Changes in Cromwell Terrace vegetation and soils

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Published by
Department of Conservation
Head Office, PO Box 10-420
Wellington, New Zealand

This report was commissioned by Otago Conservancy

ISSN 1171-9834

Reference to material in this report should be cited thus:

McKinlay, B., 1997
Changes in Cromwell Terrace vegetation and soils. *Conservation Advisory Science Notes No. 163.* Department of Conservation, Wellington.

Keywords: Sand dunes, historical vegetation changes, Cromwell Chafer Beetle Nature Reserve, Cromwell sand, Lakes Ecological Region

Turnbull (1987) mapped the area where the Kawarau River leaves the Kawarau Gorge to the Deadmans Point area (hereinafter called "the Cromwell Flat") as Gibbston outwash gravels. The edge of this structure is mapped as a terrace edge.

The sediments that are present on the Cromwell Flat were laid down about 35 000 years BP. Since then they have been subject to an ongoing process of aeolian deposition and erosion events. There have been episodes of build-up of sand, contrasted with episodes of build-up of soil. Dunes in this area have been continuously active, so there is no record of soil build-up. The natural geological processes present on the Cromwell Flat have been severely modified by the presence of cultural features such as the town and orchards. These impacts have increased dramatically in the period since the area was identified as a hydro development centre in the mid 1970s.

Park (1908) noted that drifting sands which had proved so destructive to farming on the Cromwell Flats were generally believed to have been brought down the Clutha during the great flood of 1878.

Park felt that such an explanation would account for a large proportion of the sand. However, the terrace on which Cromwell is built contains a large amount of drift sand mixed with the gravels. A constant supply of the sand, derived from the terrace faces between Lowburn and Deadmans Point, was carried by the wind across Cromwell Flat. The map accompanying his report showed this area, which included the present Cromwell Chafer Beetle Nature Reserve area, as drifting sand.

Cockayne (1911) noted that the source of the sand was the Clutha itself, near Bannockburn. He noted that the actual dunes at Cromwell were the result of high catching fences which the dunes had buried or were burying. "As well there are many low dunes, sand ridges and deep or shallow layers of sand on many parts of the plain, there being a special advance towards the Kawarau between Cromwell and the Bannockburn Bridge."

Cockayne (1911) noted that there was little plant life on the rapidly shifting sands of Central Otago - "As the sand advances over the tussockland plain it collects in great tongues on the lee side of the tussocks *Poa caespitosa*, (*P. cita*) or *Festuca rubra* var as the case may be and as the drift continues these tussocks grow upwards much after the manner of marram grass." Cockayne noted that the tussock acted as a sand binder. This is remarkable as it is not an hereditary adaptation on the part of the tussock form.

Further, Cockayne stated that where the soil is blown away and the ancient riverbed was present, the ground was studded with cushions of *Raoulia lutescens* (*R. australis*).

Cockayne noted that at that time the "sand supply from the Clutha River seems to have much diminished and in addition vast quantities of fine sand have been blown away on to the distant hills leaving chiefly on many places only the very coarse sand".

Cockayne further noted that by 1911 a "little marram and tree lupin have been planted ... At Cromwell the common tussock of the neighbourhood (presumably *Poa cita*) has been used and grows remarkably well ... but it would not tolerate a strong drift".

In 1915 the formation of the Cromwell Development Company took place. The objective of the company was to develop the sandflats surrounding Cromwell through irrigation from the Kawarau River. The launch of the company was accompanied by great fanfare and full coverage in the Otago Daily Times (ODT, 1915a, b). In ODT 1915a, a comment was made about the vast wastes of arid land that look at first sight like plains interspersed by hillocks of drifting sand and further that the loose desiccated schist from the Lowburn area was blown in sandy clouds over the valley. In ODT 1915b the cause of this exposed schist was reported to be the 1878 flood.

McIndoe (1932) undertook a major study on the growth and root forms of plants around Cromwell. She recorded *Poa caespitosa* (now *Poa cita*) roots extending three feet six inches (1.067 metres) and described in great detail the lateral root structure, relating the character of the roots to the soil. In sand the roots were straight and laterals short (about 3/4 inch or 1.905 cm) arising from the main root at right angles. When the roots entered stony gravel they became more bent, laterals extended and second order laterals were better developed.

In the four specimens that McIndoe examined, none of the root systems reached the groundwater. McIndoe therefore disagreed with Cockayne's 1921 statement that "when on dry ground (the tussock's) long deeply descending roots reach the groundwater ...".

McIndoe (1932) described the Cromwell Flats as land for the most part covered with a layer of drifting sand derived from the sandy faces of the terraces near Deadmans Point.

She described the area as being dominated by *Poa caespitosa* (*P. cita*) which has a shallow root habit. She noted that wherever the thickness of sand is sufficient to allow the retention of surface moisture, ie, greater than six to nine inches, then *Poa caespitosa* (*P. cita*) becomes dominant. Where sand is lacking, then *Raoulia lutescens* (*Raoulia australis*) dominated.

McIndoe concluded that in the period February to September 1928 vegetation varied from areas of sand over substrate (McIndoe described it only as stony gravel) where *Poa caespitosa* (*P. cita*) dominated to areas of substrate where *Raoulia lutescens* (*R. australis*) prevailed.

She noted that on areas of particularly heavy deposition, drifting dunes had formed, and on these marram had been introduced.

Parcell (1951) recorded that the sand nuisance was first recorded in Cromwell in 1864. There were large deposits of sand in the Lowburn Terrace, and the main street of the town and part of the back area were covered with sand. The sand was blown and shifted by the prevailing northerly winds until it had formed extensive deposits on the flat and threatened to engulf the town.

"The flat was heavily grazed with stock until 1870 and as a result of this and the rabbit pest the surface covering rapidly deteriorated. In a few years the native grasses had entirely disappeared from the flats and low hills leaving the valley wide open to violent wind erosion. The dust in the town continued as a major problem through 1876, aggravated by the 1878 flood which swept all the soil off the lower flat and left it covered with huge deposits of drifting fine sand. In spite of the efforts of the borough council and the government the nuisance continued unabated through 1886. Gales from the north simply blotted out the town. A campaign of planting marram grass was decided upon in April 1899. This was the beginning of a long struggle on the part of the borough to control the nuisance."

The first aerial photographs of the Cromwell area were taken in March 1949 (SN 533 F/35-37). These showed the area from the cemetery to the junction of Pearson Road and the Bannockburn-Cromwell road and thence east to the Kawarau River as a large unvegetated expanse of sand. In places the Bannockburn-Cromwell road almost disappeared from view.

The next aerial photograph was in 1958 (SN 2693/11). It showed a similar situation across the chafer beetle nature reserve area, but beyond this, land was being settled and tree lanes were present. From this photograph it would appear that the last large block of sand was in the area of the chafer reserve, especially across the Bannockburn-Cromwell road to the river.

In the 1960s Leamy and Saunders (1967) mapped some seven soil types on the Cromwell Flat. Some of these seven were Molyneux loamy sands and some Cromwell sands soils.

In the area of the Cromwell chafer (*Prodontria lewisi*) reserve two soils were mapped. They were Molyneux very shallow loamy sand and Cromwell sand. The Molyneux very shallow loamy sand was only 9 inches (22 cm) over fresh gravel. Leamy and Saunders noted that this soil suffered moderate to severe wind erosion and the surface is now protected by desert pavement. The Cromwell sand was identified as occurring on sand dunes. It was 18 inches (48 cm) of sand over gravel. In most of the profiles collected there is a buried soil within 20 inches (50 cm) of the surface. These soils were recorded as being of extreme susceptibility to wind erosion.

The soils of the chafer beetle nature reserve have been mapped by Leamy and Saunders (1967).

Hubbard (1975) prepared an interim report on the chafer beetle reserve area. He described six vegetation zones in the proposed chafer beetle reserve ranging from tall dunes with 60-100% cover to very depleted areas with 5-25% cover. The vegetation map prepared by Hubbard was reproduced in Watt (1975, 1979) and Allen (1983).

Allen 1983 gave a breakdown of total per cent proportion of each community as follows:

Vegetation Zone	Percentage	Hectares	Cover Estimates %
Tall dunes	4	4	60-100
Tussock grassland	35	34	60-100
Tussock scabweed	38	35	40-50
Scabweed	11	11	20-50
Eroded areas	6	6	5-25
Cultivated	8	8	-

Watt (1975) spent some 100 person days searching and pitfall trapping for *Prodontria lewisi*. He concluded from this that this species is associated with partly stabilised sand dunes (which means, I assume, that this is what he observed).

Allen (1983) noted that the vegetation description of Hubbard (1975) was still reasonably accurate but changes in density of some dominant species were relevant. "Of particular concern is the apparent decline of *Poa cita* - plants are now scattered and generally dead or moribund. Sweet vernal (*Anthoxanthum odoratum*) and St Johns wort (*Hypericum perforatum*) are now dominant except on gravel and other semi-bare surfaces supporting scabweed (*Raoulia* spp.)."

The most recent aerial photographs (SN 114964 D16), March 1990, confirmed by ground searches, show an almost complete decline of *Poa cita* and its replacement by exotics (see separate vegetation data for summary of the situation, eg, Rance 1990).

Conclusion

The above review shows that the natural geological process present at the Cromwell Flats has been severely curtailed in the period 1870-1995. The curtailment has taken place through settlement patterns and direct activities to reduce sand drift. I could find no information on the period prior to 1870 but it is likely that in the period 1857 to 1870 the area was grazed and burned. Whether this led to a period of instability and of free sand which was heightened by the 1878 flood, which then led on to large scale sand movements at c.1900-1905, is a matter for conjecture.

There has been a dramatic decline in the amount of free sand from 1950 to the present situation of almost none. There has also been a dramatic decline in silver tussock density in the period 1983-1995 and tussock presence in the period 1975-1994.

Acknowledgements

Ralph Allen, Landcare Research, and Brian Patrick commented on earlier drafts of this note.

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