Rare plant conservation at the Tangimoana dunelands

Nicholas Singers
84 Chelwood Street
Palmerston North

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Abstract

The Tangimoana dune system of foredunes, parabolic dunes, dune slacks, and gravel plains were identified as a recommended area for protection in the Foxton Ecological District Protected Natural Areas survey.

The main focus of the present study was of the vegetation/water relationships in the dune slacks, with special reference to the rare spiked sand sedge, *Eleocharis neozelandica.*

In addition, cuttings of the endangered native daphne, *Pimelea* "Turakina", from Himatangi were planted at the Tangimoana dunelands.

Excavating wetlands in deflation hollows for the creation of habitat for *E. neozelandica* appears after one year's observation to be a successful way to manage this species. The plant is very robust in that it can withstand extremes, and has survived well being transplanted from a glasshouse to the field situation. However, rabbit browsing appears to be a threat in late summer and may reduce reproductive output of *E. neozelandica.*

The *Pimelea* "Turakina" planted at Tangimoana dunelands have established well and seedlings are present. The plants are presently only located in two areas, which would cover less than 20 m^2. It would be advisable to plant additional plants in other locations within the Tangimoana dunelands to ensure their survival.

1. Introduction

The Tangimoana dune system of foredunes, parabolic dunes, dune slacks and gravel plains were identified as a recommended area for protection in the Foxton Ecological District Protected Natural Areas survey. The area is approximately 45 ha in size and is located south of the Rangitikei River mouth. Negotiations are currently being made with the Manawatu District Council and the Department of Conservation (DoC) to acquire the land and manage the area as a reserve for its conservation values.

I undertook a MSc thesis, initiated by DoC as part of the process to manage and enhance the conservation values of the area. The main focus of the study was on the vegetation/water relationships in the dune slacks, with special reference to the spiked sand sedge, *Eleocharis neozelandica.*

As part of the thesis work, two artificial dune slacks were constructed and *E.neozelandica* was planted in both. These plants were assessed for survival, growth and reproduction. Measurements of the topography and colonisation of the artificial dune slacks were undertaken.

Today, most dune areas of the Manawatu are highly modified and many of the previously widespread native plants exist in small areas only and are highly threatened. One such plant (presently unnamed) is *Pimelea* "Turakina", which is a small native daphne probably endemic to the Manawatu dunelands. All of the natural known populations of *Pimelea* "Turakina" are threatened with extinction, as the dune hollows that they occupy at Himatangi have been planted with exotic pines. Cuttings of *Pimelea* "Turakina" from Himatangi were planted at the Tangimoana dunelands.

Water table fluctuations of two dune slacks were monitored over the summer of 1996-97, giving additional information for the summer period. This was important as the previous two summers were wetter than other years in the past and had high water tables, which were unlikely to be representative of the average summer water table.

This report covers management experiments for the enhancement of populations of both *E. neozelandica* and *Pimelea* "Turakina" at the Tangimoana dunelands.

2. Construction of temporary wetlands in dune hollows

2.1 THE MOVING DUNE ENVIRONMENT

Parabolic dunes are formed by a break or a disturbance in the foredune vegetation, in combination with strong on-shore winds. These two factors help to create a "blowout", which is when the foredune vegetation is no longer capable of holding sand, resulting in wind erosion. The blowout forms into a long thin elliptical sand ridge as it moves through and past the foredune. The wind eventually forms this sand ridge into a parabolic dune

Parabolic dunes move inland and smother all the hinterland vegetation, creating bare sandy deflation hollows behind them. The sand in deflation hollows is blown down to the water table level. It is here in this newly created habitat that an ecological succession takes place. As the parabolic dune moves forward, enlarging the terminal deflation hollow behind. An ecological succession occurs, with the primary phase in the deflation hollow just behind the moving dune, with older vegetation occurring towards the sea.

The first plant to colonise these deflation hollows is *Carex pumilia,* a rhizomatous sand sedge which follows the moving terminal deflation hollow (Burgess 1984; Esler 1969). Following *C. pumila* is a group of plants which includes *Selliera radicans, S. rotundifolia, Isolepis cernua, I. basilaris, Triglochin striatum, Ranunculus acaulis, Gunnera arenaria, Myriophyllum votschii, Lilaeopsis novae-zelandiae, Limosella lineata, Epilobium billardiereanum,* and *Eleocharis neozelandica* (the last being classified as Endangered on the New Zealand threatened plants list, Cameron *et al.* 1995).

These plants are well adapted to this dune slack habitat, which is nutrient poor and has extremes with respect to the water table level.

Over time, the nutrient content of these deflation hollows increases with additions from nitrogen-fixing algae, e.g. *Nostoc* and *Anabaena* species, and organic matter buildup. The plants in these deflation hollows also collect wind-blown sand particles (*C. pumila* is a very good sand binder), which raise the soil surface and lower the water table. This in turn enables larger species of rushes and sedges to colonise and eventually replace the smaller colonising plants.

Dunes which are actively moving on the Manawatu coastline are deemed to be a nuisance by land managers, because they cover pasture and exotic forests. As a consequence land managers regularly stabilise dunes by planting with marram grass *(Ammophila arenaria)* followed by trees and shrubs. When moving dunes are stabilised in this way, the natural succession is altered because the dunes are prevented from creating new deflation hollows behind them. As a consequence, the colonising native vegetation is eliminated from these deflation hollows, and hence from whole lengths of the coast, as they no longer have anywhere to disperse to. The practices of sand stabilisation have created a problem for conservation managers, whose primary functions are to retain the diversity and naturalness of natural ecosystems.

2.2 METHODS FOR RESTORING DUNE HOLLOW COMMUNITIES

An experiment for the restoration of dune hollow plant communities involving the construction of two deflation hollows by excavating already existing deflation hollows was attempted. This created deflation hollows completely barren and sandy analogous to natural, newly-created deflation hollows, and with both comparably low in elevation and with high water tables. The two hollows were planted with the endangered sand spike sedge *E. neozelandica.*

The area consisted of two reasonably large (approximately 25 metres long x 6 metres wide) and low-lying parallel hollows with a small raised hummock between them prior to excavation. The deflation hollows were excavated deepest on the seaward side and gradually tapered off moving inland, as do the natural deflation hollows formed behind moving dunes (Appendix, Figure 3). The hollows were excavated to exact specifications with respect to the water table height, which related to the elevational range at which *E. neozelandica* was growing in the other dune slacks.

The excavation was carried out on the 31 January 1996. A 16 ton excavator with a 2 metre wide blade was used for the excavation work. A small dune was also removed as this was directly moving on to the excavation area. The soil surface of the hollows was rough and uneven, so it was smoothed out using the back of the excavating blade.

The wetlands were left for two months to weather and stabilise before they were planted. *Eleocharis neozelandica* plants had been grown from seed and had been propagated in beach sand with 3 month Osmocote™ (1:400 ml of sand) at the Massey University Ecology Department glasshouse. These species occurred at or adjacent to the excavation site. One *E. neozelandica* plant with five rosettes occurred on the raised hummock between the two wetlands (which was specifically avoided during the excavation process), and another plant occurred on the northern side of the north wetland. *Isolepis cernua* was widespread throughout the general area.

The wetlands were thoroughly surveyed for any plants immediately before the planting took place. The survey found several areas of *C. pumila* which had regenerated from rhizomes; 55 ramets were located over the entire excavated area. Five *I. cernua* and seven *S. rotundifolia* plants were also found. These plants were recorded again if they occurred within any of the planting quadrats. It appeared that *C. pumila* re-sprouted from rhizomes still present after the excavation took place.

A 50 metre tape measure was placed along the entire length of the excavated wetlands. Quadrats (2 m^2) were measured at the low, medium and high elevations of the wetlands. The high elevation quadrats were three metres from the edge of the excavation, while the low quadrats were in the lowest area of both wetlands, and the medium quadrats were half way between these two, approximately 10 metres from each. These quadrats were then subdivided into four 1 m^2 quadrats in which the planting took place. In each of the 1 m^2 quadrats six *E. neozelandica* plants were planted randomly.

On 22 December 1996, approximately 9 months after the *E. neozelandica* plants were planted, the quadrats were re-assessed for their survival following winter submergence. In each of the medium and high planting areas six *E. neozelandica* plants were randomly selected. They were assessed for growth, rabbit browse and reproduction. Growth was measured by placing a tag (a coloured paperclip) at the centre of the plant into the sand and measuring the length and width of each plant from this point. The longest stem of each plant was measured, giving an indication of both the growth and rabbit browse of each plant. Rabbit browse was also measured with a subjective browse score, as no browse (0), light (1), moderate (2), high (3), very high (4) and extreme (5) for each tagged plant. Reproduction was measured by counting every inflorescence, either flowering or seeding.

The topography was mapped by placing a 50 metre tape from one edge of the excavation site to the other along its axis, and measuring the elevation at every metre interval along the tape. At every 5 metre interval on the tape measure another tape measure was placed a right angles to the first. The elevation of the width of the wetlands was measured at every two metres along this tape to the edges of the site.

Colonisation of the wetlands was recorded by measuring the presence/ absence of species, their percentage cover, and the percentage sand cover in a 30 cm^2 quadrat at every metre interval along the same transect line as for the topography. Colonisation also occurs from the edges of the wetlands from clonal spread via rhizomes, etc., for example *Carex pumila* and *Selliera rotundifolia*. This edge of the vegetative spread was measured at 5 metre intervals along the transect line, in both wetlands.

2.3 SURVIVAL OF *ELEOCHARIS NEOZELANDICA*

The excavation site was constructed almost exactly as specified, except that the lowest area in the north site was excavated slightly deeper than desired. The south hollow was 25 m long, slighter smaller than the north hollow of 30 m. However, this length conformed best with the original topography. The two sites smoothed out well with wind and rain and, at the time of planting, colonisation of other plants in both sites had begun. This colonisation halted with the onset of the rise in water table above the surface in early May 1996. The water table remained above the surface in the lowest areas until late December 1996, which gave approximately eight months of submergence. The water table fluctuated above and below the highest planted areas throughout these months, enabling periods of growth for these plants.

On the 22 December, the middle and highest planted quadrats were assessed for plant survival and colonisation from other plants, as the lowest quadrats were still below the water table. The middle- elevation quadrats had some additional *E. neozelandica* plants, while the higher- elevation quadrats had none. One quadrat had 12 plants, an extra 6 plants, while another three quadrats each had an additional plant. At the time of planting, many of the *E. neozelandica* plants were carrying seed and would have released much of this seed on to the wetlands after planting. Therefore the additional plants were probably seedlings resulting from the previous year's seed set.

The highest two quadrats on the north excavation site had very low survival rates, with only a single plant surviving in one quadrat and two in another (Table 1). It appears that these plants may have been buried with sand, blown on them from an adjacent area, as the metal tag in the quadrat was buried as well. This sand had been dumped next to this wetland from its construction, and from the removal of the small adjacent dune. The plants in the high quadrats in the south excavation site, which is of a comparable elevation, survived well, with only one plant absent.

Ignoring the two quadrats which had low survival rates of *E. neozelandica* in the north excavation site, there was no difference in the survival rate between the medium- and high-elevation quadrats in both excavation sites (Table 1). Additional plants occurred in the medium- and low-elevation quadrats only. The survival rate of the low, elevation quadrat was nil as the two plants in the south wetland were both seedlings. These plants were discovered on the second and third assessment dates, on 5 and 30 January.

The higher-elevation *E. neozelandica* commenced growing sooner than those at the middle elevation, as the water table retreated below their height earlier. *E. neozelandica* grows very slowly or not at all when it is fully submerged, but it grows in waterlogged soils as well as at field capacity (Singers 1997). The elevational height at which plants are growing, therefore, reflects the length of the growing season, assuming that autumn/winter flooding in this habitat is a regular or annual occurrence. As a result, the plants in the higher-elevation quadrats were far larger than those in the middle and low quadrats.They had a higher reproductive output, as they started producing inflorescences sooner and produced more of them than those in the middle-elevation quadrats. Figure I shows the mean inflorescence number per plant for high- and medium-elevation quadrats. The high quadrats had an average of 40 inflorescences while the medium quadrats had an average of 10, in late January.

In late March there were fewer inflorescences, which may have been partly due to the increased rabbit browse (Figure 2), as rabbits remove both non-flowering and flowering stems. Rabbit browse increased as the summer progressed with the wetlands drying out. Some individual *E. neozelandica* plants were significantly affected by rabbit browse, having most of their photosynthetic stems eaten, while others were only slightly affected. It is unclear whether rabbits eat the seed heads as well as the leaves, which would significantly reduce annual seed production considering the degree of browse. However, many seeds may have been released before the rabbit browse occurred, ensuring a good release of seeds, as some seed heads were ripe on 30 January, and until this time very little browse had been recorded. If few seedling *E. neozelandica* plants colonise both wetlands next year, rabbit control may be needed to ensure a good set.

The colonisation of the wetlands occurred very rapidly as the water table dropped below the surface, with the higher areas being colonised first, followed by lower areas with the fall in the water table. *Selliera rotundifolia* is the most abundant species in both wetlands, and is present around the medium to high elevations. This species quickly colonised as the water table retreated, and for this to have happened there must have been a large seed bank present. Other plants have also colonised the wetlands, including swards of *Carex pumila* and scattered *Isolepis cernua* seedlings. Most of the *C. pumila* has either regenerated from damaged rhizomes, or spread from the edges. The elevation areas in both wetlands have still not been colonised by any species of plant, except for two *E. neozelandica* seedlings located in one of the planting quadrats in the southern wetland (Figures 4a & 4b).

The two rhizomatous plants *C. pumila* and *S. radicans* have spread via rhizomes from the outer edge of the wetlands (Figures 5a & 5b). The two diagrams show the spread of these plants. This vegetative spread was most marked in the high- to medium-elevation areas. These areas were also quickly colonised by seedling plants. As a consequence, in the second sampling these seedlings were included with the vegetative edge, as it was virtually impossible to separate which plants were extensions of the original plants and which were seedlings. The area inside the vegetative ring was virtually bare sand.

2.4 FURTHER MONITORING

Excavating wetlands in deflation hollows for the creation of habitat for *E. neozelandica* appears after one year's observation to be a successful way to manage this species. The plant is very robust in that it can withstand extremes, and has survived well being transplanted from a glasshouse to the field situation. These plants have grown extremely well and have outgrown my expectations. Rabbit browsing appears to be a threat in late summer and may reduce reproductive output of *E. neozelandica.* Additional monitoring should be undertaken regularly on a yearly basis, to monitor the colonisation of the wetlands by *E. neozelandica* and other species, and to elucidate how long these created wetlands remain a habitat for *E. neozelandica.*

3. *Pimelea* "Turakina" trials

Pimelea "Turakina" is a small shrub of dune plains, which is now known from one area only in New Zealand, within the dunelands of the Foxton Ecological District. This area lies between Himatangi and Foxton. It was first recognised by A.P Druce in another area, the dunes at Turakina River mouth (C. Ogle, pers.comm.) which gave this plant its name. However, it appears that the Turakina population has since become extinct.

Pimelea "Turakina" is a prostrate shrub when in the open, or more upright when growing amongst taller rushes. It has small (4-7 mm) obtuse to ovate glabrous leaves, which are glaucous and are almost succulent when in the open. Its habitat is around temporary wetlands on sand plains, at approximately the edge of the winter high-water line. When growing in the open and with a plentiful supply of sand, its branches collect sand and become buried, forming small raised hummocks. The individual shoots protrude from these sand hummocks, each appearing like separate plants.

3.1 PLANTING OF *PIMELEA*

In winter 1993 John Barkla (DoC Wanganui) collected cuttings of *Pimelea* "Turakina"from Basil Sexton's property on the coast at Himatangi. These were sent to the Lower Hutt City Council's Percy's Reserve to be propagated, from which were produced 29 plants. However, many *Pimelea* seedlings germinated in the plant pots, and some were large enough to be individually tagged as well. These seedlings were not removed from the pots before planting, but were left together with the other plants, in order to reduce the transplanting shock. In 29 plant pots there were 36 individual *Pimelea* plants which were tagged with aluminum tags (Numbers P512 to P547). There were also another 37 *Pimelea* seedlings which were left untagged.

All of the *Pimelea* "Turakina" plants were planted at the Tangimoana dunelands; at an isolated sand plain on 20 November 1995. The rationale behind planting them at this specific location is that the parabolic dune at the head of the sand plain is presently "blowing out", creating a new deflation basin and therefore more potential habitat. This site is also isolated from vehicles, having no accessible tracks around it which could potentially damage or kill plants. Colin Ogle (DoC Wanganui), with the Wanganui Botanical Society, was shown the location of these plants.

The *Pimelea* "Turakina" plants were planted at four places on the sand plain, in groups of between seven and eight pots having between eight and ten tagged plants in each group. Two of the groups were planted close to the end of the sand plain adjacent to the newly created deflation basin formed by the dune blowing out. The other two groups were planted further back from this, closer to the sea. Every plant was tagged with small aluminum tags numbered from P512 to P547. All of the plants were planted at approximately one metre apart, just above the winter high-water line on the edge of the temporary wetland.This wetland was near its maximum water table height at the time of planting.

On 22 June 1995, Don Ravine and I visited the Himatangi dunes to find and casually investigate the habitat of *Pimelea* "Turakina". We found many plants growing amongst *Leptocarpus similis* and *Schoenus nitens,* as well as other plants growing out in the open. The morphology of the plants varied greatly between the locations where they were growing. The plants growing with rushes were tall and appeared to be etiolated, having long internode lengths. Conversely the plants growing in the open were prostrate, with short stems and very short internodes. The plants growing in the open appeared to be growing at a similar location to *Pseudognaphalium luteo-album* with respect to the water table height, which is just above the winter high-water line.

During this visit many cuttings were taken from some of the larger plants. I propagated some of these cuttings in the Ecology Department glasshouse, while the rest were sent to Alister Pain of Talisman Native Plant Nursery. In total 25 plants were grown on from the Ecology Department cuttings, from which 22 plants were planted at Tangimoana on 9 June 1996.

These plants were planted on the same dune plain as study site two (Singers, unpublished MSc thesis) in an area approximately 150 metres from the sea, and adjacent to the excavation site. There was one extra plant, a seedling which was large enough to tag individually from the 21 pots. *Pimelea* "Turakina" has the ability to produce flowers and set seed from an early age, with plants grown from cuttings. Two of the plants were carrying many large fruit when planted. The plants were planted approximately 30 cm above the waterline around a slack (which was full of water at the time of planting) and approximately 1 metre apart in three groups of seven or eight plants. The plants were tagged with small aluminum tags with numbers from P548 to P569.

Wayne Beggs (DoC Palmerston North) was shown the location of both plantings on 30 January 1997 and will continue to ensure their survival with respect to weed control in the area.

3.2 SURVIVAL OF *PIMELEA*

The *Pimelea* "Turakina" plants from the first planting were monitored on numerous occasions throughout the summer and winter months of 1996. All plants were found at the first census, 10 January 1996, while two plants had died (P534 and P539) by the second census, 13 May 1996 (Table 3). The plants were monitored twice over the 1996 - 97 summer, on 22 December and 27 March. Four plants had died from the second planting and eight plants had died from the first planting. These plants appeared to have succumbed to a period of dry weather in January 1997. Several other plants could not be found, and have either died or been overgrown by larger plants (Tables 2 & 3).

All of the tagged plants have flowered and set fruit prolifically. There are now more plants present at the site of the first planting than were originally planted, as there are numerous seedlings around most tagged plants (Tables 2 & 3). Some of these seedlings are up to 20 cm high, and appear to be very healthy. These seedlings could also be tagged if further information is required. Few seedlings occur around the tagged plants in the second planting, which is not surprising considering their younger age and the time of planting. All of the seedlings recorded have been located directly around the tagged plants. If other seedlings have established further from the parent plants, they have not been discovered. It appears that most of the seed is falling from the parent plants and germinating below them. *Pimelea* produces fleshy fruits, probably distributed by birds or lizards (known in some other species of *Pimelea),* and these seed dispersers may not have located this new food source. Seedlings appear most prolific around plants planted close to one another.

Some of the second planting *Pimelea* have been attacked by a leaf rolling insect, which may be the larva of a native species of moth *Ericodesma aerodana* which is present in the area (C. Ogle, pers. comm.). This moth feeds on the native sand daphne, *Pimelea arenaria,* which is present adjacent to some of the affected plants. This species of moth could be controlled with an insecticide on these and other young plants in order to help them establish. The insect only seems to have a significant effect in late summer. If further plantings are carried out a protective insecticide could be applied beforehand. It would seem impractical to regularly apply an insecticide in the field if other additional work was not carried out in conjunction with the visit.

3.3 FURTHER MANAGEMENT

The *Pimelea* "Turakina" planted at Tangimoana dunelands have established well, as seedlings are present and may start flowering this coming summer. The plants are presently only located in two areas, which would cover less than 20 m^2. It would be advisable to plant additional plants in other locations within theTangimoana dunelands to ensure their survival. The dunelands are naturally dynamic, and dunes regularly move inland and cover the existing vegetation. Two small populations are very vulnerable to being buried by sand movement.

4. Water table monitoring

The water table of two natural wetlands containing populations of *E. neozelandica* was monitored in wells made from plastic pipes from July 1994 to December 1996 in the Tangimoana dunelands (Singers 1997). Over this period monthly rainfall was predominantly above average at Tangimoana, resulting in an above average water table in both wetlands. As a consequence the summer water table readings were high, often being above the wetland surface, which is an unusual event and not representative of the average summer water table. The water table measuring pipes remained in both wetlands over the 1996-97 summer, though some of these original pipes had been vandalised and no longer worked. The water table was monitored over the 1996 - 97 summer period in order to obtain additional measurements.

The plastic pipes used to measure the water table were inserted into both wetlands to below the water table level. There were eight pipes at one site and eleven at the second, placed at ten metre intervals from each other. The height of the water table in all figures is an average of all pipes at each wetland, excluding two pipes which were located on small dunes. A tape measure which displaced the water surface was placed into the pipes down to the water table height. A reading was made to the top of the pipe, and the height of the water table measuring pipe was then subtracted, in order to obtain a reading of the water table in relation to the soil surface.

Figures 6a and 6b show the water table height over successive summer periods. The 1996 - 97 data are more uniform than the previous year's data, with a gradual decrease in the water table height towards the end of the summer. Additionally the lowest mean water table height was recorded on 27 March. This may be around the level of the lowest possible water table height for the two wetlands.

5. References

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6. Appendices

Table 1 : The number of *Eleocharis neozelandica* plants in each quadrat of high, medium and low elevation in two excavated wetlands at 5 and 30 January 1997, resulting from planting six into each of the 24 quadrats on 31 January 1996.

	North wetland			South wetland		
Quadrat	High	Medium	Low	High	Medium	Low
1	1	12	0	6	7	1
2	2	5	0	6	6	1
3	6	6	0	6	6	0
4	6	7	0	5	7	0
Total	15	30	0	23	26	2

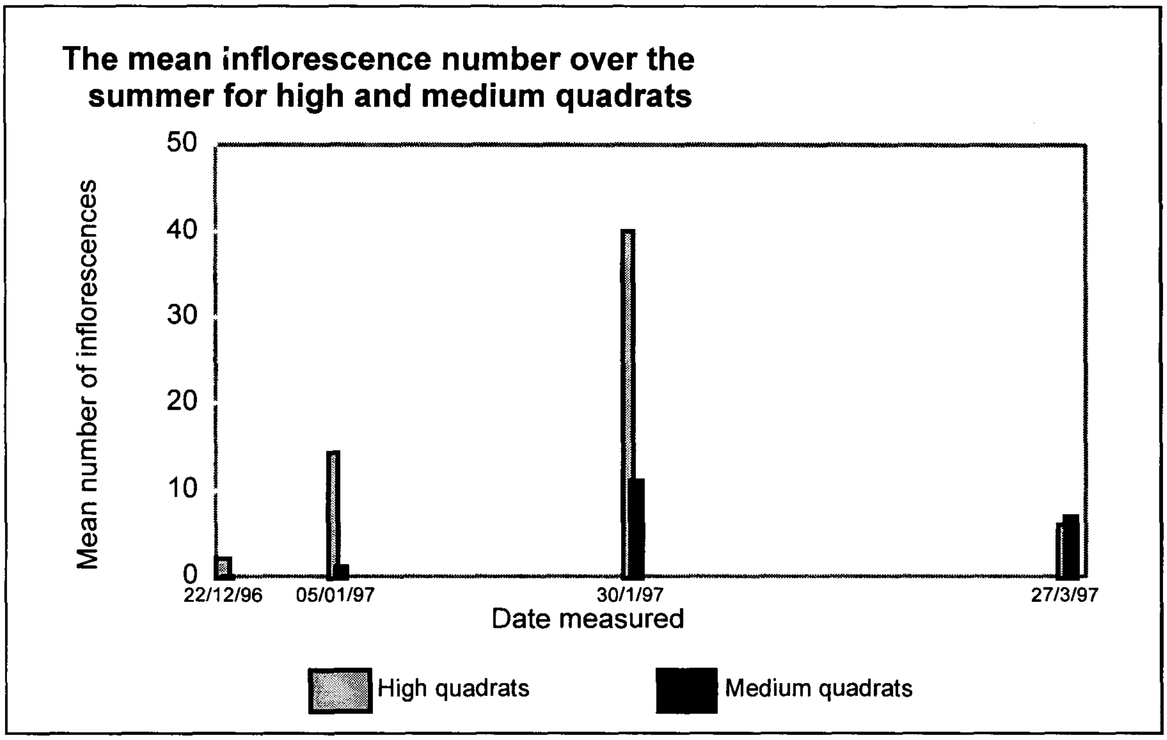


Figure 1: The mean number of *Eleocharis neozelandica* inflorescences per plant, for all plants in high- and medium-elevation quadrats from two excavated wetlands.

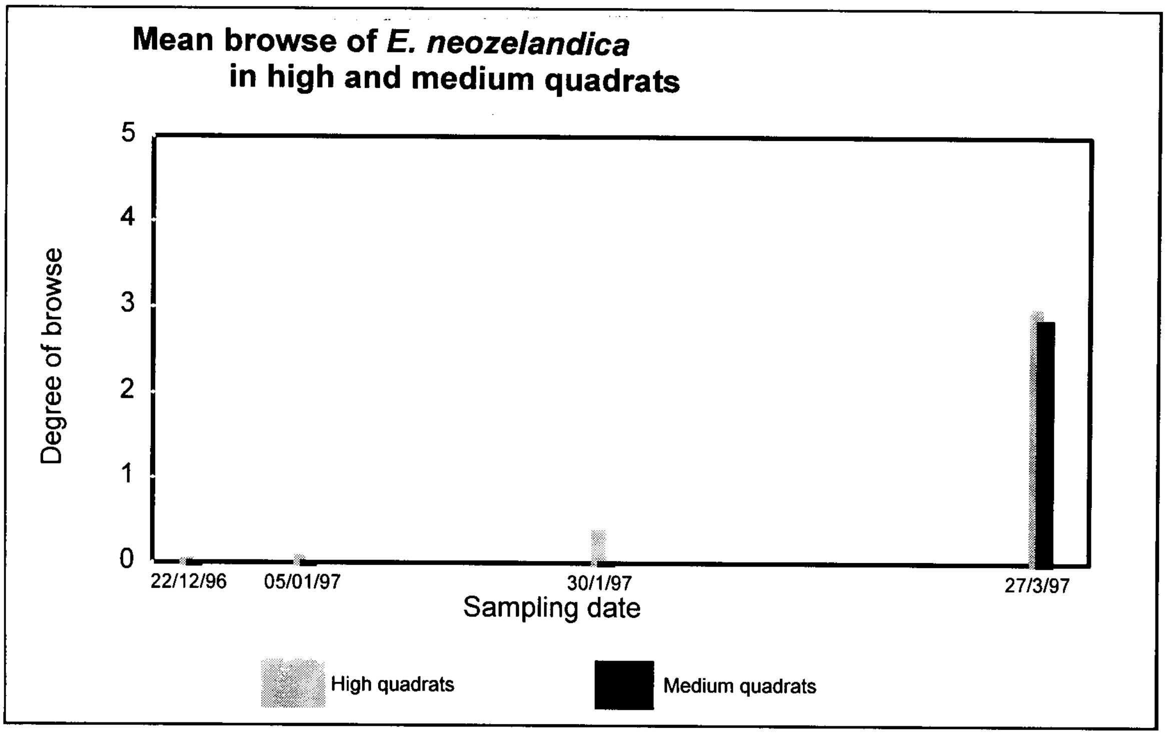


Figure 2: The mean rabbit browse of all tagged *Eleocharis neozelandica* in medium and high quadrats from two excavated wetlands. The degree of browse is: 0 none, 1 light, 2 moderate, 3 high, 4 very high, and 5 extreme.

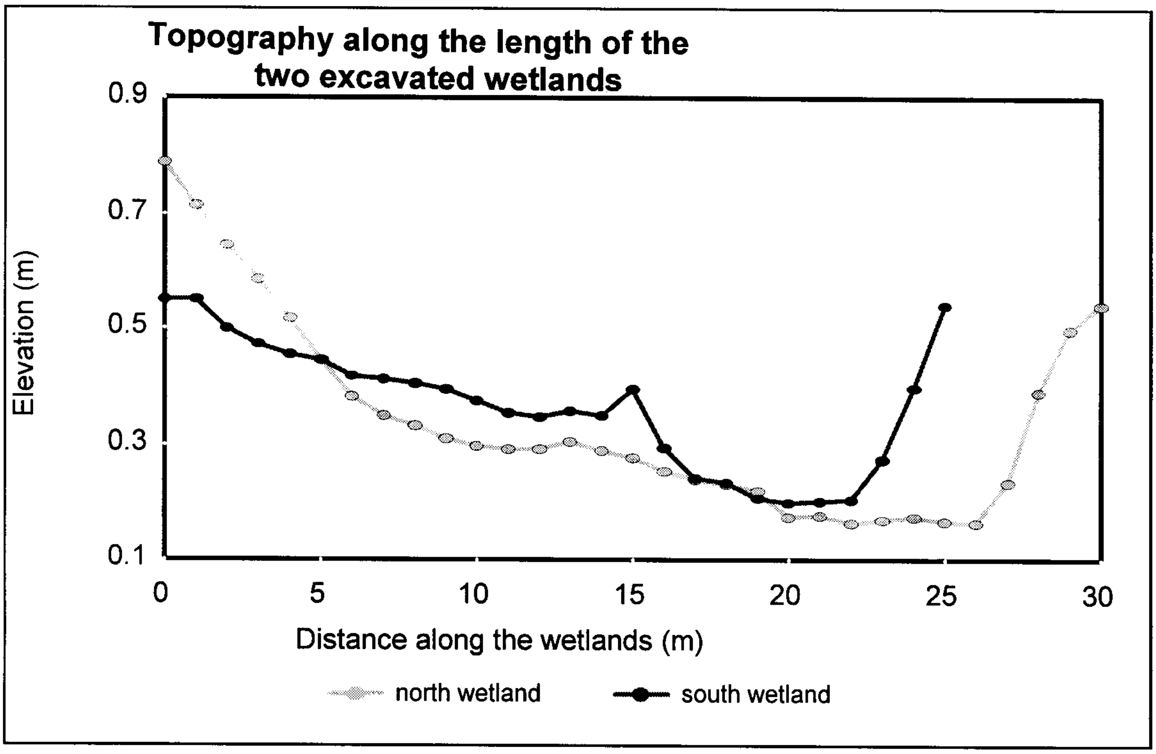
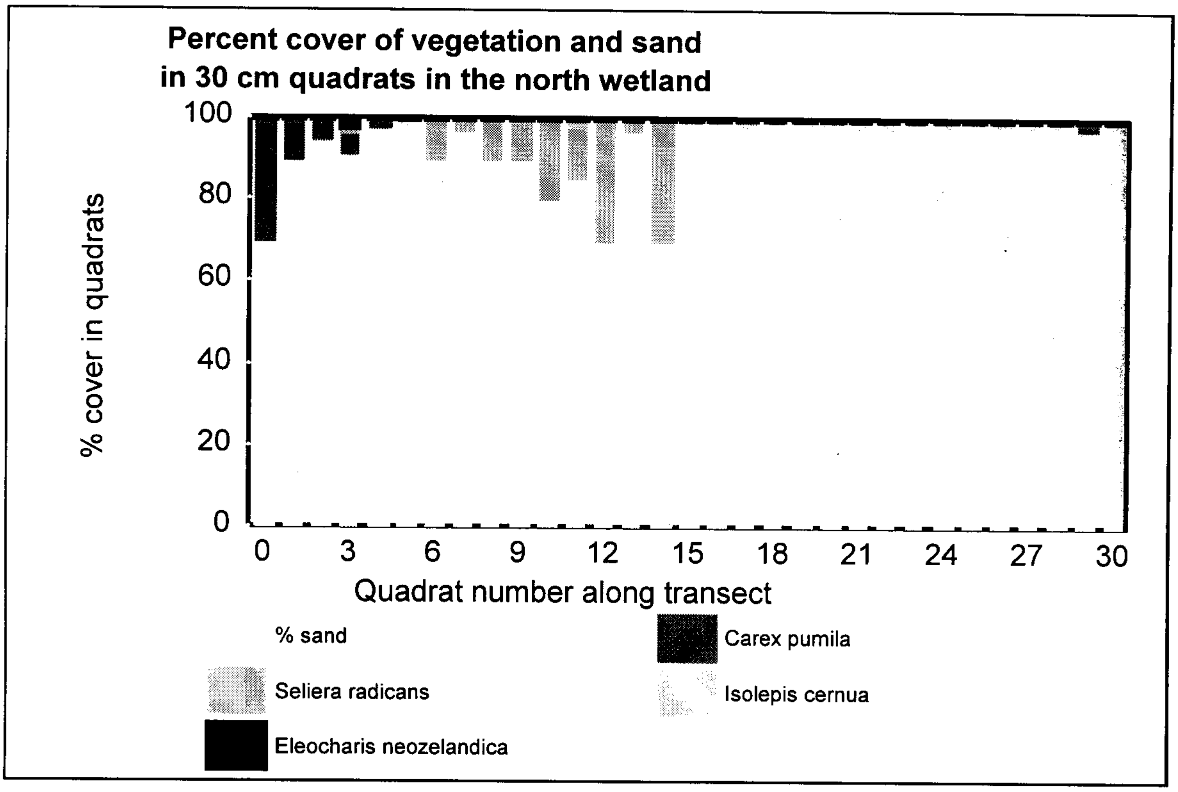


Figure 3: The topography of the north and south excavated wetlands measured at one metre intervals on a transect along the central axes of two excavated wetlands. The centres of the *Eleocharis neozelandica* planting quadrats are at 3 metres for both of the high-elevation quadrats, at 12 and 13 metres for the medium-elevation quadrats, and 20 and 24 metres for the low-elevation quadrats, for the south and north wetlands, respectively.



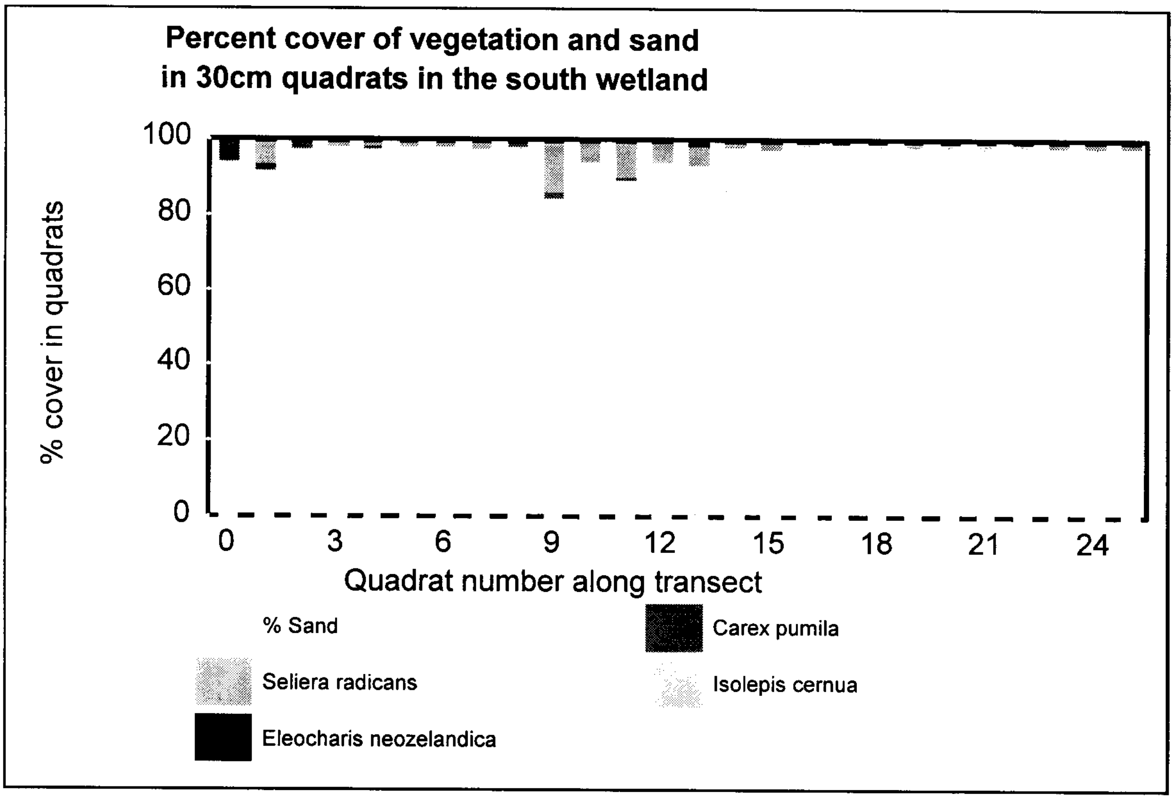
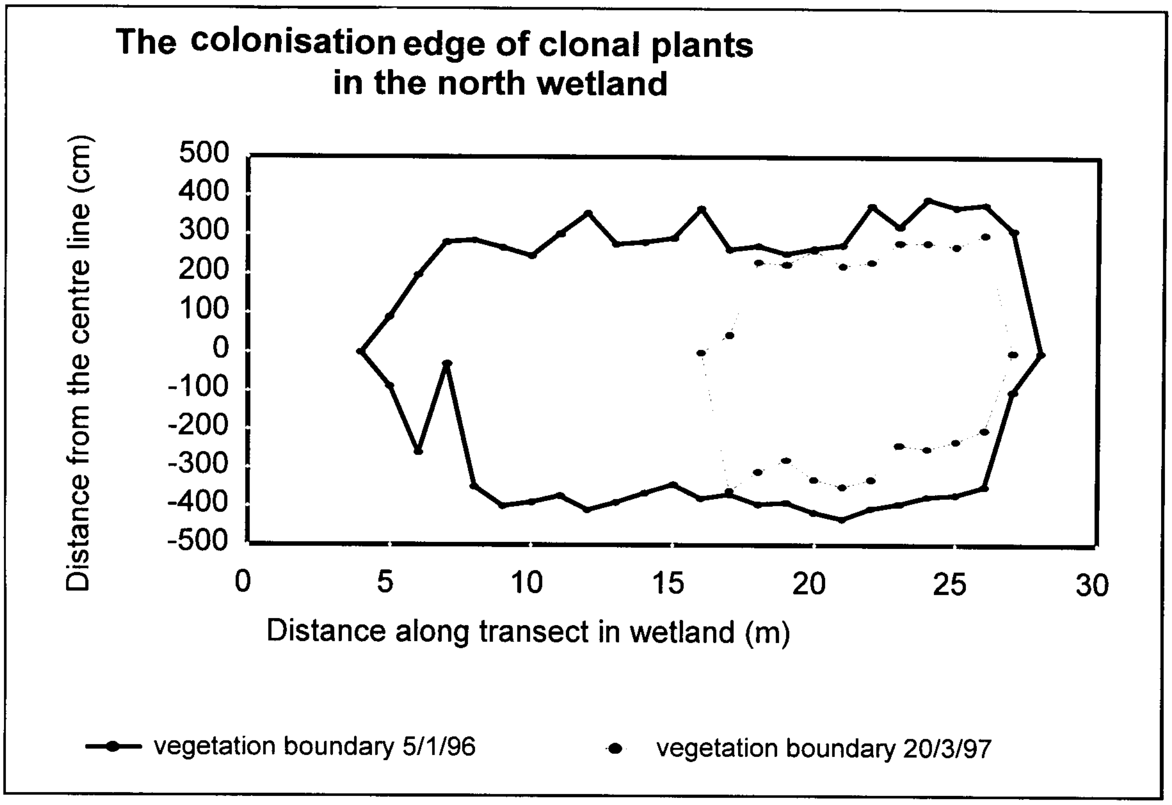
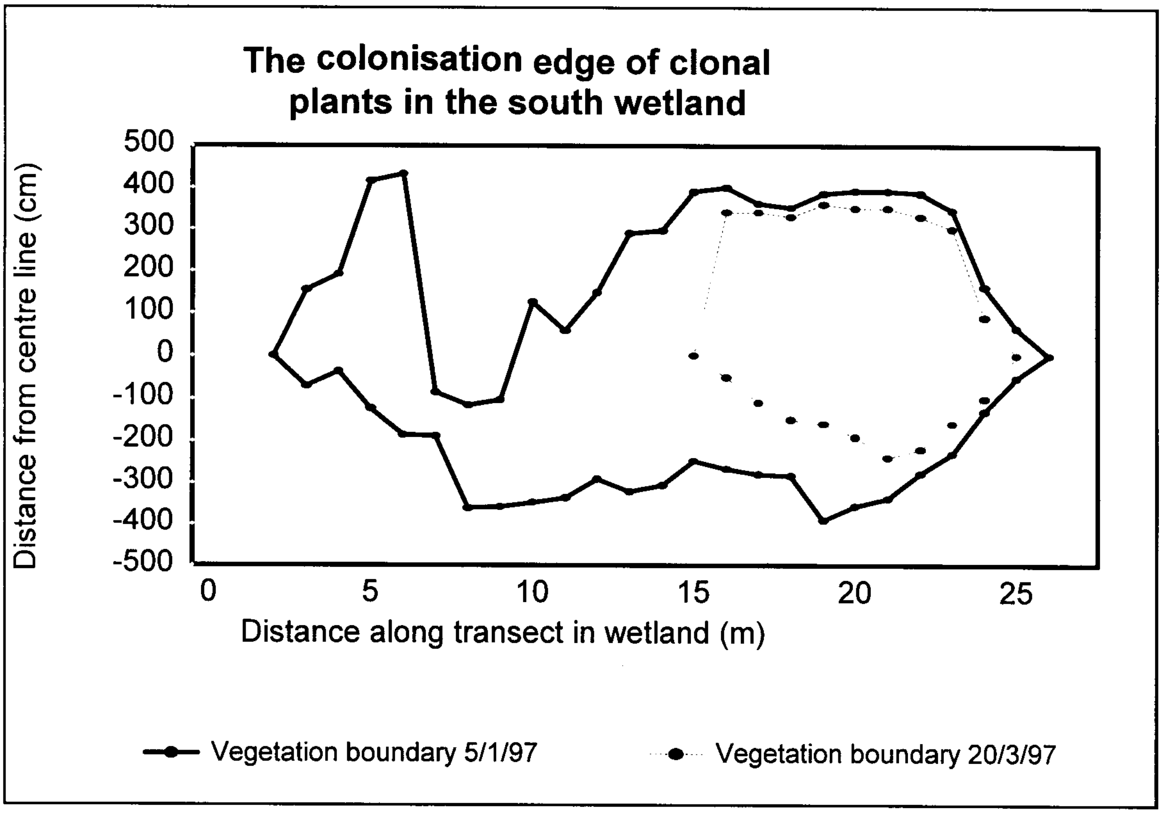


Figure 4a and 4b: The percentage cover of sand and all species present in 30 cm ^{2} quadrats at metre intervals on a transect along the central axes of both wetlands,





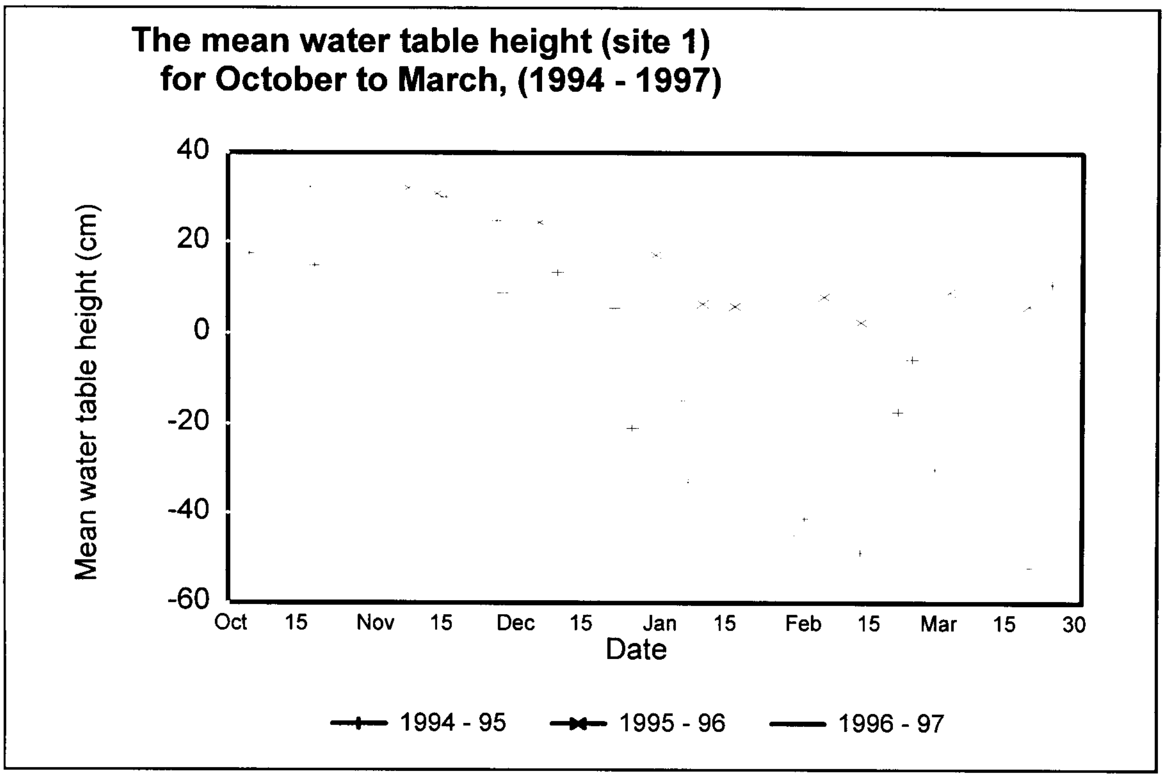
Figures 5a and 5b: The rhizomatous edge of clonal plants (*Carex pumila* and *Selliera rotundifolia*) measured at metre intervals from a transect along the central axes of both wetlands.

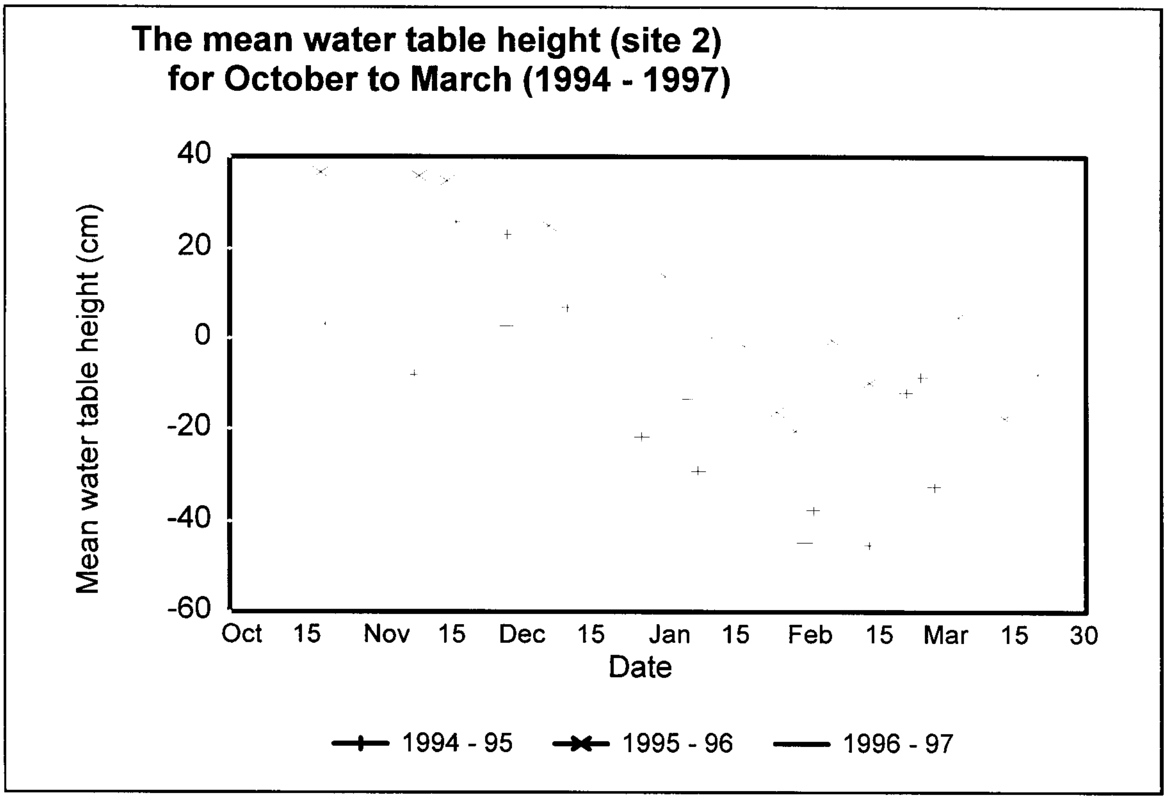
Table 2: Assessment of the survival, growth and reproduction of the Pimelea "Turakina" planted on 9 June 1996. The assessment was undertaken on 22 December 1996 and 27 March 1997.

Plant number	**Plant height (cm)**	**Flowers/ fruit 22/12/96**		**Flowers/ fruit 27/3/97**		**Seedlings around plant 22/12/96**	**27/3/97**
P554	22	Y	5	N	N	0	0
P569	17	Y	Y	Y	N	0	0
P557	16	Y	Y	Y	N	0	0
P558	20	Y	Y	N	2	0	1
P549	26 DEAD 27/3/97	Y	49	-	-	0	-
P567	17	Y	7	Y	N	0	1
P568	not found 22/12/96	-	-	N	N	-	0
P560	30	Y	19	N	N	0	0
P555	12	N	N	N	N	1	0
P552	not found 22/12/96	-	-	N	N	-	0
P553	7 DEAD 27/3/97	Y	9	-	-	1	-
P559	28	Y	9	N	N	0	0
P556	23	Y	17	N	N	0	0
P561	DEAD 27/3/97	-	-	-	-	-	-
P562	22 DEAD 27/3/97	Y	7	-	-	0	-
P564	not found 22/12/96	-	-	N	N	-	0
P565	33	Y	18	N	2	0	1
P566	not found 22/12/96	-	-	N	N	-	0
P551	26	Y	9	N	N	0	0
P563	18	Y	11	N	N	6	0

Table 3: Assessment of the survival, growth and reproduction of the *Pimelea* "Turakina" planted on 25 November 1995, assessed on 22 December 1996 and 27 March 1997.

Plant number	**Plant height (cm) and status**	**Flowers/ fruit 22/12/96**		**Flowers/ fruit 27/3/97**		**Seedlings around plant 22/12/96**	**27/3/96**
P512	7 DEAD 27/3/97	N	N	-	-	1	3
P513	not found 22/12/96	-	-	N	N	-	14
P514	16	Y	N	Y	N	0	5
P515	DEAD 22/12/96	-	-	-	-	2	-
P516	DEAD22/12/96	-	-	-	-	3	-
P517	(not found 22/12/96 DEAD 27/3/97	-	-	-	-	-	0
P518	16	Y	N	N	2	28	3
P519	12	Y	4	N	N	8	0
P520	12 DEAD 27/3/97	N	Y	-	-	11	16
P521	15	N	N	N	N	14	0
P522	13 DEAD 27/3/97	N	Y	-	-	4	2
P523	(not found 22/12/96 & 27/3/97	-	-	-	-	-	-
P524	9	Y	N	N	1	8	4
P525	9 DEAD 27/3/97	N	N	-	-	11	1
P526	16	N	N	N	N	10	9
P527	9	Y	3	N	N	9	0
P528	13	N	Y	N	N	68	46
P529	15	Y	Y	N	N	3	4
P530	12	N	Y	N	N		15
P531	15 DEAD 27/3/97	N	Y	-	-	12	15
P532	20	Y	N	N	N	10	3
P533	12	Y	N	N	N	4	4
P534	DEAD 13/5/96	-	-	-	-	-	-
P535	15 not found27/3/97	Y	6	-	-	10	-
P536	DEAD 22/12/96	-	-	-	-	1	3
P537	17	Y	N	N	N	10	15
P538	11	N	N	N	3	0	5
P539	DEAD 13/5/96	-	-	-	-	-	-
P540	18	N	N	N	N	3	0
P541	10	N	Y	N	2	0	3
P542	not found 22/12/96	-	-	N	N	-	1
P543	8	Y	N	N	N	2	7
P544	(not found 22/12/96 & 27/3/97	-	-	-	-	-	-
P545	not found 22/12/96	-	-	N	N	-	0
P546	18	Y	5	N	N	0	0
P547	15	Y	Y	Y	N	-	11





Figures 6a and 6b - The mean monthly water table height and two excavated wetland study sites for October to March, 1994 to 1997.