Biology and ecology of *Senecio glastifolius* and its spread and impacts in New Zealand

SCIENCE FOR CONSERVATION 112

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Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

Science for Conservation presents the results of investigations by DOC staff, and by contracted science providers outside the Department of Conservation. Publications in this series are internally and externally peer reviewed.

ISSN 1173–2946
ISBN 0–478–21830–3

This publication originated from work done under Department of Conservation Investigation no. 2326, carried out by Peter A. Williams (williamsp@landcare.cri.nz), Landcare Research, Private Bag 6, Nelson; Colin C. Ogle (cogle@doc.govt.nz) and Graeme La Cock (glacock@doc.govt.nz), Department of Conservation, Private Bag 3016, Wanganui; and Susan M. Timmins (stimmins@doc.govt.nz) and Virginia Reid, Science & Research Unit, Department of Conservation, PO Box 10420, Wellington. It was approved for publication by the Director, Science & Research Unit, Science Technology and Information Services, Department of Conservation, Wellington.

Cataloguing in Publication

Biology and ecology of Senecio glastifolius and its spread and impacts in New Zealand / P.A. Williams ... {et al.} Wellington, N.Z. : Dept. of Conservation, 1999.
1v. ; 30 cm. (Science for conservation, 1173–2946 ; 112.)
Includes bibliographical references.
ISBN 0478218303
1. Senecio glastifolius. 2. Invasive plants–New Zealand. I. Williams, P. A. (Peter Arthur), 1945– II. Series: Science for conservation (Wellington, N.Z.) ; 112.
583.55 20
zbn99-040067

CONTENTS

Abstract

Senecio glastifolius is a tall perennial herb from South Africa. The history of introduction and spread, biology, ecology, and impacts of *S. glastifolius* in New Zealand are summarised. It was first recorded wild in 1963 and for several decades it remained largely confined to a few ruderal sites near Gisborne and in the southern North Island. However, it now occupies a wide range of mostly coastal sites, especially from Wellington to Wanganui, where in recent years it has begun to spread dramatically along the coast. On highly modified coastal sites it has little interaction with indigenous vegetation. In contrast, where *S. glastifolius* is invading native species in habitats such as dune slacks it should be controlled as part of a site-led weed control program. All plants beyond its present range should be eradicated as part of a weed-led control program to prevent further spread of the species.

1. Introduction

Senecio glastifolius (holly-leaved senecio), a naturalised large perennial herb from South Africa, has been spreading rapidly along coastal areas south of Wanganui in the past decade. The Department of Conservation requested a study of the species to predict its likely impact on ecological values in this region and elsewhere in New Zealand. A study of the biology and ecology of *S. glastifolius* was carried out by staff from Landcare Research, Nelson, and the Department of Conservation (DOC) between October 1997–May 1998. This report summarises what is known about *S. glastifolius* in New Zealand and elsewhere in the world.

2. Objectives

1. To review the biology and ecology of *Senecio glastifolius* in its native range and the rest of the world.
2. To make predictions about its possible impacts and future spread.
3. To recommend control measures.

3. Methods

Information was obtained from international literature, South African herbarium records, and requests to colleagues in New Zealand and overseas. During 3 days in October 1997 we visited several North Island areas where *S. glastifolius* is conspicuous, both on and off land administered by DOC. Brief notes were taken on the composition of the associated vegetation, the nature and extent of the *S. glastifolius* infestation, and on the biological characteristics of *S. glastifolius*. Similar observations were made in other areas of New Zealand when *S. glastifolius* was encountered in the course of other activities.

Observations were made of *S. glastifolius* plants at Pukerua Bay near Wellington to determine their pattern of growth. Germination tests were undertaken on seed collected from these plants and from plants near Motueka.

4. Results and Discussion

4.1 TAXONOMY AND DESCRIPTION

Senecio glastifolius L. is a member of the Asteraceae family and belongs to the large group of senecios with prominent radiate capitula. It is a stout perennial (sometimes annual) with stems 1–1.5 m tall, and occasionally up to 2 m tall. The main stem, before it branches, can be 8 cm in diameter at the base of large plants. All stems produce flowers on widely spaced branches. Plants can be 0.5 m wide.

The obovate-elliptic leaves are serrate and amplexicaule, and often coarsely toothed at the base. They decrease in length from 10–15 cm at the base to 3–5 cm near the top of the stems and they also become less serrate.

The capitula range from 2–3 per plant to several hundred arranged in loose corymbs on a typical plant. These have supplementary bracts 3–5.5 mm long. The capitula have 19–23 narrow-oblong to linear involucral bracts 6–9 mm long. There are 12–22 ray florets, 12–25 mm long, that range in colour from purple to nearly white. The disks are yellow. The c. 2.5 mm long achenes are round in cross-section and either glabrous or hairy. The pappus is 7–9 mm long and seeds are 2 mm long (Webb et al. 1988).

In South Africa *S. glastifolius* is known as 'large senecio' in English and 'waterdissel' in Afrikaans. In New Zealand its common name is 'holly-leaved senecio' although it has also been referred to as 'pink ragwort' because of its relationship to the better known *Senecio jacobaea* (ragwort).

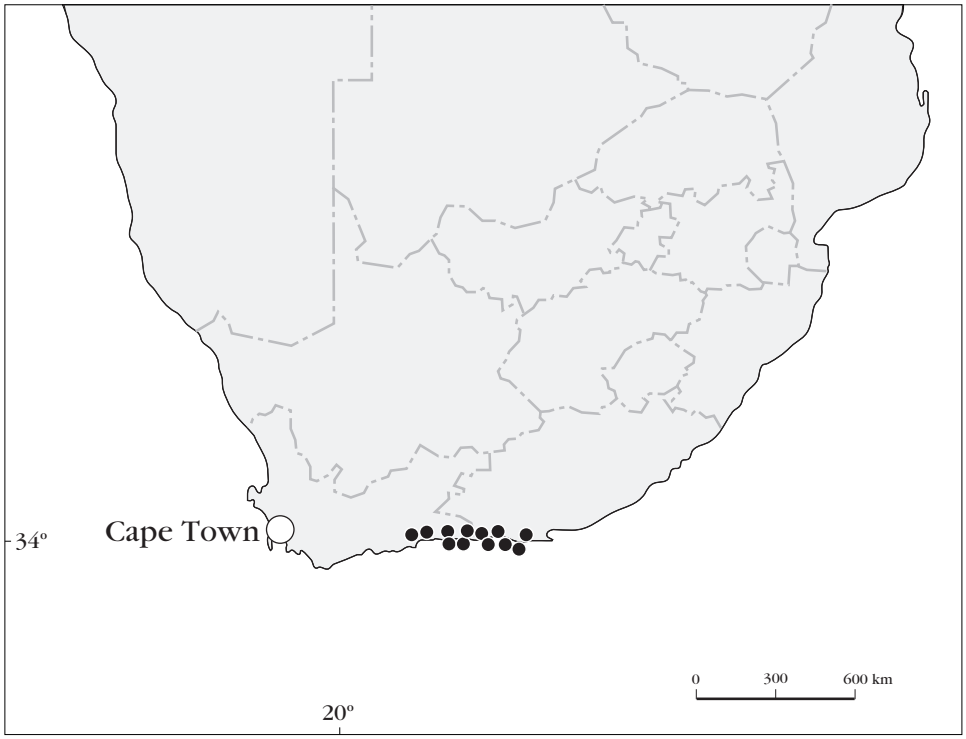

Figure 1. Distribution of *Senecio glastifolius* in its native environment of South Africa.

4.2 HISTORY AND DISTRIBUTION

4.2.1 Native range—South Africa

Senecio glastifolius is confined to a narrow coastal strip of the Cape region along latitude 34° 00' S, and between longitude 21° 00' and 26° 00' E (Figure 1).

4.2.2 New Zealand

Webb *et* al. (1988) record that *S. glastifolius* was first collected in New Zealand in 1969 but there are collections from Gisborne dated 1963 (e.g. CHR 186241). In the late 1980s its North Island distribution was Gisborne, Havelock North, Mana Island, and in the vicinity of Wellington city, and collections had been made from Motueka and Christchurch in the South Island (Webb et al. 1988). It has not been recorded in northern New Zealand nor, apparently, south of Christchurch (Figure 2). Its manner of introduction into New Zealand is unknown, and it appears never to have been offered for sale in nursery catalogues (R.B. Allen, pers. comm.). Significantly, it is not included by Williams and Timmins (1990) in a review of the weeds of conservation land, nor by Johnson (1997) in a very wide ranging account of the wild flowers of New Zealand. Johnson travelled throughout both the North and South Islands in the late 1980s to early 90s, yet he has never seen the plant (P.N. Johnson, pers. comm.). Neither was it recorded during a survey of all North Island sand dunes conducted in the mid-1980s, although the related and similarly red-to-purple flowered adventive, *Senecio elegans*, was widespread (Partridge 1992).

The first major New Zealand colonies were probably in the Tawa-Linden area of Wellington, where herbarium records show it began to spread rapidly in the late

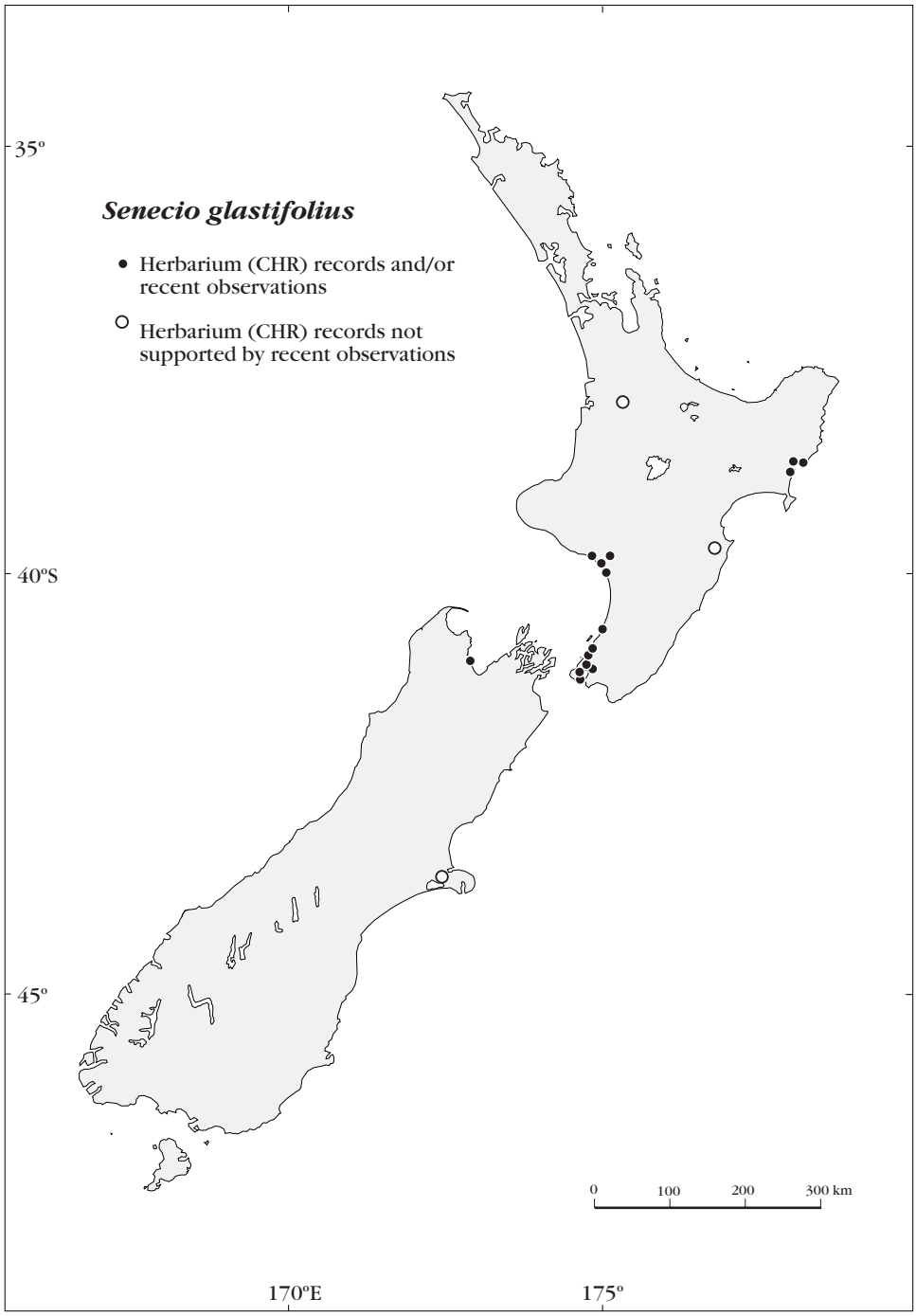

Figure 2. Distribution of *Senecio glastifolius* in New Zealand.

1960s. At the same time, it was also recorded as abundant up to c. 230 m.a.s.l. at one locality near Island Bay on the Wellington south coast. It is now particularly abundant on motorways and hillsides in the general region of Wellington–Plimmerton. The spread of *S. glastifolius* was first recorded from the western North Island at Wanganui in 1990. It is now abundant north and south of the Wanganui river mouth, and appears to be spreading rapidly, e.g. it was absent from the dunes at Castlecliff, Wanganui, in 1994, but is now present there and is common on disturbed land throughout the Wanganui Region (see Appendix 2). It is scattered intermittently down the western seaboard of the southern North Island in localities such as Waikanae (See photos 1 and 2, p. 23).

An early outbreak at Gisborne came from a nursery from where it established on adjacent wasteland, but this founder population subsequently died out (B. Clarkson, pers. comm.). Recent observations in and near Gisborne show the species is still abundant on a hillside close to the city, as well as sparingly on the coast. There is a single record of it in Hamilton city. It appears to be absent north of Wanganui on the west coast and north of Gisborne on the east coast.

The first South Island record of *S. glastifolius* was from an embankment near Motueka in 1970 when there were about 100 plants. This population exists today in similar numbers. A single herbarium specimen indicates *S. glastifolius* was present at one site on the Port Hills, Christchurch, in 1977, but it has not been seen in the region in recent years (M. Newfield pers. comm.).

Senecio glastifolius was not recorded as a weed in any DOC conservancies by Owen (1997), even amongst species listed but not considered significant enough to include in this database.

4.2.3 Rest of the world

As far as can be ascertained from floras and contacts throughout the world, Australia is the only other country where *S. glastifolius* has become naturalised. It is a localised weed around Albany, about 400 km south of Perth (Hussey et al. 1997), where it is spreading very aggressively into *Banksia* woodland and coastal shrubland on deep sands in this area. It is regarded as potentially a very serious weed in the higher rainfall (1000–1400 mm) areas of Western Australia from Busselton to Albany. The local authorities in the area have commenced a control programme (G.J. Keighery pers. comm.). It is not known as a weed anywhere else in Australia.

4.3 HABITAT

In South Africa *S. glastifolius* grows on rocky hillsides with fynbos (fine bush, a type of heathland) and karroid scrub, streambanks and marshy ground. Although a native species, *S. glastifolius* is listed as a problem plant in South Africa (Wells et al. 1986). It occurs naturally in pastoral areas, is abundant on old burn sites, a troublesome weed in newly planted plantations and a general ruderal and agricultural weed (Anon n.d., Wells et al. 1986).

An analysis of 50 herbarium records from the National Botanical Institute, Cape Town, shows that *S. glastifolius* grows between 18 and 330 m above sea level (average 132 m a.s.l.). Twenty-three records had information on habitat with the following frequency of key word groupings: fynbos 9; riparian/wetland 6; shrubs and shrubland 5; railway/roadsides 5; sand/rock 2; herbfields 2; plantation 1; disturbed 1. These data suggest that *S. glastifolius* grows in sites ranging from dry shrubland to moist herbfield of riparian zones, as well as ruderal habitats associated with transport. It occurs in disturbed bare areas, and is strongly associated with sparsely vegetated sites.

Observations made throughout the New Zealand range of *S. glastifolius* are presented in Appendix 1 (p. 18) and summarised, where appropriate, in the following sections.

4.3.1 Climatic requirements

In South Africa it is described as growing in areas with temperate climates and either winter or all-year-round rainfall (Wells et al. 1986). It is wind resistant and can grow in full sun to light shade (Anon n.d.).

In New Zealand, *S. glastifolius* grows mainly at or near sea level, or within 20 km of the coast up to 60 m. a.s.l. Its distribution covers 4 of the 15 climate districts of New Zealand (Wards 1976); these have a mean annual temperature range of 10–15°C and a mean annual rainfall of between 800–1600 mm.

4.3.2 Substrate

In South Africa it grows on 'terrestrial dry' and 'terrestrial wet' substrates (Wells et al. 1986), and in Australia on nutrient-poor deep sandy soils.

In New Zealand, *S. glastifolius* grows on rocky banks with only interstitial soil, coarse river gravel, coastal scree, sandy substrates ranging from raw sand to zonal yellow-brown soils, and yellow-brown earths, and often colonising the exposed regolith. Evidence from South Africa and Wanganui suggests it has some tolerance of high soil moisture, at least for limited periods, and grows successfully in sand dune swales, *sensu* Esler (1978), and swamp margins. It is unlikely to tolerate permanently saturated soils.

4.3.3 Plant communities in New Zealand

The most comprehensive data with which to define plant communities associated with *S. glastifolius* in New Zealand are the unpublished plant lists of CCO and the Wanganui Botanical group. These show that *S. glastifolius* is primarily a plant of partially stabilised sand dunes and other coastal sites. The main larger accompanying species are marram grass (*Ammophila arenaria*) on unstable soils and tree lupin (*Lupinus arboreus*) on more stable sites. Associated species include herbs, of which the majority are adventive, e.g. *Briza major* (hare's tail), *Crepis capillaris*, *Lagurus ovatus*, several species of *Medicago* and *Plantago*, and *Pennisetum clandestinum* (kikuyu grass). The smaller *Senecio elegans* which also has bright purple-red flowers, is often common. There are very few native herbs or shrubs on these semi-mobile and undulating deposits, apart from *Ozothamnus leptophyllus* (tauhinu), *Coprosma acerosa*, with some *Spinifex sericeus, Isolepis nodosa* (club rush), *Lachnagrostis billardieri*, *Calystegia soldanella*, *Pimelea arenaria* and *Desmocheonus spiralis* (pingao).

On sand dune swales or plains towards the rear dune systems, *S. glastifolius* may be sufficiently common to form dense patches. Floristic diversity is higher in these situations because of the greater moisture. The exotic *Lupinus arboreus* (tree lupin) is often conspicuous away from the dampest patches, while other tall plants include the natives *Phormium tenax* (flax), *Leptocarpus similis* (jointed rush) and *Isolepis nodosa*, with adventive grasses and broad-leaved herbs again very numerous. These sites often have a greater number of native species such as *Calystegia soldanella*, *Hydrocotyle novae-zeelandiae*, *Lobelia anceps,* and *Samolus repens. Senecio glastifolius* also has some capacity to tolerate salt as indicated by its association with *Leptocarpus similis* and its proximity to sea water at Motueka and Whitiau.

In their least modified form, these coastal sites harbour native taxa with very limited ranges. This situation is best represented by the Whitiau Scientific Reserve near Wanganui where there are several taxa which are listed on the official New Zealand Threatened Species list (Cameron et al.1995); e.g. *Sebaea ovata* (critical), *Selliera rotundifolia* (endangered), *Mazus novaezeelandiae* and *Isolepis basilaris* (vulnerable), and local forms of *Libertia peregrinans* and *Pimelea arenaria.*

There are also extensive populations of *S. glastifolius* south of Pukerua Bay, Wellington, on very steep coastal hills where it grows widely scattered in rough grassland with *Muehlenbeckia complexa* (pohuehue) and *Coprosma propinqua* (mingi mingi). It appears to have a particular affinity for the open areas of scree and bare ground between the shrubs. Native plants include scattered shrubs or stunted trees of *Coprosma repens* (taupata), *Melicytus ramiflorus* (mahoe), *Macropiper excelsum* (kawakawa), and *Phormium cookianum* (mountain flax). There are a few native herbs such as *Senecio lautus*, *Tetragonia trigyna* (native spinach), and ferns, e.g. *Asplenium oblongifolium, Phymatosorus pustulatus* and, less commonly, *Cheilanthes distans*, *C. humilis* and *Pellaea calidirupium*. The last three are particularly vulnerable to shading by the invasion of *S. glastifolius*.

Senecio glastifolius is perhaps most conspicuous to the casual observer where it grows on road cuttings and banks throughout the greater Wellington area. *Ulex europaeus* (gorse), *Cytisus scoparius* and *Chrysanthemoides monilifera* (boneseed) are common associated species on sites stable enough to support woody plants. Native woody species such as *Hebe stricta* (koromiko) and *Melicytus ramiflorus* are occasionally present. Adventive grasses such as *Dactylis glomerata* (cocksfoot), *Bromus* spp., and *Ehrharta erecta* (veld grass) are common, with broad-leaved herbs such as *Centranthus ruber* (spur valerian) on very rocky sites and *Foeniculum vulgare* (fennel) on areas with deeper soil.

The one recorded site of *S. glastifolius* on coarse alluvium also had numerous adventive herbs, especially legumes (*Medicago*, *Melilotus*, *Trifolium*) but there were no native plants.

Only rarely does *S. glastifolius* cover whole hillsides as it does at Kaiti Hill near Gisborne or Ivey Bay in the Porirua Harbour. This latter site was seen only from a distance but *S. glastifolius* appeared to cover hundreds of square metres in what, we were informed, was a recently felled pine plantation.

In the South Island, at Motueka, *S. glastifolius* grows amongst *Dactylis glomerata*, *Festuca arundinacea* (tall fescue), *Crepis capillaris* (hawkebeard) and other roadside weeds on the sides of an embankment forming a causeway across an estuary.

4.4 REPRODUCTION, DISPERSAL, AND GROWTH

Senecio glastifolius reproduces by seed from flowers produced over a short period in October. A few plants have a second, smaller burst of flowering in January/February which set seed in March. Occassional small (<10 cm) plants have been found in flower when growing on the most harsh sites such as the

dunes at Wherowhero near Gisborne, but it is unknown whether these plants produce viable seed. Within many populations, flower colour is variable across a range of pinks and mauves, but there does not appear to be any environmental or regional pattern to the variation.

Seeds measure approximately 2.0 x 0.6 mm in size and samples from Motueka and Pukerua Bay weighed 0.8 mg and 0.6 mg (air dried) respectively. Simple germination tests were carried out on these seeds in the laboratory, Nelson, at room temperatures, over January to March 1998. Germination began after 6 days, and continued intermittently over a further 69 days, when observations ceased. Total germination for the period was 80% for Pukerua Bay seed and 53% for Motueka seed. The latter seed may have been affected by sea spray. Similar results have been achieved in South Africa (Anon n.d.) Pulses of germination appeared to occur when room temperature was above 25°C, indicating that relatively high temperatures are required for maximum germination. New seedlings appeared in one of seven cleared plots at Pukerua Bay; germination occurred in late February. These seeds probably came from the current year's flowering. Subsequently, abundant seedlings appeared at this site in the warm wet winter conditions of July/August 1998. This provides some evidence for a persistent soil seed bank.

New stems are produced in the axils of the previous year's flowering stems, while the withered flower stalks tend to remain attached on plants growing in sheltered situations. Some plants carry two 'layers' of these old heads beneath the current flowers. Individuals are likely to be a minimum of 3 years old and are possibly 4 years old. There is no evidence for plants older than 4 years.

Seedlings are commonly found aggregated on bare ground in canopy openings amongst taller vegetation or around the immediate margins of bushes where grass growth is suppressed. Populations differ in their size class distribution, thus some are even-sized (aged?) while others have individuals of all size classes present. At any one site, therefore, establishment can be continuous over a period or, apparently somewhat synchronous.

Once they have flowered two or three times, individual plants become rather top heavy and tend to fall over, especially if they have produced large corymbs or are in exposed situations. The break point is usually at the junction of the root and the stem, at or near ground level. Fallen branches may remain attached and continue to grow. However, resprouting is variable, and no evidence was seen of synchronous death in large patches. At Pukerua Bay, a few plants that appeared to have died after flowering subsequently sprouted new shoots in February–March (1998).

Senecio glastifolius stems may occasionally form roots where they lie horizontally, or nearly so, in contact with the soil. Vegetative reproduction or a vegetative response to damage is, however, not a significant method of spread or persistence.

4.5 ECOLOGICAL IMPACTS

At the early stages of invasion one can only speculate on the likely impacts of an invasive species such as *S. glastifolius* which has not been studied elsewhere in the world. Currently over most of its range, the most obvious impact of *S. glastifolius* in New Zealand is aesthetic—it is a spectacular plant. But whether it does or will have any obvious impacts such as pre-empting sites where native species might otherwise establish, or invading and displacing native species, seems to depend on site factors.

Where it grows on anthropogenic sites such as motorway batters or ruderal areas with no native plants in the vicinity to colonise the site, *S. glastifolius* has no immediate on-site ecological impact. In other situations it appears to be the latest of a suite of adventive plant species invading areas with only some degree of naturalness, such as sand dunes already invaded by *L. arboreus* (lupins). It would appear to be having little or no additional impact on native biota in these sites either. However, such populations can still be the seed source for more valued habitats with native species within the dune systems, such as the sand swales or plains. In these sites, *S. glastifolius* appears to represent the penetration of a significant new plant growth form and a significant threat to native species. While many of these sites are also invaded by *L. arboreus* and most have a wide assemblage of adventive herbs, the tall herbaceous life form of *S. glastifolius* and the shading it can cause is a new threat to the small low-growing native shrubs and herbs characteristic of such sites (Esler 1978). Part of the threat from *S. glastifolius* comes from its apparent ability to withstand periodic poor drainage.

Some coastal cliff communities also have a high proportion of cover contributed by native plants, and the presence of *S. glastifolius* may possibly be disruptive to natural processes by both pre-empting establishment sites and by displacing small low-growing herbs and ferns.

Nothing is known about the interaction of *S. glastifolius* with native invertebrates but its leaves are eaten by the larvae of the native magpie moth (*Nyctemara annulata*). Also, the diurnal moth *Aglossa cuprealis* has been recorded feeding on the flowers (Patrick 1992). *S. glastifolius* appears to be palatable to sheep.

4.6 MANAGEMENT AND CONTROL

We are aware of only two attempts at control of *S. glastifolius* in New Zealand. In sand dune country near Wanganui DOC has used volunteer labour each October since 1995 to hand pull or cut all conspicuous plants (see Appendix 2, p. 21). On Mana Island, to the west of Wellington, where *S. glastifolius* is occasional and scattered, DOC staff pull and remove every *S. glastifolius* plant they see. These methods are obviously labour intensive, but they appear to be effective on the plants actually treated. The success of such methods is dependent on repeated efforts. Not only are adult plants ocasionally missed, but young plants that remain are likely to begin seeding within 12 months. Although a persistent soil seed bank appears unlikely, buried seed may be a problem.

4.6.1 The future?

Weed invasions can be seen as progressing through a series of phases as a species spreads to occupy the available space. This process can be examined at different scales. For example, on the Wellington motorway batters where it has been for 30 years, and in small areas in the Wanganui dune systems, *S. glastifolius* appears to be well established and perhaps to have reached its maximum density, provided the current intensity and frequency of disturbance remains similar to that at present. These areas of *S. glastifolius* can be considered to be at the entrenched phase where control can only be justified on a site-led basis, i.e. where there are significant natural values that warrant protection. Looking at the pattern of distribution of *S. glastifolius* on a wider scale, there are areas where it has expanded rapidly in recent decades; in particular, the coastal shrub-grasslands in the vicinity of Pukerua Bay.

Nationally the situation is much less advanced. *S. glastifolius* tolerates a wide range of substrates and moisture conditions and there would appear to be vast areas of suitable habitat still remaining in New Zealand. For example, the cliffs of Pukerua Bay do not differ substantially from those elsewhere in the Marlborough Sounds-Wellington Ecological region, and in the absence of sheep grazing, there is nothing to suggest *S. glastifolius* will not eventually occupy parts of all these cliffs. The spread of *Chrysanthemoides monilifera* to such habitats over recent decades, most recently and spectacularly on the Port Hills of Christchurch, is an example of a more advanced invasion of an adventive species on coastal sites. To prevent these and similar habitats being invaded by yet another weed, when *S. glastifolius* reaches regions from which it is presently absent, a weed-led approach is perhaps justified. That is, infestations should be removed as soon as they are discovered.

5. Conclusions

Senecio glastifolius has been naturalised in New Zealand for three decades. The range of sites it occupies appears similar to those of its native range in South Africa, but at lower altitudes and often on sandier soils. Over the last 20 years it has begun to spread more rapidly in some areas, notably Wellington and Wanganui, and perhaps more slowly at Gisborne. As with most weed invasions, the damage caused by the spread of *S. glastifolius* is largely undefined. Clearly it is not a problem on ruderal sites like road cuttings and where it invades habitats already severely modified by adventive plants. However, where areas of sand dune country are being invaded, already threatened native taxa are compromised by *S. glastifolius*. Different approaches to the control of *S. glastifolius* are needed throughout its range (Williams 1997).

- *S. glastifolius* should be controlled on sand dune and similar sites as part of a site-led weed control program.
- All plants beyond its present range should be eradicated as part of a weed-led control programme to prevent further spread.

6. Acknowledgements

The University of Cape Town, South Africa, provided herbarium records. R. Halsey, R. Stone, R. Lythgoe and W. Beggs of Wanganui Conservancy, DOC, supplied information. Bill Lee made helpful comments on a draft. Thomas Pearson prepared the figures and Wendy Weller did the final word processing.

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Appendix 1.

SITE FACTORS AND VEGETATION ASSOCIATED WITH *Senecio glastifolius* (SG).

Appendix 2.

Senecio glastifolius CONTROL AT WHITIAU SCIENTIFIC RESERVE, WANGANUI

Colin Ogle and Graeme La Cock, Department of Conservation, Wanganui.

Systematic control of *Senecio glastifolius* in the 250 ha Whitiau Scientific Reserve began in October 1995 using a range of methods and intensities of effort.

Plants were pulled by hand at the height of the flowering period when they are easiest to find. They were discarded where they were growing. Once the parent plants have been killed, observations suggest the flowers do not go on to form viable seed. Several excised flowering plants layed onto seed trays did not produce seedlings, but this needs to be verified under controlled conditions.

A trial was also done on cutting plants with loppers just above ground level (R Halsey, pers. comm.). The bases of the plants were not treated chemically after cutting and none of the 40 plants resprouted.

In about 5 hours, a team of 30 volunteers hand-pulled all plants found over about a quarter of the reserve (R Stone, pers. comm.). Subsequently, a similar group covered much of the remaining area of Whitiau Scientific Reserve in 2 days. About 90% of the reserve was covered again in October 1997, which took about 60 person-days. Most flowering plants were removed but many young plants were missed. Estimates of the time taken to control *S. glastifolius* at Whitiau Scientific Reserve are provisional because of the variation in physical fitness and enthusiasm among the workers.

To quantify the proportion of plants being pulled three transects were set up in dense infestations on three different types of terrain: (a) open flat areas between dunes, (b) undulating terrain on the face of a large dune, and (c) on undulating terrain away from the dunes. The transects were monitored 1 month later. In (a) where plants were easy to find, only 1 plant (15 cm tall and not in flower) of the original 70 was found. In area (b), 22 of the original 45 plants were not pulled, 3 of these were in flower. In area (c) 6 plants out of the original 64 remained. All had flowers. The large variation in results suggests plants are easiest to see and pull on gentle topography, although overall, few large flowering plants were missed.

The height and position of the plants remaining in these re-surveys was recorded for further observations. In addition, a trial covering two 10 x 10 m plots was established to record the relatively efficiency of cutting versus pulling and this will be reported on at a later date.

Photo 1 (above). *Senecio glastifolius* invading a coastal wetland area. Turakina Beach, south of Wanganui, October 1997. *Photo: P.A. Williams.*

Photo 2 (right). *Senecio glastifolius* invading a coastal cliff community. Pukerua Bay, Wellington, October 1997. *Photo: P.A. Williams*.