Preliminary report on the vegetation of the Sandspit area, Manawatu Estuary RAMSAR site, Foxton Beach, New Zealand

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Introduction

The vegetation of the Manawatu River mouth is a nationally and internationally significant site for wading and coastal birds. It also represents one of the largest areas of pristine estuarine vegetation in New Zealand. The estuarine vegetation can be subdivided into several areas, which have limited terrestrial connections. The "Sandspit" is a small area (about 4.5 hectares), which is inserted into an important feeding area for birds, while being close enough to the township to be readily visited (Figs. 1,2) This report is a preliminary assessment of the vegetation and its components of this ecologically important Sandspit, with comments on its management requirements. For this purpose the western end of the "Sandspit" terminates just before the conspicuous belt of white poplar (*Populus alba*), at an open area of largely exotic grassland vegetation.

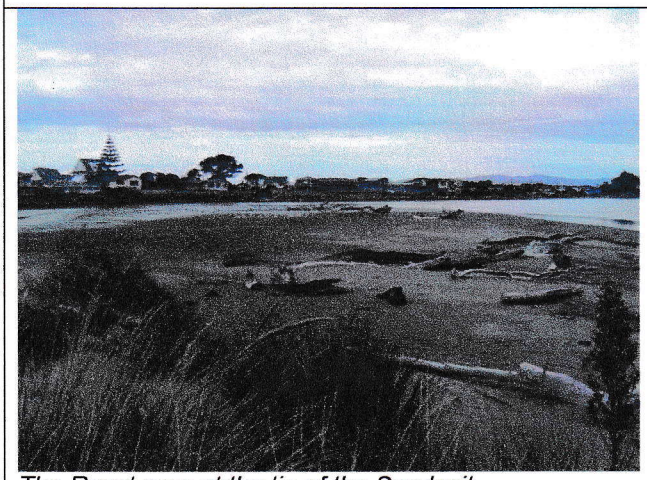
Methods

Three formal visits were made to the Sandspit area over the period mid March to late April 2008, summing to about 8 hours. During these visits the vegetation was examined in blocks. The blocks were pre-determined by careful inspection of a series of high resolution aerial photos provided by the Department of Conservation. From these, in conjunction with the rest of the estuarine and dune areas under investigation, a number of vegetation types were delimited and mapped out.

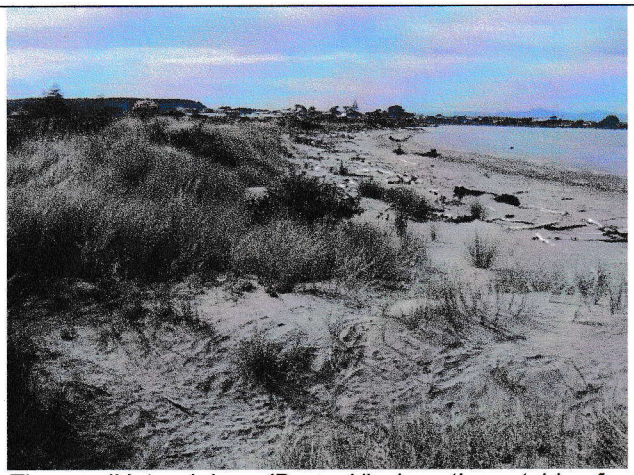
The vegetation types so defined were then "ground-truthed" by inspection, to determine whether they are in fact realistic, whether the proposed boundaries (transition zones between adjacent vegetation zones) are correct and whether other vegetation types encountered during inspection but not conspicuous in aerial photos should be accepted. To do this, each block or newly defined / delimited vegetation type was visited, and explored for species. For smaller areas, the species list was comprehensive, but for larger areas, recordings were made using a plotless sampling methodology, usually involving a sample area of about 100 m^2. A total of 23 sets of data were recorded.

In each vegetation type or sample a species list was compiled of all vascular plant species present. Taxonomy follows the Landcare Research Nga Tipu website (http://nzflora.landcareresearch.co.nz/). Each species was assigned an estimated cover value, determined using the "shadow" approach, where the proportion of the area of the block covered by each species' shadow (from solar zenith) was estimated and expressed as a percent of the substrate area of the sample. As part of the coverage, percents of bare sand, mud (including water, since this depends on the tide level), shell and woody debris were also recorded. Mean height of the canopy was also estimated. Because species can overlap each other (occuring in vertical strata) the total percent covers for a sample can be greater than 100. Maximum height of substrate above the mudflats was estimated visually. Notes were made on matters of interest and on general topography.

Figure 1: Vegetation of the Sandspit area, Foxton.

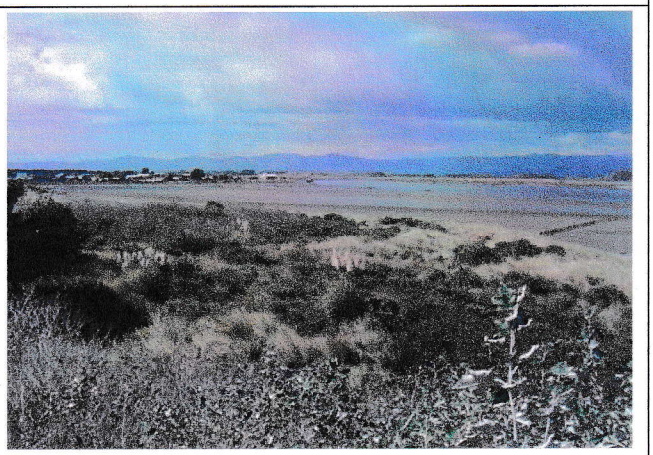


The Roost area at the tip of the Sandspit.



The small lateral dune (Dune, U) along the outside of the Sandspit parallel with the Manawatu River.

Saltmarsh (SM: foreground) and Rushland (R: background) on the inner side of the Sandspit.



Overview of the backbone of the Sandspit with the widespread vegetation being Scrub (Z).

Vegetation type Rushland (B) with a margin of **Lupinus arboreus** *(tree lupin), looking across to the mudflats between the Sandspit and the town.*

The Runnel (R), the part of the excavated drain which used to cross the Sandspit.

Results

A total of 66 species were recorded, 49 more than once. Of these, 38% are natives, two are found in New Zealand but are not native to the estuary or the Manawatu, and the rest (59%) are exotics. Five species are climbers or scramblers, while 20% are grasses, 40% dicot herbs, 16% monocots, including rushes, and the remainder (17%) trees and shrubs. The most common species, occupying from 12 to 5% of the cover of the Sandspit's samples, in decreasing order, were *Selliera radicans, Samolus repens, Bolboschoenus caldwellii, Ficinia nodosa, Schoenoplectus pungens, Ammophila arenaria, Schedonurus phoenix*, and *Juncus acutus*, the last three being exotics. In addition to this list the species *Ficinia nodosa, Plantago coronopus, Selliera radicans* and *Samolus repens* were also very common, occuring in more than half the samples, though with lower total coverage than the other species.

On the Sandspit, ten vegetation types were identified (Table 1), in addition to bare mud (M), which is covered by all high tides, and lacks species.

Table 1: Vegetation sampling effort for Sandspit area. Note: Sample number reflects that of the Sandspit alone; other samples of these vegetation types are present in other areas of the estuary.

Vegetation type code	Vegetation type	Number of samples	Species number	Exotic species diversity (%)	Proportion of plant cover in exotics	Proportion of plant cover in natives
Lowlying areas						
O	3 square meadow	3	10	20	0.05	0.95
M2	Mudflat margin	5	23	30	0.22	0.78
SM	Saltmarsh	4	21	33	0.23	0.74
Roost	Roosting bank, spit end	1	2	0	0.00	1.00
Sandspit backbone						
U	Dune	2	21	71	0.87	0.13
B	Rushland	3	35	60	0.47	0.53
RZ	Marsh scrub	2	26	62	0.41	0.59
Z	Scrub	1	22	82	0.76	0.24
Excavated drain						
R	Runnel	1	8	38	0.18	0.82
Old drain	Old drain	1	13	46	0.58	0.42

A small dune averaging 1.5m above the mudflats borders the river edge of the Sandspit, immediately adjacent to a large area of irregular topography, with sand deposits forming surfaces to 3m above the surrounding mudflats. These form the backbone of the spit. The rest of the area is lowlying, in mudflat. It is difficult to quantify the extent of unvegetated substrates in such an environment, but within the area sampled for vegetation, sand was the most common bare surface (16%), and mud less so (10%), with woody debris covering around 4% of the surface. About 35% of the surface of the dune belt was in bare sand (Table 2).

The open, lowlying areas between the spit proper and the town edge contain the vegetation types 3-Square Meadow (O), Mudflat Margin (M2), and Saltmarsh (SM). The 3-Square Meadow is dominated by the eponymous *Schoenoplectus pungens* at 60% cover (Table 2), with *Bolboschoenus caldwellii* common; both species are tolerant of large depths of water, being half submerged at high tides. Mudflat Margin (M2) and Saltmarsh (SM) occur on slightly higher terrain, and are dominated (about 30% cover) by *Samolus repens* and *Selliera radicans*, with 15% cover of exotic *Juncus acutus*. They differ in that Saltmarsh (SM) also has some cover of the native sea rush, *Juncus kraussii* as well as flax, *Phormium tenax*, the native saltmarsh shrub, saltmarsh ribbonwood (*Plagianthus divaricatus*) and the exotic shrub, *Lupinus arboreus*. Also Mudflat margin (M2) is the only occurrence in this part of the estuary of *Leptinella dioica*, a species which is nationally uncommon, but not infrequent in other parts of the estuary.

At the east end of the Sandspit is a large area called the Roost, a bird-resting area which is submerged only by very high tides or by floods. It is largely composed of sand, with only occasional native saltmarsh species present (Fig. 2, Tables 1,2).

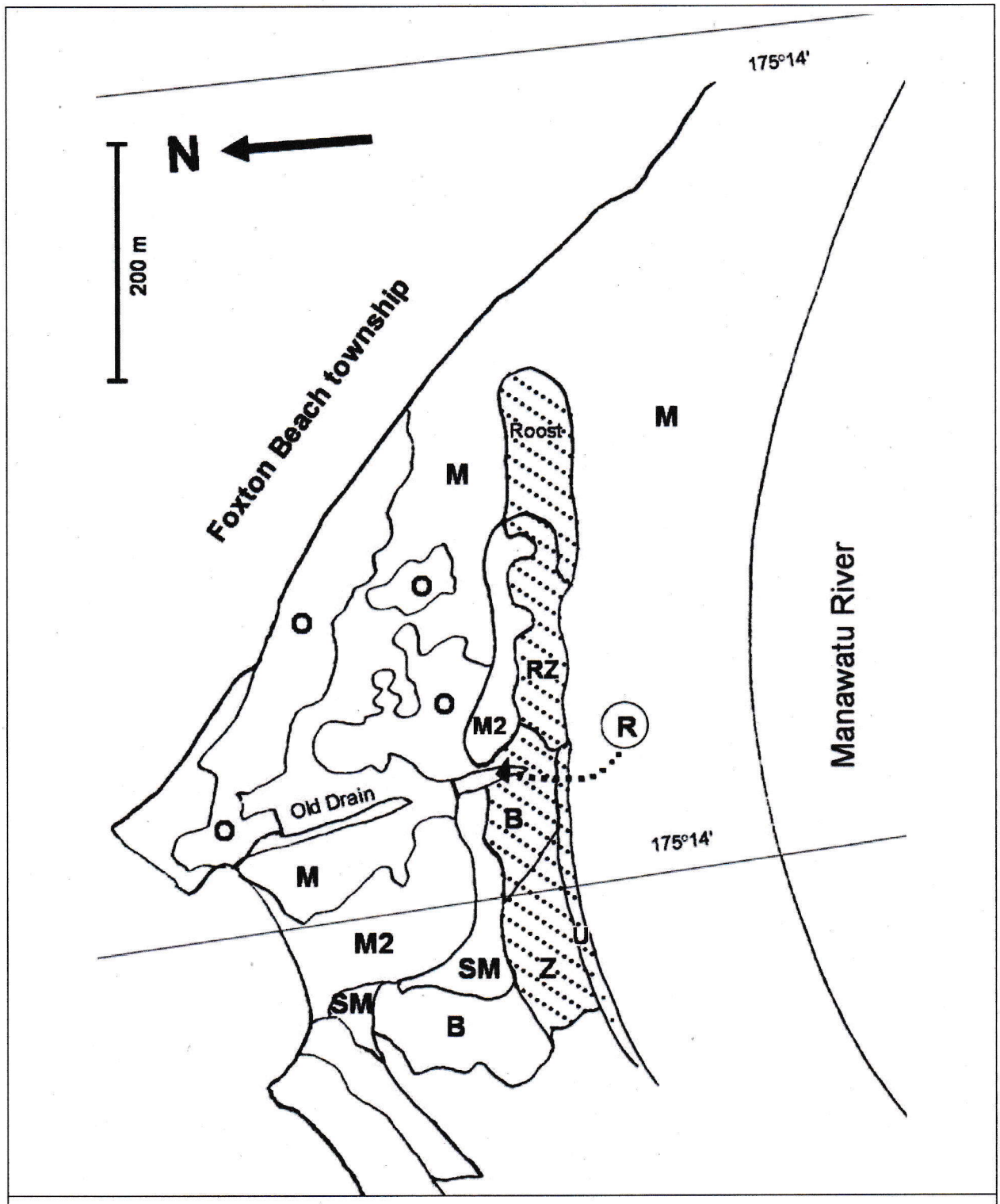


Figure 2: Map of the Sandspit area with vegetation types labelled and coded. The shaded area is the higher ground of the Sandspit backbone. M = bare mud.

Table 2: Composition of the vegetation types, organised by topography. The species are in order of their native/exotic status. Values are mean cover per sample. At the base of the table are the cover values for various substrates, and estimates of topographic height above the mudflats, and canopy height of the samples. For Status, e = exotic, z = native to New Zealand, but not the Manawatu, and n = native. For Habit, Monocot excludes rushes, which are categorised separately.

		Vegetation types											
		Lowlying areas				Sandspit backbone				Excavated drain			
Status	Species	O	M2	SM	Roost	U	B	RZ	Z	R	Old drain	Common name	Habit
e	*Acacia sophorae*	0	0	0	0	0.5	5	1.75	0	0	0	sand acacia	tree
e	*Acetosa sagittata*	0	0	0	0	0	0	0	1	0	0	climbing dock	climber
e	*Agrostis stolonifera*	0	0.5	0	0	0	0	0	0	0	0	creeping bent	grass
e	*Ammophila arenaria*	0	0	0	0	45	5	7	45	0	0	marram	grass
e	*Asparagus asparagoides*	0	0	0	0	0	0	0	3	0	0	smilax	climber
e	*Aster subulatus*	0	0	0	0	0.3	0	0	0	0	0.5	sea aster	dicot herb
e	*Atriplex prostrata*	0	2.5	0	0	0	0	0	0	0	0	orache	dicot herb
e	*Calystegia sepium*	0	0	0	0	0	0	0	2	0	0	pink bindweed	climber
e	*Carpobrotus edulis*	0	0	0	0	0	0	0	2	0	0	iceplant	dicot herb
e	*Centaurium erythraea*	0	0.5	2	0	0	0.5	0.5	0	0	0	centaury	dicot herb
e	*Conyza albida*	0	0	0.5	0	1.5	0.5	1	1	0	0	fleabane	dicot herb
e	*Cortaderia jubata*	0	0	0	0	0.3	0	0	0	0	0		grass
e	*Cortaderia selloana*	0	0	0	0	0	1.7	0.8	2	0	0	pampas	grass
e	*Crepis capillaris*	0	0	0	0	2.5	0.5	0	4	0	0	hawksbeard	dicot herb
e	*Dactylis glomerata*	0	0	0	0	0	0	0	5	0	0	cocksfoot	grass
e	*Galega officinalis*	0	0	1	0	0	5	1	0	0	0	goat's rue	dicot herb
e	*Helminthotheca echoides*	0	0	0	0	0	0	0.5	0	0	0	oxtongue	dicot herb
e	*Holcus lanatus*	0	0	0	0	0.5	0.7	0	5	0	0	Yorkshire fog	grass
e	*Hypochaeris radicata*	0	0	0	0	2.5	1.5	5	2	0	0	catsear	dicot herb
e	*Juncus acutus*	5.5	15	15.2	0	0	2.8	0.5	0	10	20	sharp rush	rush
e	*Lagurus ovatus*	0	0	0	0	0.3	0	0.5	0	0	0	hare's tail	grass
e	*Leontodon taraxacoides*	0	0	0	0	0	0.8	0	0	0	0	hawkbit	dicot herb
e	*Lillium formosum*	0	0	0	0	0.3	0.5	0	0	0	0		monocot
e	*Lotus corniculatus*	0	0	0	0	0	0.5	0	0	0	0	birdsfoot trefoil	dicot herb
e	*Lotus suaveolens*	0	0	0	0	0	0	0.5	0	0	0	hairy birdsfoot trefoil	dicot herb
e	*Lupinus arboreus*	0	0	10	0	5	5.5	0.5	25	0	0	tree lupin	shrub
e	*Lycium ferocissimum*	0	0	0	0	0	0.5	0	2	0	0	box thorn	shrub
e	*Pinus radiata*	0	0	0	0	0	0	0	3	0	0	radiata pine	tree
e	*Plantago coronopus*	0	3.8	6	0	0	0.8	6	0	1	8	buck's horn plantain	dicot herb
e	*Polypogon monspeliensis*	0	0.5	0	0	0	0	0	0	0	0.5		grass
e	*Rumex acetosella*	0	0	0	0	0	0	0.5	0.5	0	0	sheep's sorrel	dicot herb
e	*Schedonurus phoenix*	0	3.5	5.25	0	1.5	33.3	25	3	0	1	tall fescue	grass
e	*Senecio elegans*	0	0	0	0	6.5	0.5	0	0	0	0		dicot herb
e	*Solanum chenopodioides*	0	0	0	0	0	0	0	0.5	0	0	velvety nightshade	dicot herb
e	*Sonchus oleraceus*	0	0	0	0	0.5	0	0	0	0	0	puha	dicot herb
e	*Spartina anglica*	0.5	0	0	0	0	0	0	0	5	0	cord grass	grass
e	*Trifolium fragiferum*	0	0	0	0	0	1	0	0	0	1	strawberry clover	dicot herb
e	*Ulex europaeus*	0	0	0	0	0.3	0.5	2	0.5	0	0	gorse	shrub
e	*Yucca gloriosa*	0	0	0	0	0	0.5	0	0	0	0	yucca	monocot
z	*Coprosma repens*	0	0.5	1	0	0	5	0.5	2	0	0	taupata	shrub
z	*Pittosporum crassifolium*	0	0.5	0	0	0	1	0.5	0	0	0	karo	tree

Table 2. contd.

Status	Species	Lowlying areas				Sandspit backbone				Excavated drain		Common name	Habit
		O	M2	SM	Roost	U	B	RZ	Z	R	Old drain		
n	*Acaena novaezelandiae*	0	0	0	0	0	0.5	0	0	0	0	biddibid	dicot herb
n	*Apium prostratum var. fileforme*	0	2.5	1.25	0	0	0.8	1.25	0	0	0.5	native celery	dicot herb
n	*Apodasmia similis*	0	1.22	3	0	0	13	10	4	0	0	oioi	monocot
n	*Bolboschoenus caldwellii*	42.5	10	0.5	0	0	0	0	0	60	2		monocot
n	*Calystegia soldanella*	0	0	0	0	1	0.5	0	0	0	0	shore bindweed	climber
n	*Coprosma acerosa*	0	0	0	0	0	3	0	0	0	0	sand coprosma	shrub
n	*Coprosma propinqua*	0	0.5	0	0	0	0.5	0	0	0	0	mingi mingi	shrub
n	*Cotula coronopifolia*	0	0	0	0	0.3	0	0	0	0	0	bachelor's buttons	dicot herb
n	*Deyeuxia billardieri*	0	0	0	0	0	0	0.5	0	0	0	sand bent	grass
n	*Ficinia nodosa*	0	4.5	10	0.5	7.5	38.7	20	30	0	0.5	clubrush	monocot
n	*Isolepis cernua*	0	0.8	0.8	0	0	0	0	0	1	0	slender clubrush	monocot
n	*Juncus kraussii*	0.8	1.2	13.5	0	0	5.7	0	0	5	3	sea rush	rush
n	*Leptinella dioica*	0	0.7	0	0	0	0	0	0	0	0		dicot herb
n	*Lobelia anceps*	0	0	1	0	0.3	0	0	0	0	0	punakuru	dicot herb
n	*Muehlenbeckia axillaris*	0	0	0	0	0	0	0.5	0	0	0		climber
n	*Ozothamnus leptophyllus*	0	0	0	0	0.3	5	0	0	0	0	tauhinau	shrub
n	*Phormium tenax*	0	0.5	10	0	0	6	0.5	0.5	0	0	flax	monocot
n	*Plagianthus divaricatus*	0	0	2	0	0	0.8	0	0	0	0	saltmarsh ribbonwood	shrub
n	*Puccinellia stricta*	0.5	0	0	0	0	0	0	0	0	0		grass
n	*Samolus repens*	3	32	30	0	0	0	20	0	0	8	sea primrose	dicot herb
n	*Sarcocornia quinqueflora*	10	1.8	0.5	0.5	0	0	0	0	0	0	glasswort	dicot herb
n	*Schoenoplectus pungens*	60	1	45	0	0	0	0	0	5	0	three-square	monocot
n	*Selliera radicans*	2.5	37	22.5	0	0	10	25	0	1	8	remuremu	dicot herb
n	*Spinifex sericeus*	0	0	0	0	0.3	0	0	0	0	0	spinifex	grass
n	*Triglochin striata*	5	0.7	0	0	0	0	0	0	0	0.5	arrow grass	monocot
	Mud cover (%)	5.5	10.3	18.3	0	0	0	0	0	10	50		
	Sand cover (%)	0	20	0	95	35	5	35	1	0	0		
	Shell cover (%)	0	0	0	0.5	0.3	0	0	0	0	0		
	Wood cover (%)	0	9.33	5	4	6.5	0.8	10	1	5	0		
	Dune height (m)	0	0.2	0	0	1.5	2	1.2	3	0	0.3		
	Canopy height (m)	0.9	0.1	0.3	0	0.9	1.5	1.5	0.6	0.8	0.8		

The river-edge of the Sandspit has developed a linear sanddune, presumably due to windblown sand crossing the mudflats at low tides. The vegetation here, in community Dune (U), mainly consists of exotic species, dominated by marram, *Ammophila arenaria*, though native spinifex (Spinifex sericeus) is also present. There are occasional native tauhinau (*Ozothamnus leptophyllus*) and clubrush (*Ficinia nodosa*). The Dune is also the invasion site of Japanese lily (*Lilium formosum*).

The rest of the backbone of the Sandspit, on irregular, raised sandy surfaces, consists of three communities, Marsh Scrub (RZ), at the east end, Rushland (B) in the middle, and Scrub (Z) at the west end. Most of the shrub and tree species present on the Sandspit occur in these communities. All three communities have a very high proportion of both exotic species (60-80% of their floras) and high cover of exotics (53%), with only about 30% cover of native plants (Table 1). Native *Ficinia nodosa* is the only species which is common in all communities, but the local exotic taupata (*Coprosma repens*), not native to the Manawatu region, is also found in all. The robust exotic grass, tall fescue (*Schedonurus phoenix*), dominates in Rushland (B) and Marsh scrub (RZ), while

native saltmarsh plant, *Selliera radicans*, is a frequent understorey plant. Oioi (*Apodasmia similis*) is common in Rushland (B), and the native rear sanddune species, sand coprosma (*Coprosma acerosa*), and also the dune hollow shrub *Coprosma propinqua*, are both present in this community, one of their rare occurences in the estuary. Tree lupin (*Lupinus arboreus*) is common in Scrub (Z), as is *Ammophila arenaria.* This is the vegetation type with the least bare substrate, and the most developed vegetation, strata-wise.

The two remaining communities are the result of a drain, which was dug about a decade ago, splitting the mudflat and the higher areas of the Sandspit itself. Old Drain is mostly bare mud, but the aggressive exotic rush *Juncus acutus* is common, with margins of a range of saltmarsh species (Table 2). The drain recurs across community B (Rushland) as Runnel (R), and is dominated by native *Bolboschoenus caldwellii* which tolerates high water levels. In addition the two *Juncus* species occur here, as well as a small patch of the aggressive exotic mudflat grass, *Spartina anglica* (Partridge, 1987), a species under extensive management control at the estuary.

Discussion

Vegetation types

The top of the Sandspit terminates in an important roosting site for birds, called the Roost, and containing only sporadic patches of salt-tolerant vegetation. This area is basically an extension of the dune surfaces of the spit, its presence a consequence of current patterns of deposition and erosion (Hesp, 2001). In the absence of vigorous erosive episodes, it may develop into an emergent dune ridge.

The small lateral dune has vegetation typical of dunes in the area, being a mix of native and exotic foredune binders and an assortment of sand-tolerant weeds. This vegetation is typical of disturbed dunes of the Manawatu coast (Carnahan, 1957; Esler 1969, 1970), although foredunes along part of the coast are now covered, as is probably natural, in *Spinifex sericeus*. The dune's presence protects the vegetation on the inner side of the Sandspit from disturbance by all except the highest tides or very high riverflows. In the absence of major disturbance evens (floods, storms), this dune will continue to increase in height, albeit slowly, given the probably limited sand supply.

The inner vegetation of the Sandspit where frequent tidal inundation occurs, is typically salt meadow, comprising small herbs to 5cm tall, with emergent *Juncus kraussii* (sea rush) tufts. The inhabitants are all typical of vegetation of quiet but slightly salty waters (Partridge and Wilson, 1987, 1988), although *Juncus kraussii* does not occur in the far south of New Zealand (Johnson and Brook, 1998). The Manawatu dune hollow endemic, *Selliera rotundifolia* (Heenan, 1997), is not found in these vegetation types. These form a narrow strip running almost parallel with the sand dune on the inner side of the Sandspit's backbone, where they persist on the elevational (and inundational) gradient between the mudflats and the areas with accumulated sand,. Of the two here, Saltmarsh (SM) is the more terrestrialised, occuring in areas likely to be less exposed to high salt levels that the Mudflat Margin (MM) vegetation type. Such species are extremely particular in their relationship to tidal exposure (Sykes and Wilson 1989,). They are also intolerant of disturbance, including mud deposition and sand burial (Sykes and Wilson, 1990; Wilson and Sykes, 1999), as well as anthropic activities and foot traffic.

Between these two zones, where the smaller species are unable to compete, the vegetation is taller, and more terrestrialised, as riverine sediments deposited during high water episodes, and probably wind-blown sand, have increased the height of the surface above the tidally influenced mudflats. They are similar in their tall, dense plant cover, and frequency of exotic species. The lowest of these blocks is in Rushland (B) dominated by clubsedge (*Ficinia nodosa*) and tall fescue (*Schedonurus phoenix*), with *Apodasmia similis* (oioi) common. The other blocks are in what can effectively be called scrub, due to the frequency of woody species (mostly exotic shrubs or trees), and tall fescue, with a large range of other exotic species, as well as the native shrub, *Plagianthus divaricatus* (saltmarsh ribbonwood). This is one of the few woody species expected to occur in

such areas, along with *Olearia virgata* (not present on the Sandspit) and *Coprosma propinqua* on the more raised areas, while the reardune shrubs *Ozothamnus leptophyllus*, *Pimelea arenaria* and *Coprosma acerosa*, currently common present in the area between the Sandspit and the ocean, will progressively invade the Sandspit. Scrub (Z) is the most successionally developed of the Sandspit vegetation types, on the tallest dunes, and with the greatest cover of exotics (except for the poorly vegetated Dune). Eventually a plant seral succession might occur on the Sandspit, towards native reardune vegetation (featuring cabbage tree, *Cordyline australis*, flax, *Phormium tenax*, and native shrubs). However the chance of this natural successional sequence completing by attaining a vegetative cover of coastal forest is extremely low at this site. Instead the small size and exposed nature of the Sandspit make it likely that the vegetation will periodically be reset by major flood or storm events. The scrub phase is likely to remain the most developed vegetation cover of the Sandspit.

These blocks are all dissected by an old drain excavated (about 1990?), with the aim of draining the pond area near the existing toilet block. Across the mudflat the spoil mound from the drain forms a vegetation type labelled Old Drain and dominated by *Juncus acutus*. This is effectively an anomalous piece of saltmeadow with a high proportion of exotics due to its unusual topography. Across the more terrestrial area the excavation now forms a runnel which contains a range of semi-aquatic species including *Spartina*.

The drain has affected mud deposition patterns, with the more tidally exposed areas being progressively infilled by originally almost circular, but now colaescing patches of *Schoenoplectus pungens* (3-square) with some *Bolboschoenus caldwellii*, and occasional smaller or subcanopy saltmarsh species. Normal depositional processes will result in the gradual infilling of this mudflat, with consequent vegetation changes can be expected in both areas. Where this reduces the abundance and diversity of native species, these changes are to be regretted, as this area is most likely to receive very high visitation rates.

Management

The Sandspit presents several important management issues. The small size, inherently disturbed nature of the Sandspit, and its high proportions of non-native vegetation, imply that normal succession to rear dune vegetation is unlikely occur, and instead the area will oscillate (depending on the disturbance regime) between barren surfaces and those covered largely by exotics. In particular the backbone of the Sandspit is vulnerable to invasion by woody species alien to the normal successional sequence of such an estuary. A case can be made here for managing the area to retain it in sanddune and related vegetation, and to undertake a restoration programme to replace the exotics with appropriate native species. However, such a programme may need to be recommenced to repair damage after every major storm event.

Loss of the mudflat and other low-lying vegetation types from the accessible zone between the town and the Sandspit would be regretable from a visitor education viewpoint, as these vegetation types are the most natural of the readily accessible ones. Consequently the area should be monitored. Failing sufficient erosive floods, deliberate excavation of some of the area containing 3-Square Meadow could be considered as a way of reducing the overall topography of the low-lying areas, resetting the succession to terrestrialised vegetation, and providing fresh habitat for the vegetation types of lowlying areas.

The most urgent issue facing the Sandspit is the requirement to increasingly "naturalise" the vegetation. Since this area has high exposure to the settlement of Foxton Beach, it is inevitably highly disturbed, and is likely to be the area most heavily visited as the bird-viewing opportunities of the estuary become more widely known. It is therefore regretable that native vegetation does not dominate all blocks of the Sandspit, only being common in the lowlying areas which are more exposed to tidal influence. The areas with slightly raised topography are dominated by exotic plant species. A management protocol needs to be established to progressively reduce these exotics, some species of which represent serious weed threats to the estuary.

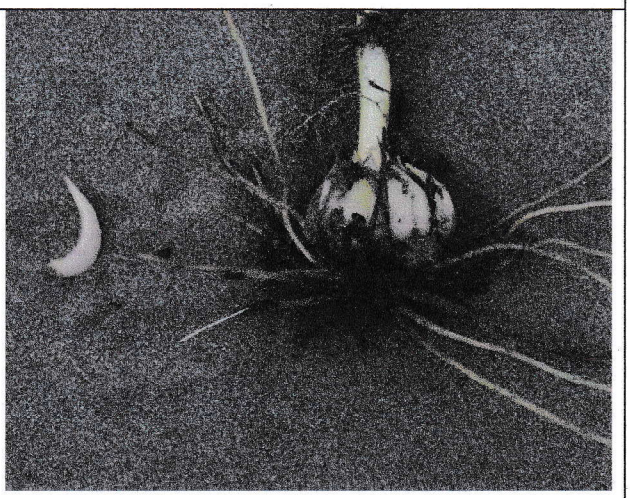
Priority needs to be given to the elimination of the woody exotics (Fig. 3; Table 3), since these are already conspicuous on the Sandspit, have the capacity to become large, and can also be aggressive in terms of spread (by seed or vegetatively). Yet they are mostly readily controlled, and some such control was observed to be under way later in the survey period. Sand acacia (*Acacia sophorae*), lupin (*Lupinus arboreus*), boxthorn (*Lycium ferrocissimum*), pine (*Pinus radiata*) and gorse (*Ulex europaeus*) are all relevant here. Lupin actually accelerates the dune succession unnaturally by the addition of nitrogen to the soil. These species can all be killed by cutting stems near ground level, and applying herbicidal paste to the cut stem bases, though care needs to be exercised in using Vigilante around native shrubs, as it is known to penetrate underground (by root contact or perhaps root grafts) to adjacent woody plants.

Figure 3: Weedy invaders of the Sandspit.

Exotic weeds **Coprosma repens** *and* **Cortaderia selloana** *in Scrub community at the spit base.*

The devastating visual impact of **Lupinus arboreus** *(tree lupin) during flowering on the Sandspit*

*Removing boneseed (***Chrysanthemoides monilifera***) from the Sandspit.*



The corm of **Lilium formosum** *and one of the bulbs which make it so persistent and aggressive.*

The group of woody weeds (Table 3) also includes a number of "mis-placed" natives, i.e. native species growing in the wrong place in the wrong region. These include *Pittosporum crassifolium*, which is not naturally found in the Manawatu at all (Esler, 1978), and *Coprosma repens* (taupata), which is a plant of rocky cliffs. Both these species, if not actually planted on the Sandspit, have

probably spread from coastal plantings in the town. Such spread is often facilitated by exotic birds (Williams and Karl, 1996), reinforcing the unsuitability of these species to the site. Since such material is often not ecologically pure (having passed through the hands of plant breeders), and is certainly not eco-sourced, any such sports should be removed promptly.

Table 3: Weed species requiring removal or development of weed control strategies.

Priority woody weeds	Priority herbaceous weeds
Acacia sophorae (sand acacia)	*Ammophila arenaria* (marram)
Coprosma repens (taupata)	*Asparagus asparagoides* (smilax)
Lupinus arboreus (lupin)	*Carpobrotus edulis* (ice plant)
Lycium ferrocissimum (boxthorn)	*Chrysanthemoides monilifera* (boneseed)
Pinus radiata (pine)	*Juncus acutus* (sharp rush)
Pittosporum crassifolium (karo)	*Lilium formosum*
Ulex europaeus (gorse)	*Yucca gloriosa* (yucca)

The next most important group of species to consider targeting are the aggressive herbaceous species (Table 3). The only plant of the aggressive coastal shrub *Chrysanthemoides monilifera* (boneseed) found on the Sandspit was removed when discovered in November 2007 (Fig. 3), but a 4m tall plant still persists in the nearly white poplar (*Populus alba*) belt, seeding onto the Sandspit. This species effectively grows like a shrub, and so is a priority for removal. Two other apparently unassuming but aggressive invaders are *Asparagus asparagoides* (smilax) and the Japanese lily, *Lilium formosum*. Both spread vegetatively rather than by seed, and are now frequent in the shrubby areas of the Sandspit. Both are difficult to control, requiring careful excavation to remove below-ground material, although smilax may be amenable to herbicidal sprays, as are the other herbaceous weeds. Presenting more major problems though, are marram and sharp rush (*Ammophila arenaria* and *Juncus acutus*), both of which are very common in some vegetation types of the Sandspit. Though easily controlled by spraying, their coverage in conjunction with their habitat means that a control programme would need to incorporate restoration components, with rapid insertion of appropriate natives into the habitat so cleared.

The final issue is public access to this important bird-viewing site, which will come under increasing demand in the future. Indeed, increasing the availability of this area to casual visitors is important in reducing future potential visitor impacts on other parts of the estuary. Now the area is protected by bollards from unwanted vehicle traffic, only foot traffic can access the eastern end of the Sandspit. However, humans wandering at will across such vegetation can generate serious damage, especially once visitor numbers increase above current. The logical method for dealing with the potentially increasing visitor numbers is to institute a formal set of walking tracks / routes, which would protect the vegetation, especially the more vulnerable shorter saltmarsh vegetation. Most people happily follow a route once supplied, and tend not to stray from it. An existing track which is dry in most tides crosses the grassland at the southern end of the Sandspit, just west of the studied area, where the vegetation is mostly of exotics, although enough native vegetation exists to make such a walkway, once suitably signposted, informative to the visitor. Consideration should be given to raising this track at its northern end, and eventually connecting it to the mainland via a raised boardwalk, perhaps along the current line of the bollards, as the "beach roadway" in front of the derelict sailing club building can be under water at high tides. Then the track could sensibly route walkers along the river side of the dune at low tides (where most visitors tend to walk by default now), although a track along the top of the dune would be needed for higher tides. This is probably best done as an informal route, with plank bridging across the drainage runnel. There are opportunities here too to introduce information sites. The scrubland vegetation at the end of the Sandspit is largely comprised of exotic vegetation, and thus is appropriate to house a small, discrete bird hide for visitors to view the Roost area. At a later date a return loop in the form of a raised boardwalk beside the drain would be attractive, and introduce a new view of the vegetation.

References

Carnahan, JA (1957): Botany of the Manawatu sand country. *Proceedings of the New Zealand Ecological Society 5*: 17-18.

Esler, AE (1969): Manawatu sand plain vegetation. *Proceedings of the New Zealand Ecological Society 16*: 32-35.

Esler, AE (1970): Manawatu sand dune vegetation. *Proceedings of the New Zealand Ecological Society 17*: 41-46.

Esler, AE (1978): *Botany of the Manawatu district, New Zealand.* E.C.Keating, Government Printer, Wellington, New Zealand.

Heenan, PB (1997): *Selliera rotundifolia* (Goodeniaceae), a new, round-leaved, species from New Zealand. *New Zealand Journal of Botany* 35: 133-138.

Hesp, P (2001): The Manawatu dunefield: Environmental change and human impacts. *New Zealand Geographer 57*: 33-40.

Johnson, PN; Brooke, P (1998): *Wetland plants of New Zealand*. Wellington, DSIR Publishing.

Partridge, TR; Wilson, JB (1987): Salt tolerance of salt marsh plants of Otago, New Zealand. *New Zealand Journal of Botany* 25: 559-566.

Partridge, TR; Wilson, JB (1988): Vegetation patterns in salt marshes of Otago, New Zealand. *New Zealand Journal of Botany* 26: 497-510.

Partridge, TR (1987): *Spartina* in New Zealand. *New Zealand Journal of Botany* 25, 567-576.

Sykes, MT; Wilson, JB (1989): The effect of salinity on the growth of some New Zealand sand dune species. *Acta Botanica Neerlandica 38*: 173-182.

Sykes, M. T.; Wilson, J. B. 1990: An experimental investigation into the response of New Zealand sand dune species to different depths of burial by sand. *Acta Botanica Neerlandica 39*: 171-181.

Williams, PA; Karl, BJ (1996): Fleshy fruits of indigenous and adventive plants in the diet of birds in forest remnants, Nelson, New Zealand. *New Zealand Journal of Ecology* 20: 127-145.

Wilson, JB; Sykes, MT (1999): Is zonation on coastal sand dunes determined primarily by sand burial or by salt spray? A test in New Zealand dunes. *Ecology Letters 2*: 233-236.