(landscapes)

"Natural" landscapes

Mountains, geomorphology, topography, lakes can be taken as given. Any major change to those by human activity would be unlikely major engineering projects and larger than any Plan change 13 considerations.

The issue is probably mostly about "natural" meaning ground cover by vegetation -as contrasted with buildings, roading, fencing, and other structures, etc.

"Natural" is said not to be confined too native vegetation, though there is a relatively strong inclination in that direction.

Attached is one assessment of past history and vegetation.

The key points are

the environment has changed

that the vegetation patterns are changing continuously
– albeit many relatively slowly on a human time scale – but other rapidly

there is no certainty, or technology, that land cover can be retained in its present state, or returned to some earlier stage, even if that was considered desirable

there has been no consensus on what time capsule would be desirable – 1950? 1930? 1880? pre-European? pre-Maori? 1000AD, 8000BC?

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Current trends in vegetation

"80% from 20%" - presently about 80% of animal production comes from about 20% of the land that has been developed (fertiliser, seeding).

Over sowing + top dressing

- Os&td developed tussock grasslands – probably relatively stable
- Cultivated and developed 'special purpose' pastures, hay paddocks, etc – increasing as use is made of the better soil areas and the inputs required
- Irrigated 'special purpose' pastures – increasing
- Large area of marginal soils – while probably little change in area will become more prominent by contrast with others.

Effect is more subdivision of landscape – but becomes more muted with time with the likes of growth of shelter belts, tracks and other activities

Flora is increasing – adventives already about a fifth, compared to the doubling in the total NZ flora

Snow tussock decreasing at moderate rainfall lower boundary being replaced by fescue tussock

Fescue tussock decreasing – My own view is that it is reaching the end of its natural life after original spread in the early Maori era.

'Tussock' or 'bunch grass' impression – decreasing with spread of adventive grasses, herbs and agricultural species.

Hieracium (mouse-ear) probably reached a maximum. Impression of some decrease due to increase in browntop after last rabbit era.

Commercial forestry – remains a potential high value option for moderate rainfall mid-slope areas

Wilding pine spread - likely to get larger

My own view is that the central dry Mackenzie was probably never forested with trees were probably confined to the mid-slope foot-hills, probably beech in the Pukaki/Tasman – but not Tekapo/Godley, and totara – possibly sparsely along the drier ranges. Early European accounts record extensive matagouri, more extensive red tussock, snow tussock extending to the edge of the central shallow out-wash soils, and more silver tussock in those areas.

There was a change in herbivory from birds to mammals – it is wrong to imply there was no previous herbivory.

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Human occupation

Maori probably commenced settlement of New Zealand 800–600 years ago with initial colonisation into the drier forest/shrublands/grasslands of the east coast of the South Island, of which the study area is a part (Anderson & McGlone 1992; McGlone et al. 1994; Challis 1995). The early period was based on base settlements, principally on Banks Peninsula, with late spring to autumn foraging from river mouth sites into other regions, including inland basins, for harvesting the four to seven species of large flightless grassland birds (moas) and water fowl (Moa-hunting period). Fire used on the hunting of these large flightless birds led to the replacement of lowland forest with shrubland/forest, and the replacement of high-country shrubland/forest/grassland with tussock grassland. This predation of moas was widespread in Canterbury in the 14th and 15th centuries and led to the extinction of moas (McGovern-Wilson & Bristow 1991; Higham et al. 1998). There was a decrease in other bird species from associated habitat change and from the simultaneous introduction of the polynesian rat and dog. The Maori population in South Canterbury/North Otago was about 200 in the 1840s and may have been higher at the peak of the Moa-hunting period (Challis 1995). The effect of the infrequent fires was that tussock grassland became the dominant vegetation type in the inland basins. One or two fires per century would probably have been sufficient to maintain the grassland. Moa remains, Maori ovens, cave drawings, and artefacts have been recorded within a few kilometres of the trial site (Challis 1995).

The European era from the 1820s repeated, on a shortened time scale, the Polynesian phases of periods of colonisation, exploitation with burning, and then consolidation. The change in herbivory in the European era was the replacement of browsing, ground-dwelling, native birds by introduced, grazing, ruminant mammals, and the change in vegetation was from endemic native species to northern hemisphere temperate grasses, herbs, and legumes which were both intentionally and unintentionally introduced.

The first large-scale land colonisation of New Zealand by Europeans was planned settlements into the drier tussock grassland/shrublands of the east coast of the South Island from the 1820s. Most of the land on the Canterbury Plains was taken up by the early 1850s. Initial European colonisation into the inter-montane areas was in the late 1850s with most "runs" (= "stations" or large farms) taken up in the following decade (Pinney 1971). The study area was first stocked by sheep in 1860 (Scott 1927). Sheep numbers in the tussock grasslands peaked in the 1880s, and on undeveloped land such as the study area continued to decrease until the start of the present study.

It is possible that we considerably underestimate the extent of the herbivore and carnivore food web components of the pre-human vegetation. The reduction of those components during the Moa-hunting period may have resulted in the vegetation being in a partial "post climax" or "overshoot" state when first seen by Europeans.

Vegetation

The broad pattern of New Zealand pre-European vegetation was related to gradients of moisture and temperature (Scott et al. 1985; Wardle 1991; Scott et al. 1995). Features of the native flora include a high degree of endemism at the species level, either as endemic genera or high endemic speciation of pandemic genera, dominance by slow growing evergreens, few deciduous trees, almost no annuals, dark sombre colours, high frequency of xeromorphic features in a generally high rainfall country (the later two features being probably an adaptation to heat deficiency rather than moisture deficiency (Wardle 1965)), no seasonal dormancy, high incidence of caespitose tussock habit not confined to Gramineae, generally lack of a "flush" growth, prevalence of broadleaf trees, presence of Asteraceae in the subalpine zone, and prevalence of wind- or moth-pollinated species.

At the end of the last glacial era at c. 14 000 yr B.P., the vegetated areas were probably of low grass *Myrsine/Coprosma* grassland shrubland. Land was rapidly reforested by podocarps through bird-dispersed seed. For the mid-altitude areas this was first by bog pine (*Halocarpus bidwillii*) and subsequently by celery pine (*Phyllocladus alpinus*). Low forest of celery pine was probably a dominant vegetation by 9500 yr B.P.

The effect of the increased summer droughts with the development of the El Niño Southern Oscillation pattern was the opening up of celery pine low forest, allowing the ingress of short-tussock grassland. This was recorded for the Idaburn valley, Central Otago, at 7000 yr B.P. (Clark et al. 1996), and the mid-rainfall Duncan Stream (40 km SW of the trial) in the Mackenzie Basin at 5500–4000 yr B.P. (McGlone & Moar 1998). Between 4000 and 1200 yr B.P., tall tussock (*Chionochloa* spp.) and spaniard (*Aciphylla* spp.) appeared and increased to dominate at the Duncan Stream site. While the charcoal evidence of the increasing frequency of natural pre-human fires is unequivocal, I do not know of any well documented case of similar natural fires in the present era.

In the post glacial period, beech forest (*Nothofagus* spp.) was recolonising the central region of the high country by marginal spread from the north and south, and probably had not coalesced in the Lake Tekapo area where the study was done.

As the name "tussock" suggests, the caespitose life form was a feature of the tussock grasslands. The dominant tussock grasses (species of *Chionochloa*, *Festuca*, and *Poa*) had many of the features of trees in being slow growing, long lived, producing only a few new leaves per tiller per year, retaining a large mass of standing dead biomass above ground, and "mast" seed years. Thus, in comparison with other New Zealand and world ecosystems there could be debate whether the relevant comparison is with other grasslands or with temperate shrublands or forests. These features are also relevant to early pastoral utilisation in the probable general over-estimation of stock carrying capacity because of the low growth increment relative to the visible biomass and the large portion of the nutrient pool that could be lost by burning. Another feature of the native grassland was the virtual absence of herbaceous legumes (one rare species) but moderate frequency of leguminous shrubs and non-legume nitrogen-fixing shrubs (*Discaria*, *Coriaria*). In combination, these features suggest an evolutionary adaptation of tussock grasslands towards a conservative life history adapted to nutrient poor, heat deficient, maritime climate conditions.

In the earliest European era the vegetation of the study area was probably *Festuca novae-zelandiae*-*Chionochloa rigida*-*Discaria toumatou*-*Aciphylla aurea* grass-shrubland which quickly became *F. novae-zelandiae*-dominant short-tussock grassland, and remained so until the 1940s. The study area had been part of a grazing block on similar landforms and had probably been lightly grazed at various times of the year. It had been unburnt for at least 70 years. In the 1940s it showed "black tussock die-back", a common localised periodic phenomenon whose cause is not clear. The site was one of the first in the region to become heavily infested with *Hieracium pilosella*, among the residual living tussock bases, and remained that way until the start of agricultural studies in the early 1980s.

Climate

The climate of the inter-montane basins tends towards semi-continental characteristics relative to the general maritime climate of most of New Zealand. The probable climate and vegetation of the New Zealand high country since the last glaciation have been described by McGlone & Basher (1995), Clark et al. (1996), McGlone et al. (1997), and McGlone & Moar (1998).

In the early period following the last glaciation the climate was probably of lower annual rainfall, with drier milder winters, but moister summer with greater frequency of cloudbursts and associated topographic fan formation. The low rainfall areas of Central Otago and the Mackenzie Basin, including the trial area, probably did not support low forest and was probably short-tussock grassland. From c. 7000 B.P. there was a gradual change in the New Zealand climate as the cyclical El Niño/Southern Oscillation pattern developed. While this increased the average rainfall, it was mainly winter rainfall, with increasing frequency of summer droughts and the increasing frequency of natural fires.

Temperature was probably briefly lower in recent millennia, which explained some of the patterns in forest succession (Holloway 1954) including the retreat of forest from the margins of the tussock grassland area. While those forest effects are now more generally attributed to Polynesian fires (McGlone et al. 1994; Challis 1995), advances of glaciers in the 19th century indicate lower mean temperatures.

There is evidence that temperatures have been rising this century, from glacial retreat, climate records (Coulter 1975), and regeneration of remnant tree stands adjacent to tussock grasslands in the study area (Scott 1959). In the high country, late 20th-century temperature increases have probably been beneficial for plant growth but may be associated with increasing drought frequency. The influence of recent depletion of the ozone layer and consequential increased radiation on tussock grassland vegetation is unknown.

The 70 year climate records from Lake Tek...