5.3 Salt marsh retreat

On the seaward side of the remnant, salt marsh vegetation has continued to retreat generally toward the east. Of the 14 datum pegs remeasured nearly 4 years after they were positioned around the edges of the remnant, 11 indicate that the vegetation has retreated from 70 cm to 1.5 m (Plate 3). The level of the substrate has decreased by 10 cm (Plate 4). However, at one inland site, there was expansion of the salt marsh vegetation by 60 cm.

6. CONCLUSIONS

6.1 Transplanting trial

This trial demonstrates the two major indigenous rush species at Maketu Estuary, *J. maritimus* and *L. similis* can be successfully transplanted to sheltered mudflats. The assessment 3.5 years after planting confirms general conclusions reached at the first assessment 5 months after planting (Bergin 1991). On a sheltered site *J. maritimus* can be successfully transplanted using a medium clump-size and *L. similis* using a large clump-size. The trial confirmed earlier work of Partridge and Wilson (1988) who found that transplanting of small clumps of *J. maritimus* results largely in failure.

On a sheltered mudflat, transplants planted at a close spacing or immediately adjacent to the existing salt marsh remnant do not benefit from the extra protection afforded by neighbouring plants at close proximity. It is only at the close spacing and using large transplants that complete vegetation was achieved at Maketu within 3.5 years of establishment. Gillespie (1988) suggested that transplants at wide spacing (1 m between plants) may take up to three years for clumps to coalesce into a uniform marsh. However, the Maketu trial clearly indicates that transplants at wide spacing will take considerably longer.

A major disadvantage is that large clump-sizes require considerably more planting effort than smaller clump-sizes. Although sites where transplant material was sourced for the trial recovered quickly, large scale revegetation programmes using large clump-sizes could cause unreasonable damage to source areas. This is likely to be a major practical concern to managers. For *J. maritimus*, managers have the option of choosing either large or medium clump-sizes for transplanting, although results show that there are nearly 20 percentage points difference in survivals between the two clump-sizes. The choice of clump-size for *J. maritimus* however, is also influenced by plant spacing and the urgency for getting complete canopy closure. Larger clump-sizes planted at close spacings will give the quickest canopy closure compared with other combinations using smaller clump sizes and wide plant spacings.

As predicted in the 5 month assessment, transplanting of *J. maritimus* on the exposed site has completely failed. The most likely cause for this is the severe exposure on the seaward side of the estuary where wave action from open water constantly buffets transplants during wind at high tides. If transplanting is to be considered on such sites, then temporary artificial barriers should be considered in an attempt to reduce wave action on newly planted areas. In contrast to sheltered sites, mutual protection of plants at close spacing could enhance establishment on exposed sites and is one of the many treatments that requires further investigation on these difficult sites.

Plate 3: On the exposed seaward side of the salt marsh remnant, the margin of the vegetation has continued to retreat at a significant rate (0.7-1.5 m over 4 years). This datum peg was placed 4 years earlier at the edge of the vegetation but wave action and other factors during this period has resulted in the vegetation retreating by over 1 m. Parts of the original soil horizon are also evidence of the salt marsh retreat.

Plate 4: The level of the estuary has decreased around parts of the salt marsh remnant by 10 cm over the last 4 years. Consequently, edge plants particularly on the exposed side of the remnant are undermined by wave action, exposing root systems, and plants are washed out resulting in loss of salt marsh vegetation.

The low survival of medium and small clump-sizes of *L. similis* indicate that large clump-size is the only option for successful establishment of this species. Unfortunately, plant spacing was not tested with this species with all plots planted at only medium spacing (70 cm apart). It is likely to be a further year or more before even the larger *L. similis* transplants coalesce into uniform salt marsh vegetation (Plate 5). However, in a pilot planting of *L. similis* established a few months before the main transplanting trial was established, a dense uniform stand has formed indicating that although it is slower to expand than *J. maritimus*, *L. similis* will eventually occupy the site (Plate 6). All transplants in the pilot trial were equivalent to the large clump-size and were planted at the close spacing of 4 plants/m^2 (plants 50 cm apart).

6.2 Salt marsh retreat

Clearly, the salt marsh remnant at Maketu Estuary is still retreating at a significant rate. If at least 1 m of erosion of vegetation occurs each year along exposed margins, then the present remnant is likely to be reduced to discontinuous patches of salt marsh vegetation within 50 years and to disappear within a century.

The abrupt differences in levels between the salt marsh and the lower adjacent mudflat remains a significant feature. Suggestions that decline of the salt marsh is the result of the reducing elevation of the area, exposing marginal vegetation root systems to constant wave abrasion, and a possible link to the diversion of the Kaituna River nearly 40 years ago is discussed in Bergin (1991).

7. RECOMMENDATIONS

Where large scale transplanting is considered and resources are limited, medium-size clumps should be planted at wide spacing, with some mortality inevitable. However, where resources are sufficient, including adequate labour and a nearby source of healthy transplant material, and rapid revegetation of mudflats is desirable, the best option is to plant large transplants (100 x 100 x 150 mm depth) at close spacing (50 cm between plants).

Further work should include determining the optimum plant spacing for *L. similis*. Transplanting mixed species clusters of both *J. maritimus* and *L. similis* may also be worth evaluating.

Where restoration of previously vegetated sites is to be considered, it is prudent to consider, where possible, the relative proportions of species that once occurred on the site and their spatial patterns. The Maketu trial tested a greater range of treatments and sites using *J. maritimus* as it dominated both sheltered and exposed sites in contrast to *L., similis* which occurred only on the inland side of the remnant. Close examination of local vegetation composition and pattern of natural stands can often be a useful indicator of any habitat preferences and an appropriate mix of species before embarking on a revegetation programme of nearby degraded sites.

As most of the salt marsh vegetation decline of the Maketu Estuary is occurring along the exposed seaward side of the remnant, further investigation of techniques for transplanting indigenous vegetation to exposed mudflats is , urgently required.

Plate 5: Large clumps of **Leptocarpus similis** *have not expanded as fast as* **Juncus maritimus**. *It will be at least a further year before this medium-spaced cluster (planted 70 cm apart 4 years earlier) of* **L. similis** *will have a closed canopy.*

Plate 6: **Leptocarpus similis** *established in a pilot trial has expanded in 4 years to fully occupy the site. Large clumps (100 x 100 x 150 mm depth) were transplanted at close spacing (50 cm apart). Although not tested in the main trial, the pilot trial does indicate that large clump-size and close plant spacing is the preferred option for this species. Growth of* **L. similis** *is not as fast as* **Juncus maritimus.**

8. ACKNOWLEDGMENTS

Greg Steward and Jessamy Herbert assisted with fieldwork. Mark Kimberley carried out the data analysis and John Herbert commented on the manuscript.

9. REFERENCES

Bergin , D. O. 1991: Experimental restoration of indigenous salt marsh, Maketu Estuary. Forest Research Institute Contract Report: FWE 91/31 (unpubl.). 19 p.

Gillespie, P. A. 1988: Preliminary report of the feasibility of salt marsh restoration in the Maketu Estuary, Bay of Plenty. Aquatic Resources Group, Cawthron Institute. 28 pp plus appendices.

Partridge, T. R.; Wilson, J. B. 1988: The use of field transplants in determining environmental tolerance in salt marshes of Otago, New Zealand. *New Zealand Journal of Botany*, Vol. 26: 183-192.

10. **APPENDIX** - Survival, mean top height, health score and canopy closure of transplant groups for major salt marsh species planted on the sheltered mudflat site, Maketu Estuary. Figures with the same letters are not significantly different.

Species	Treatments	No. of transplants	Survival of transplants (%)	Mean Group Height (cm)	Group* Health Score (1, 2, 3)	Group** Canopy Closure Score (1,2,3)
Juncus maritimus	Clump size					
	— large	180	89 a	98.9 a	1.0 a	1.8 a
	— medium	180	70 b	88.2 b	1.0 a	2.3 b
	— small	180	24 c	83.6 b	1.3 b	2.8 c
	Spacing					
	— wide	180	61 a	87.1 a	1.1 a	2.7 a
	— medium	180	61 a	93.2 a	1.1 a	2.3 b
	— close	180	61 a	90.9 b	1.1 a	1.8 c
	Block No.					
	— S1	180	55 a	92.7 a	1.1 a	2.2 a
	— S2	180	61 a	95.4 a	1.1 a	2.3 a
	— S3	180	67 a	82.2 b	1.1 a	2.4 a
	Fertiliser					
	— absent	270	62 a	90.2 a	1.2 a	2.4 a
	— present	270	60 a	90.6 a	1.0 a	2.2 a
	Clump-size x spacing					
	— large x close	60	93 a	100.7 a	1.0 a	1.0 a
	— large x medium	60	85 ab	101.7 a	1.0 a	1.8 b
	— large x wide	60	88 ab	95.0 ab	1.0 a	2.5 cde
	— medium x close	60	65 b	84.1 bc	1.0 a	2.0 bc
	— medium x medium	60	74 ab	94.2 ab	1.0 a	2.2 bcd
	— medium x wide	60	71 ab	84.2 bc	1.0 a	2.7 de
	— small x close	60	24 c	81.6 c	1.2 ab	2.6 de
	— small x medium	60	23 c	85.5 b	1.3 b	2.8 e
	— small x wide	60	26 c	82.2 c	1.3 b	3.0 e
Leptocarpus similis	Clump size					
	— large	60	78 a	76.7 a	1.0 a	2.7 a
	— medium	60	22 b	63.3 a	1.7 a	3.0 a
	— small	40	5 b	50.0 a	2.0 a	3.0 a
	Block No.					
	— S1	60	33 a	68.3 a	1.0 a	2.7 a
	— S2	60	42 a	56.7 a	2.3 a	3.0 a
	— S3	40	30 a	72.5 a	1.0 a	3.0 a

* Health score -1-good; 2-intermediate; 3-poor

** Canopy closure score -1-closed; 2-intermediate; 3-poor