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fringes into fresh sand. There was more of the control plot like this at the beginning of the study than in the exclosures: in fact there was very little mature marram in the rabbit exclosure. So what Figure 12 shows are three different invasion stages: explosive early colonisation within the rabbit exclosure, expansion and thickening within the big exclosure, and consolidation within the control.

Marram grass, a European species, has been deliberately introduced to areas of mobile sand around the world in order to stabilise them (Buell et al. 1995). It is now recognised that much of this has been misguided, and marram is now considered a major global weed because of what it does to dune systems. It displaces native sand specialist plants and ossifies dunes. The coastal energy of nature - wind and sea - has to go somewhere. What usually happens is that abrupt sand cliffs, very prone to dramatic local erosion, appear at the foredunes, and deep unstoppable wind scoops and chasms occur within the dunes. That, the loss of pingao, spinifex and other native sand plants, and the development of the weedy vegetation described above, will be the fate of the Ocean Beach dunes unless the marram is controlled.

### 4.1.5 *Carex pumila*

*Carex pumila* is a small native sand sedge, usually encountered in damp (not wet) dune hollows but seemingly equally at home on drier sites. It is quite common on the Ocean Beach dunes, but to most visitors it would go unnoticed. In Plot 1 it was a minor component of the vegetation, forming less than 1% of the cover in both the big exclosure and the control. Within the rabbit exclosure it increased six-fold, to a peak of 3% cover in 1995 (Figure 13). Its subsequent decline, like that in the big exclosure, was probably largely caused by the increase in marram grass. Rabbit browse of *Carex pumila* was observed in both the big exclosure and control.

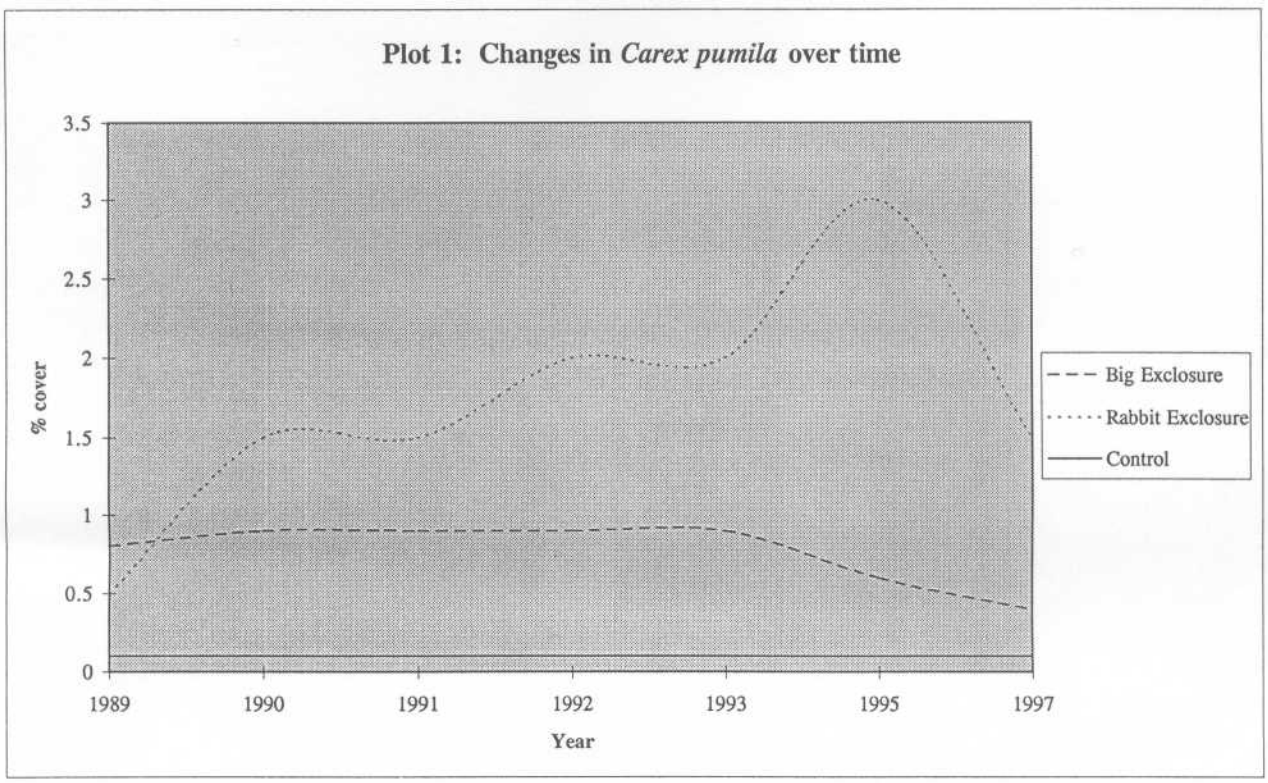


Figure 13. Changes in *Carex pumila* over time in Plot 1.

### 4.1.6 Coprosma acerosa

*Coprosma acerosa* is one of the few woody plants to make a successful living on New Zealand sand dunes. It is quite versatile, also tolerating flood-prone river banks, arid river beds, cliffs and hillsides from the coast to montane zones. Superficially it looks like a sprawling entanglement of rusty wire mesh, but at close quarters it has a genuine beauty of specialised adaptation in its orange stems, tiny narrow leaves and pale blue teardrop fruit.

In the study of Plot 1, *Coprosma acerosa* was the only native plant to increase at the same time as the marram grass. Within the rabbit exclosure it positively skyrocketed, increasing 24-fold in eight years (Figure 14), whereas it showed lesser increases elsewhere and was far less abundant. The obvious explanation is that it was being seriously impeded in growth by rabbits. This was confirmed by direct observation of *Coprosma acerosa* being browsed very hard by the rodents, particularly when young (Figure 34).

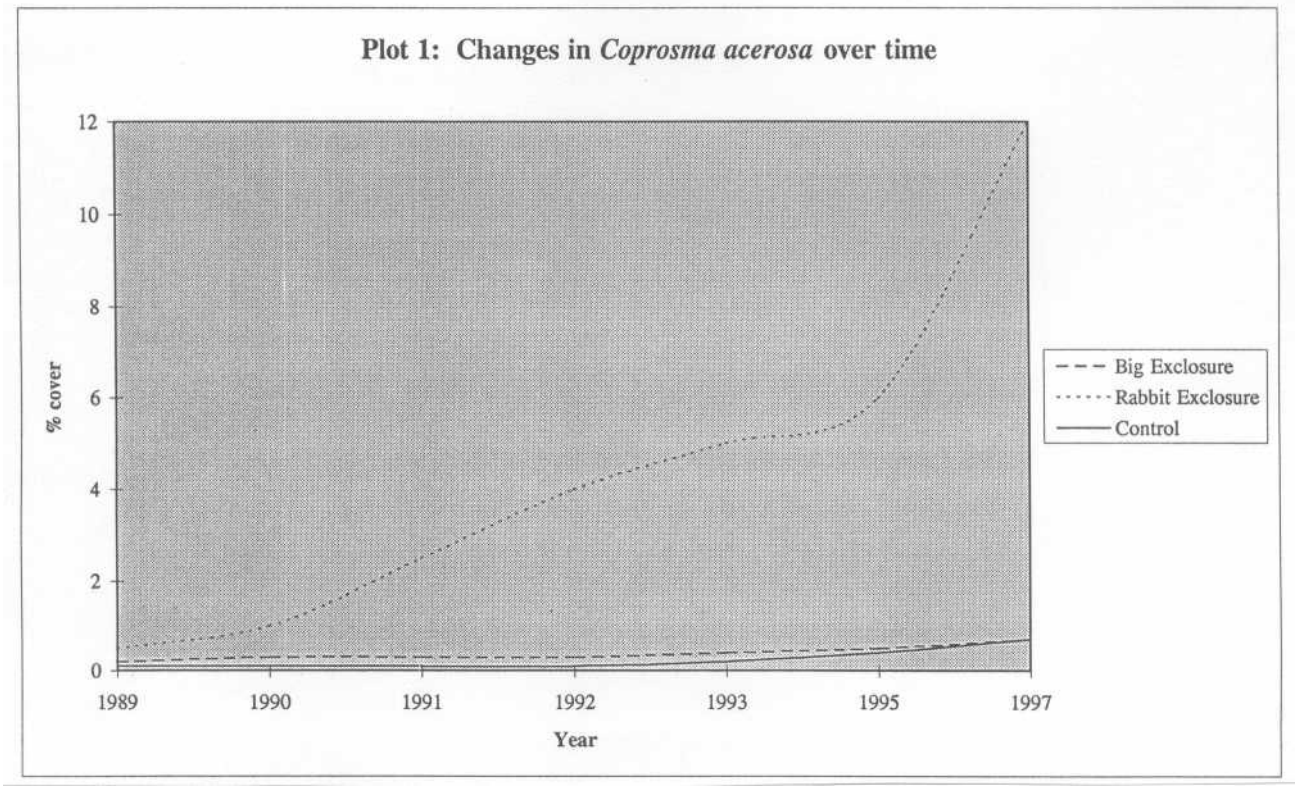


Figure 14. Changes in *Coprosma acerosa* over time, Plot 1.

### 4.1.7 Other vegetation

Vegetation in Plot 1, other than the plants dealt with in detail, included the natives tauhinu, knobby clubrush and shore bindweed *(Calystegia soldanella)*. None was very common. More abundant were various grasses, rosette plants ("flatweeds"), thistles and leguminous herbs, originating from the adjacent pastures, and vagrant plants such as evening primrose *(Oenothera biennis)*. In total, though, all this vegetation amounted to a relatively small proportion of the total plant cover and biomass.

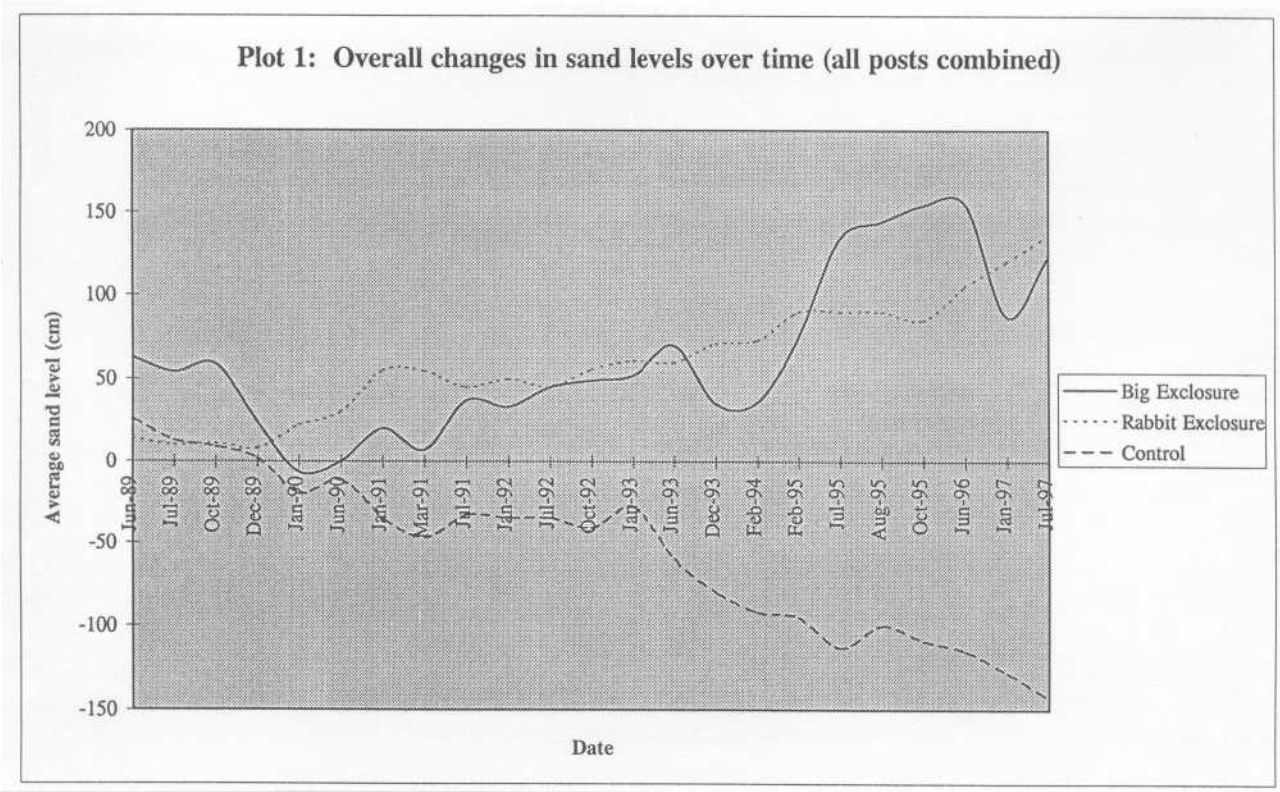


Figure 16. Overall changes in sand levels over time, Plot 1.

Figures 17-19 & 35 track the more complex processes happening in the dunes on a smaller scale. Within the big exclosure (Figure 17), there was a massive ongoing build-up of sand in the southwestern corner, that required three extensions of the posts and netting there. Meanwhile, in other places, there was either a much slower steady build-up or a steady deflation. In some places build-up alternated with deflation. In several instances adjacent posts showed opposite trends.

Within the control (Figure 18), the pattern was more splayed. At one post on the eastern side the sand steadily built over time. In most other places it deflated to varying degrees (most rapidly in the south), whilst in the south-western corner it initially deflated then proceeded to build.

Within the rabbit exclosure (Figure 19) there was a considerable sand build-up at three of the four corners. At the other corner (the northwest) there was an initial rapid build-up followed by a steady deflation of that built sand.

What these graphs symbolise is the dynamic and subtle nature of sand dunes. So long as there is sand to be blown and wind to blow it, the dunes will be forever changing their shape. Prevailing winds (in this case westerlies) will shape the dune system in a general direction. However, individual storm events can make just as much impact, plucking sand, driving it, etching and scouring. They may reverse in a matter of hours months of steady directional progress, or destroy in a singe outburst the impression of stability in a place. What happens at any one site depends on what obstacles exist, how they are shaped and what has happened there previously. This study has revealed in many ways that this is how the Ocean Beach system works. The sand level measurements have put a handle on it.

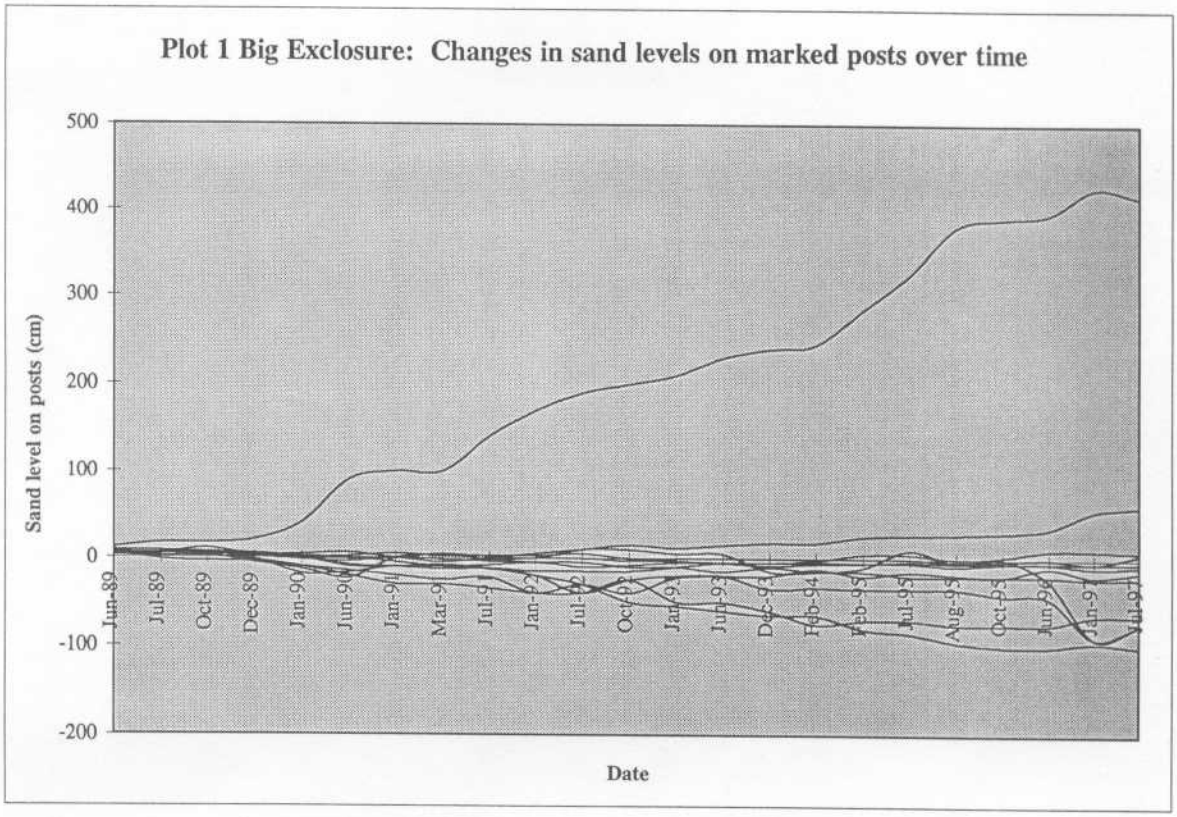


Figure 17. Changes in sand levels over time in the big exclosure, Plot 1.

I think that what I have observed at Plot 1 is the movement of the same sand around the system. It has progressively deflated from unvegetated broad hollows and built at the faces of mobile dunes and where there are solid barriers. Two such solid barriers are the close-mesh rabbit netting and areas of mature marram grass. I am sure that such barriers are bad for the wild spirit of the dunes. They prevent the natural flow of sand around the system, making conditions less favourable for the native plants that are adapted to go with that flow. This is another aspect of the litany against marram.

## 4.2 PLOT 2

Plot 2 examined a totally different circumstance from that of Plot 1. It was a mere 10 m x 10 m square on a stable heavily vegetated dune flat. The unusual thing was that in 1989 adult pingao was flourishing on the site, although browsed by cattle, sheep and goats. I put in the plot to follow the fate of the pingao. I did not expect it to be able to persist on such a site.

Sure enough, the pingao declined virtually to extinction within six years (Figures 20, 21 & 3C). For the first year of the study it expanded, but its ascent was brief and from then on it dwindled away. I think there is no great mystery to what happened.

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