WEEDS AND INDIGENOUS BIODIVERSITY OF THE MANAWATU-WANGANUI SAND COUNTRY

Colin C. Ogle
22 Forres Street, Wanganui
Email: robcol.ogle@xtra.co.nz

Introduction

In my paper at the CDVN conference last year (Ogle 2001) I used the term 'sand country' to include all land derived from moving sand, including elevated dunes and the land of low relief between the dunes – sand plains, swamps, and lakes. Biodiversity in sand country at the ecosystem level includes grasslands, sedgelands, rushlands, herbfields, shrublands and forest. Sand country from near Patea in the north to Paekakariki in the south has been defined as Foxton Ecological District (FED) (McEwen 1987; Ravine 1992). At its inland limits, sand abuts elevated marine terraces (Manawatu Plains ED) where it often impedes drainage. Wetlands are common along this boundary.

New Zealand's sand country is home to numbers of threatened plant species, many of them found in no other habitats. Twenty-three species with a nationally threatened or uncommon status are present, or are known to have occurred in the past, in sand country between the Manawatu River and South Taranaki. For a whole range of habitats, usually unspecified, it has been widely accepted that weeds are a major cause of decline of indigenous species that have a threatened or uncommon status (Williams & Timmins 1990, 1999; Polly & West 1996; Buddenhagen et al. 1998, Reid 1998; Dopson et al. 1999). Of species classified as threatened in the Department of Conservation's priority categories A and B (Molloy & Davis 1994), it was calculated that 57% (59 species) were threatened by weed encroachment (Dopson et al. 1999). Quantitative studies of weed impacts on indigenous sand country ecosystems and species are lacking, although there are data already that might be useful in such work.

As the importance of protecting indigenous biodiversity becomes accepted, exotic plants are becoming recognised as undesirable in sand country, especially in important reserves and other natural areas. Many lists have been made of plants in various parts of FED and some of these include adventive species, i.e. plants foreign to the area that are self-establishing, which many people would call weeds. Obviously some adventive species are far more common and widespread than others. Various classifications of adventive plants have been published, such as Heenan et al. (1998) who distinguished between fully naturalised and casual weeds. Casual weeds were further divided into garden escapes and garden discards.

In this paper, I will limit my discussion geographically to that part of FED that lies north of the Manawatu River. The total area of indigenous vegetation on this sand country is small and fragmented but it still contains considerable biodiversity at both the species and ecosystem levels (Ogle 2001).

Threatened plants of Foxton Ecological District (FED)

Nationally threatened and uncommon plant species occur at a number of places in FED, although some have become extinct within the past several decades from some places (Table 1, Ogle 2001).

National ratings & Species	COMMON NAME	Present?[1]
THREATENED		
Critically endangered		
Pimelea "Turakina"	a native daphne of dune slacks	p
SEBAEA OVATA	a gentian of dune slacks	p
Endangered		
Pterostylis micromega	swamp hood orchid	
Vulnerable		
Isolepis basilaris	a minute sedge of dune slacks	p
Mazus novaezeelandiae subsp. *impolitus*	dwarf musk (of dune slacks)	p
Ranunculus recens var. *recens*	a dwarf buttercup	e
Selliera rotundifolia	a half-star	p
DECLINING		
Austrofestuca littoralis	sand fescue	e
Eleocharis neozelandica	a dune wetland sedge	p
Ileostylus micranthus	a mistletoe	(e)
Leptinella dioica subsp. monoica	a button-daisy	p
Libertia peregrinans	sand iris	p
Pimelea arenaria "southern"	sand daphne	p
Sonchus kirkii	native sowthistle	p
Urtica linearifolia	swamp nettle	p
RECOVERING		
Conservation dependent		
Desmoschoenus spiralis	pingao	p
NATURALLY UNCOMMON		
Sparse		
Crassula ruamahanga	a small semi-aquatic herb	p
Korthalsella salicornioides	dwarf mistletoe	(e)
Lepilaena bilocularis	a minute aquatic herb	p
Ranunculus macropus	an aquatic buttercup	p
Range restricted		
Crassula manaia	a minute succulent	p
Leptinella dispersa ssp. *rupestris*	a creeping button-daisy of damp sand	p
Limosella "Manutahi"	a succulent herb of damp sand	p

[1] Recent and historic records indicate the species is regionally e = extinct; (e) = probably extinct; p= present

Fig. 1. Threatened and uncommon indigenous vascular plants of Foxton Ecological District, north of the Manawatu River (adapted from Ogle et al. 2001).

The 23 species recorded in this part of FED and which have a nationally threatened or uncommon status (de Lange et al. 1999) are listed in Fig. 1[1]. This table shows that two or perhaps as many as four species have probably become extinct across the whole district. Presumed to have been extinct for some decades, sand fescue and a dwarf buttercup would have inhabited dry dunes and damp dune slacks, respectively. The two mistletoes were known until the 1990s in just one site each, the last *Ileostylus* plants showing intense possum browsing sign and dwarf mistletoe grew on kanuka that were felled to plant pines. Several others are known now from just one or two sites, having been recorded more widely in the past (Ogle 2001). The species which have probably had the most dramatic declines in known range are *Sebaea ovata, Eleocharis neozelandica* and *Libertia peregrinans*.

[1] South of the Manawatu River, FED has or had additional species with a threatened or uncommon status nationally, including *Ophioglossum petiolatum*, *Pimelea tomentosa*, and *Amphibromus fluitans*.

Adventive plants (weeds) of FED

My unpublished database of adventive plant species, including casual records (see above and Heenan et al. 1998), from a range of places in FED north of the Manawatu River contains 580 species. Many of these are very common and widely distributed. Others are known from one site only. Both the number of species and presence of individual species vary through the length of the district (Figs. 2, 3). The records come from published and unpublished plant lists and other work and from herbaria records.

Beach (north to south order)	Number of adventive species					
	Trees, shrubs, lianes	Grasses	Other monocots	Dicot herbs	Ferns, fern allies	Totals
Patea	21	18	25	118	1	183
Waipipi	3	11	6	34		54
Waitotara R (right bank)	5	24	7	58		94
Castlecliff (west of town)	12	16	20	53		101
Castlecliff (town to river)	29	24	21	80		154
Whitiau (Whangaehu R)	13	31	9	88	2	143
Koitiata (Turakina R)	17	20	8	54		99
Tangimoana	10	17	7	50	1	85

Fig. 2. Numbers of adventive species in coastal dunes in parts of Foxton Ecological District

Published accounts of the botany of parts of FED were given by Esler (1978) for the Manawatu and Duguid (1990) for Horowhenua. These both include plant lists and other comments about the status of species of the sand country. Both the Wanganui and Wellington Conservancies of the Department of Conservation have databases of the lists of plants that they hold for specific places. Many of these lists are unpublished. Where they bear the date of a survey at a particular time, such lists are a record of not only what was present but, just as importantly for some future uses, what was not seen. If a weed was not recorded earlier but is now obvious, it seems likely that it has arrived since the earlier survey. However, caution needs to be exercised in reaching this conclusion, for the plant may have been present earlier but not seen, for reasons that include incomplete coverage of the specified survey area, the species was uncommon or seasonally inconspicuous, or the recorder's unfamiliarity with the species.

Some biologists collected voucher specimens of plants for herbaria and I would encourage more people to do so. Specimens are a useful source of distribution information and the labels with the specimens often (in fact, should) give specific details of the location, date of collection, abundance of the species and the nature of the vegetation and other aspects of the plant's habitat.

Beach (north to south order)	Locations of selected adventive species						
	Acacia sophorae Sand wattle	*Anredera cordifolia* Madeira vine	*Chrysanthemoides monilifera* Boneseed	*Cyperus congestus* Purple umbrella sedge	*Juncus acutus* Sharp rush	*Lobularia maritima* Sweet alyssum	*Senecio glastifolius* Pink ragwort
Patea		x				x	
Waipipi				x			
Waitotara R (right bank)				x			
Castlecliff (west of town)	x					x	x
Castlecliff (town to river)	x	x	x			x	x
Whitiau (Whangaehu R)	x			1 on 1/00		x	x
Koitiata (Turakina R)	x		x			x	x
Tangimoana	x			1 on 3/96	x	x	x
Himatangi	x				x	x	?
Foxton Beach	x		x		x	x	?

Fig. 3. Distribution of selected adventive plants along the northern half of Foxton Ecological District.

Examples

a) Escapes from plantings

The subsequent spread of certain species planted for sand stabilisation was probably not anticipated, but it can result in costly weed control work for other agencies or individuals. In the northern half of FED, Acacia sophorae is the most obvious example and the topic of a separate session in this conference. Other species of this region that have been planted for sand stabilisation but which are now self-establishing to a greater or lesser degree include pyp grass (Ehrharta villosa), coastal tea-tree (Leptospermum laevigatum), saltbush (Atriplex halimus), coastal banksia (Banksia integrifolia) and Buddleja dysophylla.

Only four species of the African genus Ehrharta have been recorded in New Zealand and all occur in FED. Pyp grass (E. villosa) was planted as a trial on dunes at Koitiata in the 1960s and seemingly abandoned and forgotten (Edgar & Connor 2000). It was rediscovered in 1990 and, in 1991, a survey revealed that it occurred across some 700 m x 300 m, among pines, dune flats and marram-covered dunes. It appears to out-compete marram with a dense mat of shallow rhizomes, its main method of spreading, as the seeds have low viability. Although the land was partly a council recreation reserve and partly private pine forest, in the late 1990s the Department of Conservation (DoC) undertook to eradicate pyp grass from its only known site in New Zealand. The recreation reserve had contained several threatened species in the past (Ogle 2001) and still had tiny remnants of dwarf mazus and sand iris in the 1990s. In addition, pyp grass was seen as a potential threat to natural dune vegetation throughout New Zealand if people took it elsewhere. The rather unusual opportunity to eradicate an aggressive weed from the whole of New Zealand seemed feasible for pyp grass. After three years' work and as eradication seemed imminent, a second population was discovered in southern Hawkes Bay.

Coastal tea-tree was planted near the coast in Santoft Forest near the wreck of the ship"Fusilier", perhaps as a buffer for young pine plantations. With a party from the Wellington Botanical

Society in February 1987 I searched unsuccessfully for self-establishing plants. However, in March 2000 with a DoC party I discovered many seedlings and saplings of coastal tea-tree, some of them fruiting, along with mature trees. Such a lag-phase in establishment is not uncommon among weeds and shows the potential folly of assuming that any exotic species is 'safe' to plant because it is not known to spread. Also planted in Santoft, mostly along road edges, was coastal banksia. In 1992 I found small numbers of seedlings there, up to 2 m tall.

A tufted grass, Ehrharta calycina, was first recorded at Santoft in 1956 (Edgar et al. 1991) and I collected herbarium material in 1987. It may have been planted here originally because it has few New Zealand records and at least one other is also associated with planted pines, at Waitarere Beach just south of the Manawatu River. In 2000 we searched for E. calycina and found that, unlike the coastal tea-tree at the same site, it had scarcely spread at all although it was fruiting and young plants were present. Either this grass has a long lag phase or some factor is restricting its spread.

Another adventive plant in New Zealand that is confined to FED and shows no sign of extending its range is marsh woundwort. Although it was first recorded in 1878, it is known from only two locations, namely Koitiata and the Hokio estuary near Levin (p796., Webb et al. 1988).

b) Escapes from other weedy areas

The largest number of species in sand country are either pasture plants or widespread weeds in other habitats. For conservation management of natural areas, exotic pasture species, including clovers and grasses, are often seen as problem weeds. Examples follow later. Among those plants which almost all people would regard as weeds is yet another Ehrharta species, veld grass (E. erecta). At Santoft in 2000 it was found growing with E. calycina, though it was not seen there in 1987. Veld grass has one of the most spectacular increases in abundance and range of any exotic species in New Zealand since its first record in 1943 in Wellington (Ogle 1988). Based upon herbarium collections, there seems to have been a lag phase until the late 1970s. It has seldom been sown deliberately and at least some of its spread is by bird dispersal of seed. Now it is in a wide range of lowland habitats between Northland and Canterbury, including dune country and offshore islands. North of the Manawatu River it is known from just three places in coastal dunes, namely Patea, Castlecliff and Santoft, but I predict that it will spread to other dunes of the region. Dunes at Castlecliff have dense swards of veld grass that appear to smothering other species.

To complete the Ehrharta discussion, the fourth species recorded in New Zealand is annual veld grass (E. longiflora). Its only records are from Wanganui, on sand along track sides and under trees in urban areas. It also a weed Australia from where it may have come to Wanganui, perhaps on clothing. I first collected it in 1989 and soon found it to be locally abundant in an area about 1 km^2. I have been monitoring it for a decade, but it seems to be spreading very little. Sand excavated from infested areas and taken to new sites has been the source of most new occurrences. Its behaviour and life history are so similar to ripgut brome (Bromus diandrus) that it would probably grow in similar places in natural vegetation on dunes.

The accidental arrival of weeds with human activities can be seen in many terrestrial sites in dunes. In the early 1990s, a gravel track was laid into dunes at Tangimoana, in order to plant pine trees in what is now Tawhirihoe Scientific Reserve. The gravel was sourced from the Rangitikei River bed nearby where, among many weeds, meadow horsetail (Equisetum arvense) is locally abundant. This weed has been known from the lower reaches of the Rangitikei River

since at least 1978 (Brownsey et al. 1985), which was one of the earlier records outside of urban areas. In Tawhirihoe Reserve it was noted first in the gravel track, from where it is now spreading by its rhizomes. (The bed of the Rangitikei River is the source of greywacke shingle for a wide region. It is beyond the scope of this paper to examine the massive spread of horsetail around the road verges of the whole region over the past decade, from this source.) A sedge, Cyperus congestus, is becoming one of the most common road-ditch plants in the southern North Island, probably spreading by machines and by flowing water. However, it is also starting to appear in dune wetlands (Fig. 3) where early control by pulling and removing plants before they have mature seed is probably the best option for control.

To stress that wetlands are part of sand ecosystems, Fig. 4 shows a few species selected from unpublished lists of plants made at three dune lakes near Wanganui. The records are derived from a detailed botanical survey of 10 dune lakes in 1978 (Kelly 1978) and my opportunistic surveys in the 1990s. Part of the difference in recorded species is probably the result of different survey methods - my surveys were shore-based only, but included a search of shore drift for deep-growing species. However, some suggestions can be made about species now present but not recorded by Kelly (1978). At Lake Wiritoa, Kelly (1978) did not record the aggressive water plants Egeria densa, Elodea canadensis, Potamogeton crispus, or Ceratophyllum demersum, all of which are now abundant and a major impediment to recreational use of Lake Wiritoa. It is well-known that water weeds are spread by boats and boat-trailers. Lake Wiritoa has a public boat ramp and is used frequently by power boats. Neither of lakes Kaitoke or Westmere has access for power boats; any boating use is restricted to canoes or small dinghies. Some of the difference in the weeds that occur in these three lakes (Fig. 4) can be attributed directly to power boats.

c) Casual species – garden escapes and discards

Growing to the west of the beach settlement at Castlecliff, Wanganui, are a number of species that most people would recognise as garden plants. These were planted almost certainly into dunes by persons unknown, probably several decades ago. Some species have probably increased very little since they were planted (e.g. Gladiolus carneus, Babiana stricta, Ixia maculata, Amaryllis belladonna), some have produced few offspring but formed large clumps (e.g., at least three Watsonia species, Scilla peruviana, Arctotis stoechadifolia), some have dispersed a little by seed (e.g., Tritonia lineata, T. crocata, Agapanthus orientalis) and some have become so common that their eradication could scarcely be considered now (Gazania rigens, Lampranthus glaucus, Freesia refracta) (Ogle 1993 and later revisions). I led the local botanical group and others here on surveys in spring (August-October) for several years, mainly because that was a comfortable temperature for survey and most of the known species were flowering.

			Dune lakes		
			Westmere	Kaitoke	Wiritoa
Aquatic weed species	*Egeria densa*	1978		x	
		1990+		**X**	**X**
	Elodea canadensis	1978			
		1990+			X
	Ceratophyllum demersum	1978			
		1990+			**X**
	Myriophyllum aquaticum	1978		x	
		1990+		**X**	
	Veronica anagallis-aquatica	1978			
		1990+		**X**	
	Potamogeton crispus	1978	x	x	
		1990+	**X**	**X**	**X**
	Vallisneria sp.	1978			x
		1990+			**X**
	Ranunculus trichophyllus	1978			
		1990+			**X**
Regionally uncommon indigenous species	*Potamogeton ochreatus*	1978	x		x
		1990+	**X**	**X**	**X**
	Potamogeton pectinatus	1978		x	
		1990+			
	Myriophyllum triphyllum	1978	x		x
		1990+	**X**		
	Ruppia megacarpa	1978			x
		1990+			

Fig. 4. Distribution of selected exotic and indigenous aquatic species in 3 dune lakes of Manawatu-Wanganui region. Data from Kelly (1978) and Ogle (unpublished data from 1990 onwards).

In late November 2000 I returned to the site and found a large clump of 'fairy bells' (Dierama sp., probably D. pendulum) in flower among a patch of Watsonia spp. This points to the need for repeated surveys in different seasons in order to record the full range of plants in sand country.

Patea Beach represents a different but extreme example of garden discards in dunes. In an attempt to stabilise encroaching dunes on the true right bank of the Patea River mouth, the local council encourages residents to take garden waste to a specified site on the dune crest. Vehicle access was constructed from dumped clay which was rolled hard across the sand and the heaps of green waste are bull-dozed flat from time to time and covered with more clay. In between times, garden plants and other weeds grow and reproduce, some spreading into nearby areas of marram. Between July 1999 and March 2001 180 species were recorded growing on and around the dump site, of which 172 were attributable to garden dumping. These included national surveillance weeds such as Madeira vine (Anredera cordifolia) and palm grass (Setaria palmifolia). Many species have proved to be truly short-lived casuals, like garden pea, radish, carrot and broccoli. The legacy of past dump sites lingers on in places like Tangimoana where, a decade after the dump was closed and covered in sand, garden species such as silver beet (Beta vulgaris), mignonette (Reseda alba), Narcissus sp. and ice plant (Carpobrotus edulis) persist. Ice plant in particular has spread widely into the adjoining Tawhirihoe Scientific Reserve.

Dune swamps are the main habitat for hemp agrimony (Eupatorium cannabinum), a European daisy that probably started its move into the wild as a garden escape near Hawera. The first collection was in 1972 (CHR 234517) then 1981, followed by a 'rush' of collections from 1994 onwards, between Hawera and Maxwell, south of Waverley (Heenan et al. 1999). This colourful, rhizomatous daisy is now in most swamps in its present range, although it is unknown in the wild outside this district. The lag phase was about 20 years and there appears little to prevent its spread throughout New Zealand wetlands. As with the rapidly spreading pink ragwort (Senecio glastifolius) (Williams et al. 1999) control in specific places might be an option, but only before it becomes well-established.

Interaction between weeds and threatened plants

In the example discussed above of weeds in dune lakes, it is tempting to suggest that the apparent demise of some indigenous aquatic species present in 1978, such as *Myriophyllum triphyllum* and *Ruppia megacarpa*, is the result of competition from the exotic species. If those indigenous species have, indeed, become extinct in lakes where they were present in the past (Fig. 2), there might be other reasons. Vigorous growth of water weeds is one outcome of eutrophication. If the identified lakes have changed in their chemical or physical characteristics, these changes might not have suited some native species. Nevertheless, a comprehensive survey of the 10 lakes surveyed by Kelly (1978), using the same methodology, might provide a large enough sample to determine whether there is a significant correlation between the presence of water weeds and the loss of native aquatic plants, in both time and space.

For some terrestrial dune sites there are plant lists on dates a decade or more apart. An example is Koitiata at the Turakina River mouth. Although he did not record the adventive species here, Druce (1975) listed a range of indigenous species that can no longer be found there, despite numerous searches. These included species of short open vegetation on periodically flooded dune slacks, namely *Pimelea* "Turakina", *Corybas* sp., *Carex buchananii, Isolepis basilaris, I. cernua, Juncus caespiticius, Epilobium billardiereanum, Gunnera arenaria, Mentha cunninghamii, Myriophyllum pedunculatum, M. votschii,* and *Sebaea ovata.* Some of these are in the national threatened and uncommon plant list (Fig. 1). All these species are known still from dune slacks in other parts of FED, although not all together. I visited Koitiata with Tony Druce in 1993 and he said that the place was 'unrecognisable'. Weeds such as pampas grass, pink ragwort (*Senecio glastifolius*), silver poplar (*Populus alba*), boneseed (*Chrysanthemoides monilifera*), sand wattle and willows (*Salix* spp.) had filled much of the space. In addition, the indigenous jointed wire-rush or oi (*Apodasmia* [*Leptocarpus*] *similis*) had become more common and in dense stands. Open sites that are needed by specialist plants of dune slacks scarcely exist now. Weeds contributed to the loss of habitat for a range of species and their local extinction. However, the increase in jointed wire-rush is indicative of natural plant succession with time. In times when dune sand and river meanders occurred without human interference, new dune slacks would have been forming for the specialised inhabitants to occupy as their old sites gave way to taller species that create a total ground cover.

Faced with no prospect of new dune slacks, Jim Campbell of DoC in Wanganui is leading an attempt to reverse 'natural' succession in small parts of dune slacks in Whitiau Scientific Reserve at the mouth of the Whangaehu River. In about 1998 the immediate species of concern there was an annual herb, *Sebaea ovata*, in its last known site in New Zealand[2]. By then its extent and abundance were far less than when the species was found here in 1989 (Ogle 1989). Space for each year's seedlings seemed to be getting less, with rank grasses and mat-forming and rosette

[2] In 2000, Jim Campbell found a new population of *S. ovata* further west, in a dune slack near the moth of Waitotara River.

weeds such as strawberry clover (*Trifolium fragiferum*), hawkbit (*Leontodon taraxacoides*), jointed-leaved rush (*Juncus articulatus*), Yorkshire fog (*Holcus lanatus*) and tall fescue (*Schedonorus phoenix*) and, latterly, a small blue iris (*Sisyrinchium* sp.). As at Koitiata, native jointed wire-rush was also invading the site. Several trials of weed control were attempted, with limited success. As the total number of *Sebaea ovata* plants reduced to a few dozen, a more radical approach was tried. Close to the last site for *S. ovata*, a mechanical digger was used to scrape the vegetation and top 10-100 mm of sand from trial plots. Monitoring of these scrapes continues (J Campbell, pers. comm.). A few *S. ovata* plants have appeared and quantities of the 'vulnerable' species, *Selliera rotundifolia* and *Isolepis basilaris*. The last two species had been in the area with *S. ovata*, although *I. basilaris* seemed to be becoming scarce. Other small-statured species that were thought to be locally uncommon have appeared in the scrapes, including *Myriophyllum votschii* and *Limosella lineata*.

Discussion

It is a matter of simple observation to see that some indigenous species of sand country are more resilient than others in the face of human induced changes, including weeds. Spinifex, club sedge (Isolepis nodosa) and sand convolvulus (Calystegia soldanella) are examples. Many other indigenous species have declined, seemingly correlated with a rise in weed species diversity and weed abundance. Examples have been given from dune slacks and dune lakes. Much larger sets of data exist which might be used to strengthen these preliminary findings.

More data might be gathered also with the objective of determining the impacts of certain weeds on indigenous plant species, particular threatened species. Considering the number of authors who have accepted that weeds smother indigenous vegetation, suppress regeneration and cause a loss of indigenous species, there are remarkably few studies in New Zealand which have examined precise interactions between weeds and indigenous flora. One recent study which did quantify the impacts of a weed in indigenous vegetation was of the vine old man's beard (Clematis vitalba) in forest near Taihape (Ogle et al. 2000). There it was demonstrated that old man's beard or its control had resulted in losses of indigenous species and that the losses had been greatest among indigenous species with a nationally threatened or uncommon status. This study might be adapted for research on dune weed impacts.

A comment above about the impacts of weed control as opposed to the impacts of the weed itself needs stressing. The control of pampas grass by spraying in Whitiau Scientific Reserve resulted in the loss of the only known patch in the reserve of a regionally uncommon sedge, Carex litorosa. Natural areas in dunes have too many nationally and regionally special plants, often scattered among the weeds, for non-targeted weed control to be acceptable.

Details were given above for Castlecliff Beach, as a rather extreme example of how deliberate plantings become a source of exotic plants into sand country. Some people would see this as an acceptable practice, especially if the planted species do not spread of their own accord or, in other words, do not become weeds. However, exotic plants can be unpredictable when planted in New Zealand. The spectacular spread at Castlecliff of Lampranthus glaucus, a small shrubby ice-plant, could scarcely have been predicted. The spread of amenity plantings in places like Santoft pine forests also demonstrates the need for special care in planting in or near sand country. The ecological and financial consequences of unleashing yet more major weeds upon our sand ecosystems can be horrendous.

References

Brownsey, P J; Moss, T C; Sneddon, B V 1985. Cone production in Equisetum arvense. *Wellington Botanical Society Bulletin 42:* 16-21.

Buddenhagen, C E; Timmins, S T; Owen, S J 1998. An overview of weed impacts and trends IN: Dept of Conservation Strategic Plan for managing invasive weeds (Ed. S J Owen) pp 11-21. Department of Conservation, Wellington.

de Lange, P J; Heenan, P B; Given, D R; Ogle, C C; Johnson, P N; Cameron, E K 1999. Threatened and uncommon plants in New Zealand. *N Z Journal of Botany 37:* 603-628.

Dopson, S R; de Lange, P J; Ogle, C C; Rance, B D; Courtney, S P; Molloy, J. 1999 The conservation requirements of New Zealand's nationally threatened vascular plants. *Threatened species occasional publication No. 13.* Biodiversity Recovery Unit, Department of Conservation, Wellington.194p.

Druce, A P 1975. Indigenous vascular plants of Turakina Beach, Manawatu coast. (Unpublished) Botany Division, DSIR, Lower Hutt. 2p

Duguid, F C 1990. Botany of the northern Horowhenua lowlands, North Island, New Zealand. *New Zealand Journal of Botany 28*: 381-437.

Edgar, E; Connor, H E 2000. *Flora of New Zealand V. Grasses.* Manaaki Whenua Press, Lincoln. 650p.

Edgar, E; Connor, H E; Shand, J E 1991. Checklist of oryzoid, arundinoid and chloridoid grasses naturalised in New Zealand. *New Zealand Journal of Botany 29:* 117-129.

Esler, A E 1978. Botany of the Manawatu District, New Zealand. *DSIR Information Series No. 127.* Government Printer, Wellington. 206p.

Heenan, P B; Breitwieser,I; Glenny, D S; de Lange, P J; Brownsey, P J 1998. Checklist of dicotyledons and pteridophytes naturalised or casual in New Zealand: additional records 1994-1996. *N Z Journal of Botany 36:* 155-162.

Heenan, P B; de Lange, P J; Glenny, D S; Breitwieser, I; Brownsey, P J; Ogle, C C 1999. Checklist of dicotyledons, gymnosperms, and pteridophytes naturalised or casual in New Zealand: additional records 1997-1998. *N Z Journal of Botany 37:*629-642.

Kelly, D 1978. A plant distribution survey of twelve coastal lakes (unpublished). Rangitikei-Wanganui Catchment Board and regional Water Board, Marton.

McEwen, W M 1987. *Ecological regions and districts of New Zealand,* 3rd revised edition. NZ Biological Resources Centre, DSIR, Wellington.

Molloy, J; Davis A 1994. *Setting priorities for the conservation of New Zealand's threatened plants and animals.* Department of Conservation, Wellington.

Ogle, C C 1988. Veld grass *(Ehrharta erecta)* has come to stay. *Wellington Botanical Soc. Bulletin 44* : 8-15.

Ogle, C C 1989 *Sebaea ovata* (Gentianaceae) and its habitat near Wanganui. *Wellington Botanical Soc. Bulletin:* 92-99. (*Sci. Pap. 85*).

Ogle, C C 1993 (and later revisions, to 2001). Vascular plants of Castlecliff Beach Reserve, Wanganui. *Wanganui plant list 4 (unpublished).* Dept. of Conservation, Wanganui.

Ogle, C C 2001 Conserving indigenous biodiversity of New Zealand's sand country. Pp. 46-47 In: G Steward, D Gainsford, K Baverstock and N Sullivan (compilers) *Proceedings of the Coastal Dune Vegetation Network 2001Conference 'Contrasting Coastlines'* (unpublished). Forest Research, Rotorua.

Ogle, C C; La Cock, G D; Arnold, G; Mickleson,N 2000. Impacts of an exotic vine *Clematis vitalba* (F. Ranunculaceae), and of control measures, on plant biodiversity in indigenous forest, Taihape, New Zealand. *Austral Ecology25:*539-551.

Ogle, C C; La Cock, G D; Nicholls, V 2000. Nationally threatened and uncommon plants of Wanganui Conservancy. In: G La Cock (2001) Threatened plant strategy, Wanganui Conservancy. Dept of Conservation, Wanganui. 52p.

Polly, B; West C 1996. Kitchener Park, then and now. *Wellington Botanical Soc. Bulletin 47*: 7-9.

Ravine, D A 1992. Foxton Ecological District. Survey report for the Protected Natural Areas Programme. *NZ Protected Natural Areas Programme report No. 19.* Department of Conservation, Wanganui.

Reid, V A 1998. The impacts of weeds on threatened plants. *Science and Research internal report No. 164.* Department of Conservation, Wellington.

Webb, C J; Sykes, W R; Garnock-Jones, P J 1988. Flora of New Zealand Volume IV. Botany Division, DSIR, Christchurch.1365p.

Williams, P A; Ogle, C C, Timmins, S M; Reid, V; La Cock, G D 1999. Biology and ecology of *Senecio glastifolius* and its spread and impacts in New Zealand. *Science for conservation 112.* Department of Conservation, Wellington.

Williams, P A; Timmins, S M 1990. Weeds in New Zealand protected natural areas. Review for the Dept. of Conservation. *Science and Research series No. 14.* Dept. of Conservation, Wellington.