaricata* (*Lepidium obtusatum* and *Lepidium flexicaule*).

Waikato: *Lepidium oleraceum* agg. and *Rorippa divaricata* (*Lepidium flexicaule*).

Bay of Plenty: *Lepidium oleraceum* agg. and *Rorippa divaricata.*

East Coast/Hawkes Bay: *Rorippa divaricata* (*Lepidium oleraceum* agg.).

Wanganui: *Lepidium oleraceum* agg. and *Rorippa divaricata.*

Wellington: *Lepidium oleraceum* agg. (*Lepidium tenuicaule* and possibly *Lepidium flexicaule*).

Nelson/Marlborough: *Lepidium oleraceum* agg., *Lepidium flexicaule*, *Lepidium banksii* and *Rorippa divaricata* (also *Lepidium naufragorum* which might be present).

Canterbury: (*Lepidium oleraceum* agg.).

West Coast: *Lepidium naufragorum* and *Lepidium flexicaule.*

Otago: *Lepidium oleraceum* agg. and *Lepidium tenuicaule.*

Southland: *Lepidium oleraceum* agg. and *Lepidium tenuicaule* (also *Lepidium naufragorum* which might be present).

Outcome

Summary information updating Appendix 3 of this recovery plan presented by each Conservancy to the Coastal Cresses (Nau) Recovery Group within two years and publication of a report summarising the current status of all coastal cress species in New Zealand including an assessment of their threat and priority categories within three years.

Key personnel

Biodiversity staff in Northland, Auckland, Waikato, Bay of Plenty, East Coast/ Hawkes Bay, Wanganui, Wellington, Nelson/Marlborough, West Coast, Otago and Southland Conservancies, and the Coastal Cresses (Nau) Recovery Group. Also Kaupapa Atawhai managers, iwi and the general public where appropriate.

Objective 6. Implement management of extant coastal cress populations to sustain them at their current sites with involvement by all interested parties including landowners and iwi.

Explanation

There is evidence to suggest that coastal cresses are declining at a number of sites because of factors such as stock grazing and coastal development/erosion. While severely threatening coastal cresses, these factors can be readily addressed through management and if implemented, such management should assist in avoiding local extinctions in the short-term and allow time to put in place more substantive long-term management solutions (e.g. as a result of Objectives 8 and 10). In some situations, coastal cress sites are on private land and there is little awareness of the issues associated with these species. It is important that the tenure of all coastal cress sites is identified and where possible mechanisms put in place to improve their conservation (e.g. QEII covenants, fencing and new grazing regimes). Implementation of this objective should be undertaken in close liaison with iwi and with private landowners.

This objective is aimed at ensuring the restoration of existing populations and in particular to ensure that there is no further local extinction. Objective 10 discusses restoration of new populations.

For *Lepidium tenuicaule*, restoration of existing populations will need to address the threats facing the turf communities within which this species occurs (e.g. grazing and invasion by exotic grasses).

Plan

Each Conservancy needs to undertake an assessment of tenure of all coastal cress sites, and where appropriate enter into discussions with iwi and private landowners over options for securing the protection of the site and plants present (e.g. through QEII covenants, fencing, etc).

For Otago and Southland Conservancies to establish *Lepidium tenuicaule* management programmes (including restoration and controlled grazing) that assess the influence of invasive species and disturbance associated with grazing and human activities on the establishment, growth and survival of this species.

Outcome

Removal of immediate threats facing coastal cress species within five years either through a change in land tenure or through the implementation of appropriate management actions to secure sites (e.g. through QEII covenants, fencing or a clear understanding with land owners).

Key personnel

Biodiversity staff in Northland, Auckland, Waikato, Bay of Plenty, East Coast/ Hawkes Bay, Wanganui, Wellington, Nelson/Marlborough, West Coast, Otago and Southland Conservancies.

Objective 7. **Establish a detailed monitoring programme that assesses trends in population abundance through time for at least three representative populations of each extant coastal cress species, and for at least three representative populations within each of the six geographical areas that *Lepidium oleraceum* agg. occurs, including suspected undescribed taxa.**

Explanation

Coastal cresses show considerable variation in abundance from year to year, making it difficult to detect underlying longer-term changes in abundance (especially declines in abundance). A high management priority is therefore to establish for a representative range of populations of each coastal cress species monitoring programmes that allow such variation to be assessed. Monitoring is essential for understanding population trends and rates of change, and will more generally assist in assessing the conservation status of coastal cresses.

Because of the taxonomic uncertainties within the *Lepidium oleraceum* agg. complex (Objective 4), it is suggested that more populations be monitored for this group than for the other species. The six geographical areas within which *Lepidium oleraceum* agg. occurs (northern North Island, southwestern North Island, Cook Straight and northern South Island islands, Otago, Foveaux Strait and southern islands, and Chatham Islands) provide a useful framework for this. However, there are almost certainly undescribed species in the Foveaux Strait and southern islands, and Chatham Islands areas and additional monitoring should be undertaken for populations of these entities until their taxonomic status is resolved.

To be effective, monitoring programmes need to be designed so that there is sufficient statistical power to detect changes in abundance. Monitoring also needs to be undertaken at the same time each year in a manner that allows comparable data to be collected at each measurement (see Norton 1996 for more detailed information on monitoring approaches). Monitoring sites should be, wherever possible, reasonably accessible. In the early phases of monitoring (first 2–3 years), monitoring should be undertaken 2–4 times each year where possible, but once a better understanding of the annual dynamics of coastal cress populations has been obtained, monitoring can be reduced to once each year.

Plan

The Biodiversity Recovery Unit (BRU) of DOC is developing a standardised monitoring protocol for threatened plants. The Coastal Cresses (Nau) Recovery Group will develop a coastal cresses monitoring protocol from this which will be made available to all Conservancies to assist in the development of individual coastal cress monitoring programmes.

Conservancy staff should select representative sites for monitoring of each coastal cress species (some coordination for the Coastal Cresses (Nau) Recovery Group is needed to ensure that a nationally representative set of sites are monitored). Monitoring programmes will then need to be implemented based on standard protocols to be developed by BRU.

Outcome

Define standardised monitoring protocol including guidance on site selection within one year and establish all monitoring within three years.

Key personnel

Biodiversity staff in Northland, Auckland, Waikato, Bay of Plenty, East Coast/ Hawkes Bay, Wanganui, Wellington, Nelson/Marlborough, West Coast, Otago and Southland Conservancies, BRU staff, and Coastal Cresses (Nau) Recovery Group.

Objective 8. Carry out or promote research to better understand the ecology of coastal cresses and to develop methods to control the factors that threaten them.

Explanation

While our knowledge of coastal cress ecology and some of the factors that have been involved in their decline is better now than it used to be (e.g. Norton et al. 1997), there is still much that we do not know. A good understanding of ecological processes such as the role of nutrient enrichment in the survival of coastal cresses and information on the prevention, impacts and control of various threats to these species is essential for their successful recovery.

White rust appears to be having a major impact on some coastal cress populations, especially in situations where plants are stressed, and may be a key factor in their decline. Several introduced invertebrate browsers including snails and slugs also appear to be major threats to coastal cresses, especially when rodent control operations have been undertaken as rodents have restricted the abundance of these species. In both situations, we know very little about the impact of pests on coastal cresses or about the best means to prevent the introduction of, or control the impact of these pests. The impact of kiore (*Rattus exulans*) on the coastal cresses also requires investigation, especially if kiore are to be left at some sites for cultural reasons. Such research could be readily undertaken using ex-situ trials.

An association between coastal cress populations and bird colonies has been commented on in several studies, but there has been no experimental research that has attempted to quantify the importance of this link. In fact the only study that has been undertaken on this link more generally was a limited one on *Leptinella featherstonii* (Ibell 1990) that suggested that this species might be dependent on guano for its survival. However, this study lacked suitable replication. What is required is a properly replicated research programme that quantifies the importance of different levels of nutrient enrichment for the growth of different coastal cress species and compares these nutrient levels with those recorded at coastal cress sites in the field.

Plan

To fund/support research on (in order of priority):

1. The development of protocols to prevent the spread of pests including white rust, snails and slugs to coastal cress sites, including quarantine issues.
2. The importance of substrate nutrient levels for the establishment, growth and survival of coastal cresses. This should be undertaken as a glasshouse experiment complemented by field research (see Objective 10).

3. A better understanding of the impact of white rust on coastal cresses including an assessment of the vulnerability of plants under different nutrient conditions and the development of methods to control white rust in the field.
4. A better understanding of the impact of snails and slugs on coastal cresses and the development of methods to control these invertebrate herbivores in the field.

Outcome

Outcomes are dependent on funding, but it is hoped that protocols to limit the spread of white rust and other pests can be developed within two years, and that research on the impacts and control of these pests and on the importance of nutrient levels for coastal cress growth can be completed within five years.

Key personnel

Science and Research (Peter de Lange), University of Canterbury (David Norton), Auckland Regional Botanical Gardens (Steve Benham), Landcare Research, Mt Albert (Eric McKenzie and others) and other research providers.

Objective 9. Establish ex-situ collections of at least three representative populations of each extant coastal cress species, and for at least three representative populations within each of the six geographical areas that *Lepidium oleraceum* agg. occurs, including suspected undescribed taxa.

Explanation

Ex-situ collections of coastal cresses will be an important complement to in-situ field management programmes as they (i) provide a safe-guard against the local extinction of wild populations, (ii) provide a source of plants that can be used for restoration projects, (iii) can play an important educational role, being readily available to the general public, and (iv) provide a source of material for experimental studies. Ex-situ collections are particularly important for educational and research purposes as they provide a source of plants that does not require any impact on wild populations. Ex-situ collections are, however, vulnerable to disease and predators, and also run the risk of hybridisation between different species growing at the same site. Predator and disease issues can be dealt with through appropriate garden management, while hybridisation can be dealt with by having different provenances at geographically separated locations (as Auckland Regional Botanical Gardens presently do for *Lepidium oleraceum* agg. by distributing plants to schools in the Auckland area).

To be effective as a reserve of plants for restoration, ex-situ collections will need to include a range of plants (genotypes) from each species. This should involve at least three genotypes for *Lepidium flexicaule*, *Lepidium naufragorum*, *Lepidium tenuicaule* and *Rorippa divaricata*, all wild populations of *Lepidium banksii*, and a range of genotypes from each of the six distributional regions for *Lepidium oleraceum* agg., ensuring that all undescribed entities are included. It is also important that ex-situ collections are not based in one garden as this reduces the potential effect of a major die-off

should it occur. Present collections of coastal cresses are held by the Auckland Regional Botanical Gardens, Otari Botanical Gardens, Department of Conservation Motukarara Nursery, and Southland Threatened Plant Garden (Appendix 5).

Seed banks and other long-term storage facilities present some very real opportunities for insuring against species extinction. While there are only limited facilities available in New Zealand for doing this, there are an increasing range of options outside New Zealand and some interest has been expressed recently in using coastal cress seeds in cryopreservation trials (Steve Benham pers. comm. 1998). These opportunities need to be followed up.

Plan

To facilitate the establishment of ex-situ collections of coastal cresses by making seed and/or live plants available to three key botanical gardens (Auckland Regional Botanical Gardens, Otari Botanical Gardens, Wellington, and Dunedin Botanical Gardens), and the Southland Threatened Plant Garden and others if material is available, to use as a basis for their collections. Department of Conservation staff will need to liaise with these gardens in setting up their collections and there will be a need for national coordination to ensure that representative collections are established (coordinated by the Coastal Cresses (Nau) Recovery Group). In addition, options for seed bank and cryopreservation storage should be followed up.

Outcome

Establishment of collections of representative populations of coastal cresses in three botanical gardens within five years.

Key personnel

Biodiversity staff in Northland, Auckland, Waikato, Bay of Plenty, East Coast/ Hawkes Bay, Wanganui, Wellington, Nelson/Marlborough, West Coast, Otago and Southland Conservancies, Biodiversity Recovery Unit Staff, Science and Research (Peter de Lange), Auckland Regional Botanical Gardens (Steve Benham), Otari Native Botanic Gardens (Anita Benbrook) and Dunedin Botanical Gardens (Jane Wright).

Objective 10. Establish restoration programmes for all species, where possible integrated with animal control programmes, to increase the number of wild populations and to better understand the factors that limit these species and to develop translocation protocols for restoration programmes.

Explanation

All coastal cresses, except *Lepidium oleraceum* agg., have limited numbers of wild populations remaining, while most populations of *Lepidium oleraceum* agg. are small (< 20 plants; see Appendix 3 for details). Most populations are vulnerable to infrequent but damaging disturbances (e.g. large storms) which could quickly result in local extinction, and in the case of *Lepidium banksii* and *Rorippa divaricata*, could result in complete extinction. Restoration provides a means to increase the total number of populations in the field thus reducing the

chances of extinction. The restoration efforts undertaken by Nelson/Marlborough Conservancy with *Lepidium banksii* are a good example of the benefits of restoration in reducing extinction potential. Restoration can also be tied into the research programme described in Objective 8 to further our knowledge of the optimum conditions for the growth of coastal cresses. Restoration of new sites extends the management initiatives outlined in Objective 6 aiming to enhance existing coastal cress sites.

Restoration of coastal cresses is not necessarily straightforward and needs to be undertaken with a good understanding of the key threats facing coastal cress populations; restoration without addressing these threats is unlikely to be successful. Particular opportunities for restoration occur where rodents and other predators are being removed from islands as it is likely that there will be an increase in the abundance of nesting sea birds in the medium- to long-term. However, changes in the abundance of pests such as snails and slugs in response to rodent removal needs to be factored into coastal cress restoration efforts. Weed management is also likely to be a key issue in coastal cress restoration, both through developing techniques that enable weed competition to be minimised without affecting coastal cress plants and with respect to iwi and public concerns about herbicide use. For *Lepidium tenuicaule*, restoration will need to address the overall turf community.

Translocation protocols also need to be developed, both with respect to what populations should be used as sources for restoring new wild populations and for preventing the spread of unwanted pests and other diseases between sites (see Objective 8). For determining source populations, a good understanding of variation within *Lepidium oleraceum* agg. in particular is required, ensuring that restored populations are the 'correct' provenance for the site.

Lepidium banksii and *Rorippa divaricata* are seen as the highest priorities for restoration, but there are also opportunities for the return of *Lepidium flexicaule* to the Auckland area as recent searches of Rangitoto Island have confirmed that it is no longer present there.

Plan

Biodiversity Recovery Unit are developing a standardised translocation protocol, which will be available to all Conservancies to assist in translocation projects.

For Northland, Auckland, Bay of Plenty, East Cape/Hawkes Bay and Nelson/Marlborough Conservancies to determine appropriate sites for *Rorippa divaricata* restoration and to establish restoration programmes. These programmes should assess the importance of substrate fertility, shade and weed competition on the establishment and growth of this species through appropriate planting design.

For Nelson/Marlborough Conservancy to continue their current programme of *Lepidium banksii* restoration and to utilise further plantings to test for the importance of substrate fertility and wetness on the growth and survival of this species.

For all appropriate Conservancies to put in place restoration programmes for *Lepidium oleraceum* agg. that allow the importance of environmental variables such as substrate fertility, substrate stability, substrate wetness and shade on the growth and survival of this species to be assessed.

For Auckland and Waikato Conservancies to undertake some preliminary restorations using South Island *Lepidium flexicaule* material in order to reintroduce this species to the North Island (perhaps on Rangitoto Island and the Aldermen or Mercury Islands).

For West Coast and Nelson/Marlborough Conservancies to determine appropriate sites for *Lepidium flexicaule* restoration and to establish restoration programmes. These programmes should assess the importance of substrate fertility, substrate stability, substrate wetness and shade on the growth and survival of this species to be assessed through appropriate planting design.

Outcome

Establishment of at least three new *Rorippa divaricata* populations in the next three years and five within five years (one in each Conservancy) as an insurance against local extinction of this species. Continuation of the current *Lepidium banksii* restoration programme to ensure that the current restored sites are sustained for the next five years. For all Conservancies concerned to put forward proposals for restoration of *Lepidium oleraceum* agg. populations as appropriate. For Auckland and/or Waikato Conservancies to establish at least one *Lepidium flexicaule* restoration programme within the next five years.

Key personnel

Biodiversity staff in Northland, Auckland, Waikato, Bay of Plenty, East Coast/ Hawkes Bay, Wanganui, Wellington, Nelson/Marlborough, West Coast, Otago and Southland Conservancies, Science and Research (Peter de Lange), University of Canterbury (David Norton), Auckland Regional Botanical Gardens (Steve Benham), Otari Botanical Gardens (Mike Oates) and Dunedin Botanical Gardens (Jane Wright), and the Coastal Cresses (Nau) Recovery Group.

10.3 COASTAL CRESSES (NAU) RECOVERY GROUP

The Department of Conservation has established a Coastal Cresses (Nau) Recovery Group to oversee and coordinate the implementation of this recovery plan. The membership of this group is described in Appendix 6.

11. Acknowledgements

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Appendix 1

DESCRIPTIONS OF THE INDIGENOUS NEW ZEALAND COASTAL CRESS SPECIES BASED ON WEBB ET AL. (1988) AND GARNOCK-JONES & NORTON (1995)

Lepidium banksii (FIGURE 8)

A perennial, glabrous herb, except for distinctive pale clavate hairs on pedicels and slender hairs on sepals. Stems spreading to erect, stout, barely flexuous, 20–50 cm tall. Leaves similar, oblanceolate-spathulate, sharply and finely serrate, cuneately narrowed to broad flat petiole about the same length as the lamina, 1.5–5 x 0.5–0.8 cm. Racemes terminal on short leafy branchlets, 2–6 cm long; pedicels erecto-patent, 5–8 mm long at fruiting. Flowers small, petals white, narrowly obovate, equalling sepals. Stamens 4. Silique broadly ovate, notched at apex, slightly winged, 5–5.5 x 4–5 mm; style very short; stigma slightly > notch.

Figure 8. *Lepidium banksii* (drawing by Catherine Beard).

Lepidium flexicaule (FIGURE 9)

A perennial prostrate to decumbent herb, 10–25 cm long, finely puberulent. Leaves fleshy, dull green. Basal and cauline leaves often withering at fruiting, obovate to oblanceolate, pinnatifid with 1–3 pairs of pinnae, bluntly toothed or crenate at distal margins, 5–7 x 1.5–2.5 cm. Denticles present along leaf margin. Cauline leaves obovate, oblanceolate or spathulate, bluntly toothed or crenate at apex and distal margins, with triangular denticles on the margins, 1–2.5 x 0.5–1 cm. Racemes 15–40 mm long, terminal and leaf-opposed, rachis and pedicels puberulent or glabrous. Flowers small (2 mm diameter), sepals green, petals equalling sepals, white. Stamens two. Silique broadly elliptic to broadly ovate, style shorter than the notch.

Figure 9. *Lepidium flexicaule* (drawing by Catherine Beard).

Lepidium naufragorum (FIGURE 10)

Perennial herb, with stems ascending to erect, 15–45 cm long, glabrous. Leaves glabrous, fleshy, bright green. Basal and lower stem leaves withering at fruiting, pinnatifid, narrow-oblong to narrow-oblanceolate, 6–12 x 1.5–2.5 cm, pinnae in 3–7 pairs, sharply toothed at apex and distal margins. Middle stem leaves similar, or becoming shallowly pinnatifid, sharply serrate. Upper stem leaves narrow-obovate to linear-oblanceolate, pinnatifid to simple, sharply toothed at apex, 1–5 x 0.2–1 cm. Racemes 30–100 mm long, terminal and axillary, rachis glabrous or sparsely hairy, pedicels sparsely hairy. Flowers c. 3 mm diameter, petals white, slightly longer than green sepals. Stamens four. Silique broadly elliptic, style equal or exceeding the shallow notch.

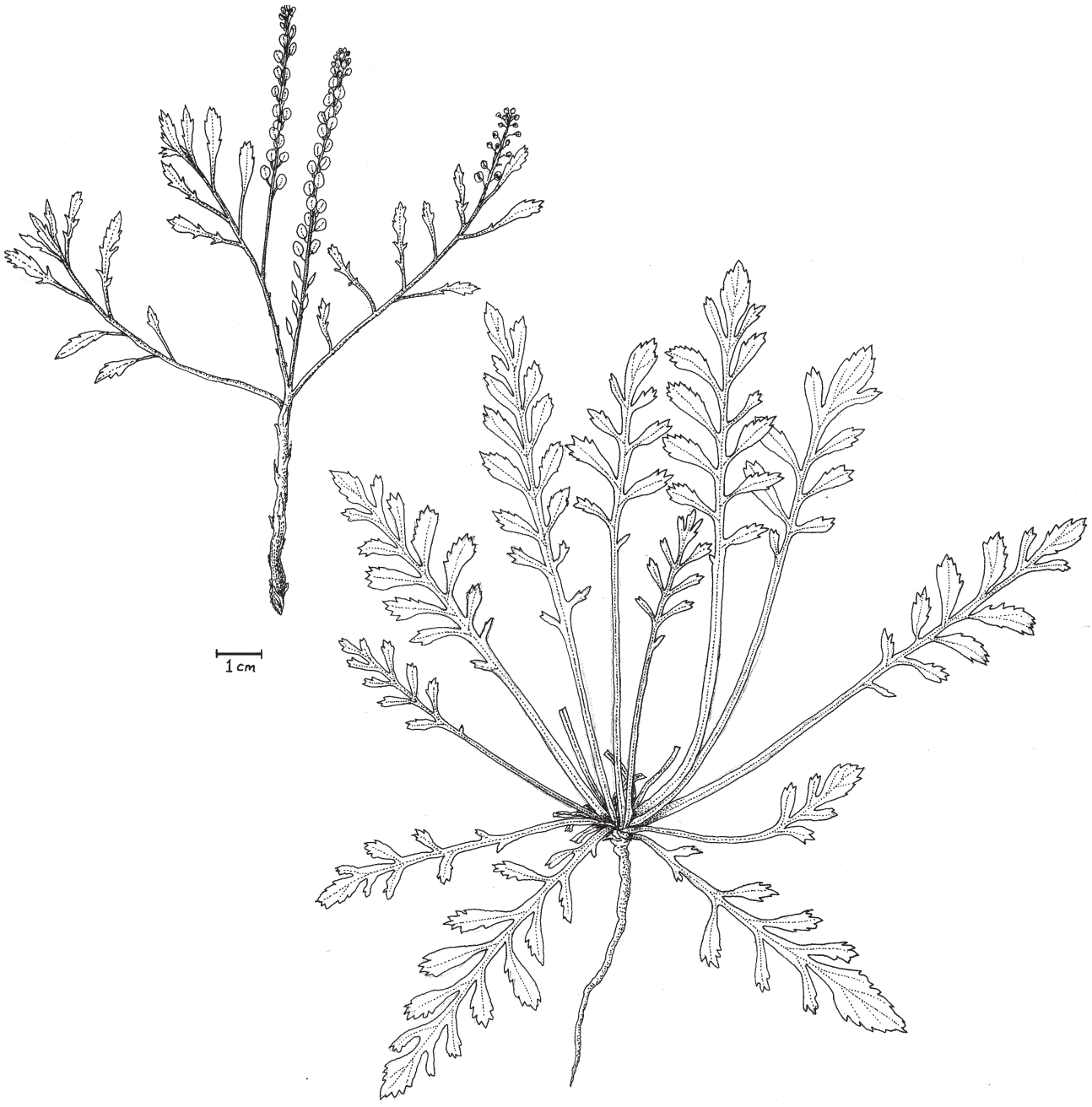

Figure 10. *Lepidium naufragorum* (drawing by Catherine Beard).

Lepidium obtusatum (FIGURE 11)

Glabrous perennial herb with decumbent to ascending stout, flexuous stems, 20–30 cm tall. Leaves all similar, obovate-spathulate, crenate to bluntly dentate. Rosette leaves 3–7 x 0.5–2 cm, cuneately narrowed to broad, flat petiole longer than the lamina. Stem leaves toothed at apex, 1–2 x 0.5–1.5 cm; petiole less than lamina or absent. Racemes terminal on short leafy branchlets, 3–5 cm long; pedicels erecto-patent, 3–5 mm long at fruiting. Sepals c. 1.5 x 0.8 mm. Petals white, obovate, < or = sepals. Stamens 4 or 6. Silicle broadly ovate, shallowly notched at apex, slightly winged, 4.5–5.5 x 4–4.5 mm; style very short; stigma - notch.

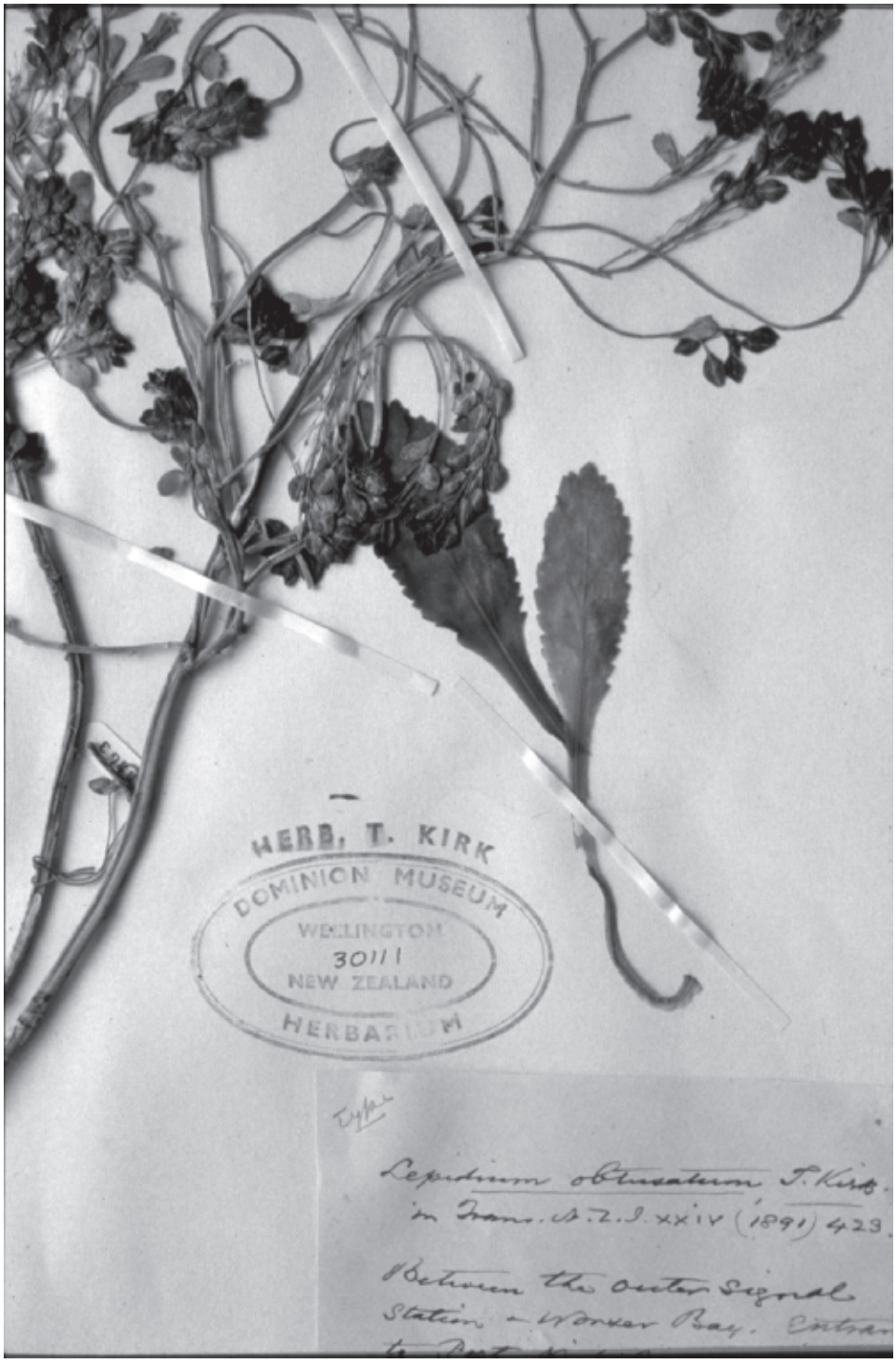

Figure 11. *Lepidium obtusatum* (reproduced from a slide by Jeremy Rolfe).

Lepidium oleraceum agg. (FIGURE 12)

Very variable (between populations) glabrous perennial herbs with decumbent to erect, stout, usually flexuous stems, to 50 cm tall. Leaves similar, narrow-oblanceolate to obovate, evenly toothed in distal portion (although teething varies from almost complete around leaf margin to only a few at the leaf tip), cuneately narrowed to winged petiole at base, bright green, often fleshy, 2–10 x 1.5–4 cm. Racemes terminal and lateral, 5–10 cm long at fruiting; pedicels erecto-patent, 5–10 mm long at fruiting. Sepals 1–1.5 x 0.5–1 mm. Petals white, obovate-spathulate, slightly > to twice length of sepals. Stamens 2 or 4. Silicles broadly ovate, usually truncate at base, acute at apex, not winged, 3–4 x 2.5–3.5 mm; style 0.1–0.2 mm long.

Figure 12. L*epidium oleraceum* agg. (reproduced from Cheeseman1914).

Lepidium tenuicaule (FIGURE 13)

Perennial strongly tap-rooted prostrate herb with glabrous stems 8–15+ cm long. Leaves glabrous or with a few hairs on midrib and margins. Basal leaves persistent, pinnate, 2–10 x 0.5–1.5 cm. Pinnae in 7–15 pairs, acutely toothed. Stem leaves toothed at apex, becoming entire, narrow-spathulate to linear-oblanceolate, cuneate at base, long-petiolate, 5–20 x 2–5 mm. Racemes 5–10 cm long at fruiting; rachis and pedicels glabrous or sparsely hairy; pedicels distant, spreading, 2–4 mm long at fruiting. Sepals sparsely hairy or rarely glabrous, 0.5–1 x 0.3–0.5 mm. Petals usually 0, or white. < sepals. Stamens usually 4. Silicles suborbicular, 1.5–2 x 1.5–1.8 mm; style 0.1 mm long, free from the very narrow wing, - or slightly > the very shallow notch; valves glabrous.

Figure 13. *Lepidium tenuicaule* (drawing by Catherine Beard).

Rorippa divaricata (FIGURE 14)

Glabrous perennial taprooted erect herb, stems to 1 m tall. Leaf margins shallowly dentate. Lower leaves petiolate; petiole winged and expanded into deflexed amplexicaul lobes at base; lamina pinnatifid, 10–16 x 3–7 cm. Upper leaves smaller, linear to lanceolate, simple, cuneately narrowed to expanded amplexicaul base. Pedicels erecto-patent at flowering, spreading at fruiting, 5–12 mm long. Sepals 2–3 mm long. Petals white, c. = sepals. Siliques patent, linear, ± terete, 15–30 x 1–1.5 mm; valves with a weak median vein, or veins 0; style c. 2 mm long. Inflorescence large with branches divaricating.

Figure 14. *Rorippa divaricata* (drawing by Catherine Beard).

KEY TO THE INDIGENOUS COASTAL *Lepidium* SPECIES

(adapted from Garnock-Jones & Norton 1995)

1. All leaves simple, margins toothed or crenate at least at apex 2
   Basal and lower stem leaves pinnate to pinnatifid, lobes toothed or crenate 4

2. Siliques acute at apex, not winged, not notched, 3–4(–5) x 2.5–3.5(–5) mm ..... *L. oleraceum* agg.
   Siliques obtuse at apex, winged and notched, 4.5–5.5 x 4–5 mm 3

3. Siliques truncate to cordate at base; leaves sharply toothed; pedicels with sparse or golden clavate hairs ..... *L. banksii*
   Siliques cuneate to abruptly cuneate at basal leaves toothed to crenate; pedicels glabrous ..... *L. obtusatum*

4. Inflorescences terminal and leaf-opposed by overtopping lateral racemes; stamens 2; leaf margins bluntly toothed or crenate ..... *L. flexicaule*
   Inflorescences terminal and axillary; stamens 4; leaf margins acutely serrate 5

5. Stems prostrate; petals shorter than sepals; siliques suborbicular, 1.5–2 x 1.5–1.8 mm ..... *L. tenuicaule*
   Stems suberect to erect; petals slightly longer than sepals; siliques broadly elliptic, 2.8–4 x 2.3–3.2 mm ..... *L. naufragorum*

Appendix 2

NAMES USED IN INDIGENOUS NEW ZEALAND COASTAL CRESSES

***Lepidium banksii* Kirk (1899)**
Lepidium banksii var. *ovatum* Kirk (1899)

***Lepidium flexicaule* Kirk (1882)**
Lepidium incisum Banks et Sol. ex Hook. f. (1853)
Nasturtium neozelaandicum Kuntze (1891)

***Lepidium obtusatum* Kirk (1892)**

***Lepidium oleraceum* Sparrm. (1780)**
Lepidium oleraceum var. *acutidentatum* Kirk (1899)
Lepidium oleraceum var. *frondosum* Kirk (1899)
Lepidium oleraceum var. *serrulatum* Thell. (1906)

***Lepidium tenuicaule* Kirk (1882)**
Lepidium australe Kirk (1882)
Lepidium tenuicaule var. *australe* Kirk (1899)
Lepidium tenuicaule var. *minor* Cheesem. (1911)

***Lepidium naufragorum* Garn.-Jones et D.A.Norton (1995)**

***Rorippa divaricata* (Hook. f.) Garn.-Jones et Jonsell (1988)**
Cardamine divaricata Hook. f. (1852)
Rorippa stylosa Auct. N.Z. non (DC.) Allan (1961)
Rorippa gigantea Auct. N.Z. non (Hook.) Garn.-Jones (1978)

Appendix 3

PRELIMINARY SUMMARY OF THE SITES AT WHICH COASTAL CRESSES ARE KNOWN OR STRONGLY SUSPECTED TO OCCUR IN WITH AN ESTIMATION OF ABUNDANCE WHERE AVAILABLE

Lepidium banksii

Totaranui: 2 populations of 29 and 13 plants, plus six small populations of 1–6 plants.
Abel Tasman National Park: two island restoration plantings.
Waimea Estuary: restoration plantings at two sites.
Moture Estuary: restoration plantings at two sites.

Overall abundance: 50–60 wild plants in two main sites in one small area of Abel Tasman National Park.

Lepidium flexicaule

Point Elizabeth: 10–20 plants.
Dolomite Point: c. 60 plants in two populations, and a further 5–10 plants along main walking track.
Seal Island: 6 plants
Charleston: 1 or 2 plants (possibly now locally extinct, 1998).
Tauranga Bay fur seal colony: c. 100 plants.
Scotts Beach (rock stack): c. 30 plants.
Scotts Beach (track side—2 sites): c. 145 plants present scattered along track side.
Swan Burn: 13 & 14 plants present in two populations.
Koura Beach: 5 plants.
Te Taitapu coastline (seven sites): 410 plants

Overall abundance: c. 600 plants at 16 sites.

Lepidium naufragorum

Cascade Point: c. 100 plants on small islet.
Taumaka and Popotai, Open Bay Islands: The stronghold of the species where several thousand plants are present.
Arnott Point: 20–30 plants present in two populations.
Knights Point: c. 100 plants present amongst rocks and on adjacent rock stack.
Motukiekie: Several juvenile and adult plants.
Perpendicular Point: c. 5 plants on two ledges in shag colony and 100+ plants on a debris slope in the same area.
Seal Island: Two plants (one a seedling) present at fur seal haulout.
Wall Island, Tauranga Bay: c. 100 plants scattered along edge of taupata shrubland.

Overall abundance: several thousand plants at nine sites, but most at only two sites.

Lepidium obtusatum
No recent records, thought to be extinct.

***Lepidium oleraceum* agg.**
Northern New Zealand including the Waikato coastline:
Macauley Island, Kermadecs: current status uncertain.
Three Kings: 4 plants on Hinemoa and c. 15 on West Island.
Motuopao Island: 20 plants.
Matapia Island, Ninety Mile Beach: c. 100 plants.
Cavallii Islands: no recent records but probably present.
Poor Knights: only one plant seen in 1997.
Mauitaha, Hen and Chickens group; 5 plants present.
Island off Breen Head: 2 plants.
Mokohinau Island
– Fanal/Motukino Island: c. 100 plants.
– Motuharakeke Island: current status uncertain.
– Pokohinu (Burgess) Island: 2 plants 1997.
– Motupapa Island: current status uncertain.
– Stack D, Mokohinau Group: present in 1993, curent status uncertain.
– Hokoromea Island: present in 1993, current status uncertain.
Grey Archipelago, Great Barrier Island; status uncertain but likely to be small.
Rakitu (Arid) Island, Great Barrier Island: present in 1982, curent status uncertain.
Broken Island Group, Great Barrier Island: present in 1985, current status uncertain.
Cape Colville: 2 plants.
Coromandel Islands: perhaps 4–5 plants.
Mercury Group: 5–10 plants.
Ohinau group: 4–5 plants.
Aldermans: current status uncertain.
Rocks around White Island: 3 plants.
Matariki Islands, Manaia Harbour, Coromandel: 1 plant present in 1971.
Motukaramarama (Bush Island), Motukawao: 12–19 plants present in 1983.
Motukorure (Centre Island), Mercury Bay: 7 plants 1989.
Karewa Island off Matakana Island: 6 plants.
Motuputa Island off Motiti Island: 2–3 plants in 1995.
Volkner Rocks: 1 plant 1993.
Champagne Rocks (Crater Bay), White Island: 1 plant in 1990.
Oaia Island, Muriwai: present but numbers uncertain.
Ngatatura Point: 8 plants.

Overall abundance: c. 300 plants at c. 32 sites.

Southwestern North Island
Sugarloaf Islands, New Plymouth; 30–40 plants in several populations plus restoration plantings.
Kapiti Island: c. 35 plants present on stack off Wharekohu Bay.
Mana Island: 7 plants on stack on southeastern side.

Overall abundance: c. 80 plants at 3 sites.

Cook Strait and northern South Island islands

Nukuwaiata, Inner Chetwoods: current status uncertain.
Tarakaipa, Tennison inlet: a few plants present.
Long Island: status uncertain.
Motuara Island: status uncertain.
Kokomohua (near Long Is): not common.
Motungarara: not common.
Taunahaika Island, near D'Urville Is: not common.
Sentinal Rock, north of Chetwoods: not common.
D'Urville Island: status uncertain.
Titi Island: very uncommon.
Stephens Island: abundant.
North Trio: status uncertain.
Duffers Reef (Forsyth Is): status uncertain.
Sout and North Brothers: status uncertain.
Ngurora Is and adjacent island near Kaihoka: uncertain number

Overall abundance: unknown number of plants at 15 sites.

Otago

Matiaha Head: local
Bridge Point: 20 plants
Long Beach: 10 plants.
The Mole: several hundred plants.
Taiaroa Head: 10 plants at two sites.
Submarine Rock: 17 Plants in 1989.
Wharekakahu Island: status uncertain.
Green Island; at least 6 plants present in 1983.
Highcliff: several hundred plants present.
Sandymount: 15 adult plants in 1985.
Nugget Point: status uncertain.

Overall abundance: several hundred plants at 11 sites.

Foveaux Strait and southern islands

Omaui Island: status uncertain
Womens Island: frequent in 1976, curent status uncertain.
Bird Island: scattered plants 1965, curent status uncertain.
Big Island; two plants present in 1995.
Little Moggy Island: c. 100 plants observed 1995.
Kaimohu Island: c. 100 plants observed 1995.
Pohowaitai Island: formed patches in 1965, current status uncertain.
Tamaitemioka Island: formed patches in 1965, current status uncertain.
Poutama Island: occasional plants observed 1965, current status uncertain.
Solander Island: 5 plants observed in1973 not seen since.
Little Solander Island: occassional in 1973, current status uncertain.
Northeast Island, Snares Islands: scattered sites on, 1998.
Antipodes Island: locally common on a single headland, 1998.

Overall abundance: perhaps 200–500 plants at 13 sites

Chatham Islands

Kaingaroa: 2 plants
Kahunene near Waitangi: 10–20 plants
Cape Young: 1 or 2 plants, but possibly gone from this site now.
Tuku-a-Tamatea: status uncertain.
Islet off Point Gap: 2 seedlings
South of Point Gap: 100 plants
Moriori Creek: 2 plants
North of Otawae Point: 1 plant
Otawae Point north side: 20 plants
Otawae Point: 20 plants
Otawae Point soth side: plants present, status uncertain.
Cove north of Kawaki–Waiparua Creek mouth: 6 plants

Rangatira Island—several populations, 100–200 plants
The Sisters: good numbers
The Star Keys: present, status uncertain
The Pyramid: present, status uncertain
Rabbit Island: present, status uncertain
Murumuru: present, status uncertain
Little Mangere: present, good numbers
Mangere Island: several hundred plants
Pitt Island: present status uncertain
South East Island: status uncertain

Overall abundance: c. 200–300 plants on Chatham Island and c. 1000 plants on outlying islands.

Overall abundance for six regions: 2000–5000 plants at c. 75 sites.

Lepidium tenuicaule

Katiki Point (viz Okahau Point): 30+ plants in 1996.
Shag Point: several hundred plants.
Stony Creek: present and can be locally common.
Bobbys Head: 30+ plants in 1996.
Cape Saunders, Otago Peninsula: several hundred plants present at two sites.
Watsons Beach near Quoin Point: Several thousand plants present.
Waipapa Point: c. 500 plants in three subpopulations.
Greenhills, Omaui Peninsula: about 30 plants.
Omaui, adjacent to Omaui Island: 2–3000 plants spread between four sites.
Howells Point, Riverton; c. 50 plants.
Oraka Point, Colac Bay: several hundred plants at five sites.

Overall abundance: 5000–10 000 plants at 11 sites.

Rorippa divaricata

Totaranui: status uncertain
Tutaerere Point, Rakaunui Peninsula, Kawhia: uncommon in 1988, not relocated 1991.
Lake Tikitapu, Rotorua: 2 populations of 10–20 plants present (plus restoration plantings).
Mokoia Island, Lake Rotorua: current status uncertain, not relocated 1996.

Lake Okataina: 6 plants seen in 1998.
Fanal/Motukino Island: 500–600 plants present in 1995, but only one seen in 1997.
Medlands Beach, Great Barrier Island: present in 1989, current status uncertain.
Lady Alice Island, Hen and Chickens group: present in 1980, current status uncertain.
Hen Island: current status uncertain.
Aorangi island, Poor Knights; c. 200 plants present in 1995.
Great Island, Three Kings: one plant present in 1996.

Overall abundance: 800–1000 plants at ?9 sites.

Appendix 4

THREATENED PLANT RECORDING SHEET

Send initially to the Conservancy botanist for forwarding to Landcare Research for entry onto the Department of Conservation/Landcare Research Threatened Plant Database.

<table>
<tr><td colspan="3">THREATENED PLANT SITE REPORT</td><td colspan="2">Threatened Plants Database
Landcare Research
PO Box 69
Lincoln</td></tr>
<tr><td colspan="3">PLANT NAME:</td><td colspan="2"></td></tr>
<tr><td colspan="3" rowspan="2">LOCALITY:</td><td colspan="2">LAND DISTRICT:</td></tr>
<tr><td colspan="2">DOC CONSERVANCY:</td></tr>
<tr><td colspan="3" rowspan="2">HABITAT:</td><td colspan="2">ECOLOGICAL DISTRICT:</td></tr>
<tr><td colspan="2">NEAREST MAJOR LOCALITY:</td></tr>
<tr><td colspan="3" rowspan="2">REMARKS:</td><td colspan="2">LAND TENURE:</td></tr>
<tr><td colspan="2">OWNER/OCCUPIER:</td></tr>
<tr><td>MAP SERIES:</td><td>MAP NO:</td><td>GRID REFERENCE:</td><td>ALTITUDE:</td><td></td></tr>
<tr><td colspan="5">LOCALITY MAP, SKETCH, NOTES (optional):</td></tr>
<tr><td></td><td colspan="2">OBSERVER/SOURCE:</td><td>DATE:</td><td></td></tr>
</table>

Appendix 5

PROVENANCED MATERIAL HELD AND PROPAGATION TECHNIQUES

Provenanced material

Collections of provenanced coastal cress material is held at the following gardens/nurseries:

Auckland Regional Botanical Gardens (correct February 1998):
Lepidium banksii, Totaranui
Lepidium flexicaule, Scotts Beach
Lepidium naufragorum, Open Bay Islands
Lepidium oleraceum agg., Motuopio Island
Lepidium oleraceum agg., Fanal (Motukino) Island
Lepidium oleraceum agg., Matapia Island
Lepidium oleraceum agg., The Mole, Dunedin
Lepidium oleraceum agg., Ngatutura Point
Lepidium oleraceum agg., Stephens Island
Lepidium oleraceum agg., Motukaramuramu Island
Lepidium oleraceum agg., North Matariki Island
Lepidium tenuicaule, Shag Point

Otari Gardens, Wellington:
Lepidium naufragorum, Open Bay Islands

Department of Conservation Motukarara nursery (correct November 1997):
Lepidium oleraceum agg., Otawae Point, SW Chatham Island
Lepidium oleraceum agg., Kaingaroa, Chatham Island
Lepidium oleraceum agg., The Sisters, Chatham Islands

Southland Threatened Plant Garden:
Lepidium banksii, Totaranui
Lepidium flexicaule, ex Shannel Courtney (provenance uncertain)
Lepidium naufragorum, Open Bay Islands
Lepidium oleraceum agg., Ngatatura Point
Lepidium oleraceum agg., The Mole
Lepidium oleraceum agg., Snares
Lepidium oleraceum agg., Antipodes
Lepidium tenuicaule, Waipapa Point

Propagation

Coastal cress species are readily grown from seed but are not suitable for taking cuttings. Unless essential, whole plants should not be removed from the field as the long tap roots makes successful transplanting difficult.

Appendix 6

COASTAL CRESSES (NAU) RECOVERY GROUP

Suzan Dopson (Biodiversity Recovery Unit: Recovery Group Leader)

Bec Stanley (Auckland Conservancy)

Shannel Courtney (Nelson/Marlborough Conservancy)

Brian Rance (Southland Conservancy)

Peter de Lange (Northern Regional Science Group)

David Norton (University of Canterbury)

Kaupapa Atawhai Representative