

Figure 24 Localities and sites visited, Otago and Canterbury.

One might be forgiven the pun, that this place is a goldmine for weeds! There is a great diversity of both native and introduced plants forming a mosaic, the composition of which is more or less in conformation with the boulder- and gravel-dominated landscape created by the goldmining process.

The hill-slope

This area was not visited, but observed from the park. The manager described a recent increase in sediment coming onto the park, caused not only by unusually high rainfall,



Figure 25 Oblique aerial photograph of Kawarau Goldmining Centre. Note steep bluffs above site, the storage dams below the prominent gully at left, head races entering the sluiced areas, and tail races cut through the Queen's Chain (centre). The interpretation track is prominent.

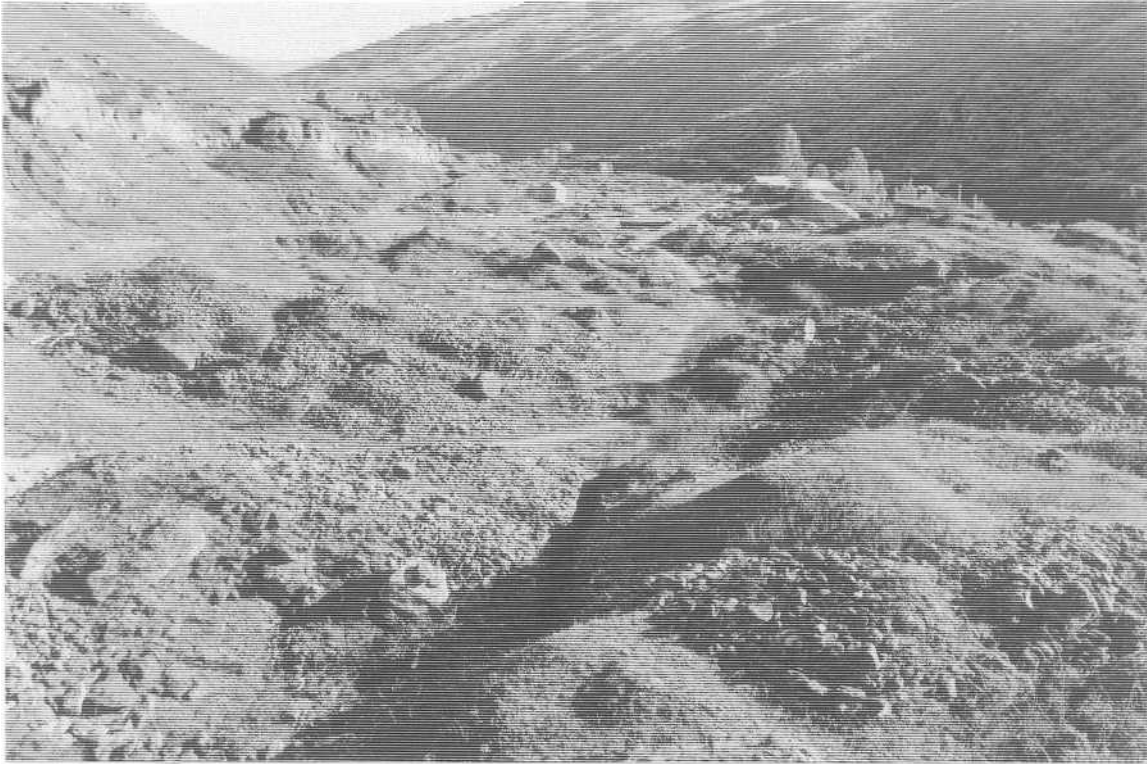


Figure 26 Kawarau Goldmining Centre. General view showing diversity of surfaces - remnants of loess covered terrace, and hill slope, bluffs, piles of boulders (tailings), fine deposits. Fine soils are covered with indigenous grasses (*Rhytidosperma* sp., blue-wheat grass, plume grass) and exotic weeds such as St John's Wort. Rocky areas support a variety of indigenous shrubs and sweet briar.

but through increased grazing pressure (sheep) exacerbated by rabbits. Visually the slope is an intricate mosaic of schist rock outcrops and native grassland of silver tussock and "danthonia" (*Rhytidosperma* spp.). Grassland is most continuous at higher levels, and shrubs are established around the rocks and on talus surfaces over most of the slope, especially *Discaria toumatou* (matagouri) and *Coprosma propinqua*. In the lowermost quarter of the slope, brier (*Rosa rubiginosa*) is dominant and, where the slope is gentle enough to be cultivated, the native grassland has been replaced by St John's Wort (*Hypericum perforatum*), reportedly increasing in recent years. There could be several reasons, some compounding, for this increase: cultivation undoubtedly encourages it, so that there is a greater local seed-source; rabbits graze the tussocks and inter-tussock vegetation and create bare-ground which is ideal for colonization; and there has been greater than normal rainfall over the last few years. At the time of our visit (late March) the St John's Wort had completed flowering (when it creates a yellow-orange carpet) and presented a rusty-brown landscape somewhat in keeping with the overall yellow to grey tone of the remarkable natural landscape.

The schist rocks are clearly the source of some sediment because a light-coloured coating is visible and this evidently has washed off in recent heavy rain, no doubt made more erodible by the trampling of animals.

Rock outcrops within the park

Rock outcrops are an integral part of the Kawarau Gorge landscape and constitute an important feature of the park, not only as a component of sluiced landforms, but also of historic importance as a place where people sheltered, both Māori and goldminer. Formerly the rocks were used as moa shelters (moa egg shell and bone occurs throughout the terrace soils) and today they are nesting sites for kahu (New Zealand falcon), *Falco novaezelandiae*. The rocks also support largely indigenous vegetation, not only on their surface, but also in the spaces between and around them, and sheltered sheltered micro-environments in crevices beneath them.

On the rock surfaces the following species constitute a highly specialized vegetation that needs to be protected from unrestrained human trampling: *Melicytus crassifolium* (porcupine plant), *Hebe pimeleoides* (var. *rupestris*), *Raoulia australis*, *R. aff. parkii*, *R. glabra* (rare), *Vittadinia australis*, *Graphalium* sp., *Geranium microphyllum*, *Colobanthus* sp. (small cushions), *Carex* sp. (small mat), a number of small grasses, especially *Rytidosperma* spp., and several ferns (*Pellaea falcatum*, *Cheilanthes sieberi*). Grey, crustose lichens are dominant.

In sheltered rock crevices several other ferns are located, including *Asplenium trichomanes*, *A. flabellifolium*, *Blechnum penna-marina* and *Polystichum richardii*. Around the rocks are scattered swards of bracken, but most conspicuous are the groves of matagouri, *Coprosma propinqua* and sprawling masses of lawyer (*Rubus schmelidoides*) and *Muehlenbeckia complexa*. Scattered shrubs of *Olearia odorata*, *Carmichaelia petriei* and *C. compacta* occur. Where present, these plants all have excellent site-conservation values.

Within the park itself brier has recently been sprayed and will soon not be a feature. However, elsewhere, on adjacent rocky areas, brier is dominant, forming a sometimes continuous canopy 2-3 m high, or a discontinuous canopy associated with native shrubs such as *Coprosma propinqua*. Its habit and attractive seasonal range of colours (grey winter stems, pink spring flowers, light green summer leaves and scarlet autumn fruits) integrate brier well into the rugged landscape, and its deciduous character allows native plants to establish beneath. However, to date no native tree has colonised, although kānuka, mānuka and Halls totara are probably capable of doing so and thereby locally excluding brier. Widespread spraying of brier would simply open the vegetation for re-colonisation, but local spraying or hand clearance seems appropriate for the park area owing to the prickly nature of brier. We observed that possums eat brier fruit and spread seed, and no doubt other animals do likewise. There may be specific microsites where brier should be encouraged as a soil conservation shrub, e.g., at the advancing upper end of eroding gullies.

The remnant alluvial terraces

A characteristic landscape feature of Central Otago are the large alluvial terraces bordering narrow or broad valleys. The Kawarau terraces are no exception (the inundation of terraces along the Clutha River is one of the environmental losses caused

by "Lake" Dunstan), and are not only built by the river itself but also added to by wind-blown loess and colluvium from adjacent mountain slopes. Goldmining has physically destroyed the terraces, of course, but significant areas remain, not only beyond the reach of sluicing water, but also as little remnants within the gold-working area. Along the Kawarau River a "Queens Chain" appears to have been recognised and left intact. Being gently sloping or flat, and also fertile, the terraces have also received the brunt of agriculture, both grazing and cropping. Of great archaeological significance, and well exposed to view because of the vegetation, are the various forms of headworks: supply races leading from gullies, holding dams (to store water overnight) and head races.

Because of these land uses, natural vegetation is restricted and much of that observed in the park is weedy pasture, grazed by sheep, horses and rabbits. An "original" cover of native grasses, perhaps dominated by silver tussock, is still actively being replaced by oversown grasses such as rye-grass and clover, the attendant pasture weeds such as vipers bugloss and *Crepis capillaris* and, most recently, explosive invasion by St John's wort. Existing silver tussocks are being closely cropped and killed by both rabbits and perhaps horses (part of a horse-trekking activity ancillary to the main park activity).

The terrace land has some gully erosion caused by water flowing from the catchment behind, and also some erosion caused by roading and runoff from rock faces. Attention to drainage structures (culverts, water-tables along roads) is clearly a priority, and the construction of low-visual-impact debris dams may also assist in preventing the build up of water volume with erosive power. Additionally, the native shrubs (matagouri, *Coprosma*, *Olearia*) and vines (lawyer and *Muehlenbeckia*) could be established around the edges of erosion features.

Mined land and tailings (Fig. 27(a), (b))

The vegetation of the gold-tailings is a most significant factor in terms of ground protection and presentation to visitors. It is diverse and dynamic. In broad terms the vegetation is a weedland of introduced plants, associated with a minor but potentially significant cover of native grasses, and scattered native shrubs. Brier has been an increasingly significant element, but was recently sprayed. Because a greater percentage of the surface is bare, however, brier will re-colonise. Rabbits seem to be a factor in maintaining the soil and vegetation in an unstable condition; tracking by people and various aspects of park management also encourage vegetation change.

A notable feature of the weeds is their distribution in local stands, reflecting soil and water variables as well as the intense and localised human activity. Small areas can be dominated by *Hieracium pilosella* (which is apparently expanding), California thistle, *Euphorbia lathyris*, *Melilotus albus*, California poppy, winged thistle, St John's Wort, horehound, wild mignonette, vipers bugloss, woolly mullein, wild teasel and on bouldery sites, thyme. *Centranthus ruber* occupies sites at the crest of gullies, while vervain forms scattered dense thickets, especially along tracks, where California stinkweed also occurs.

A number of introduced plants could have ethnobotanical significance: gooseberry, feverfew, thyme, tobacco (not seen but reported by the manager), brier, wild teasel and asparagus (from Chinese gardens?). Some weeds should be removed, for various reasons: Old Man's Beard (one plant seen), California thistle (potential to cover terrace grassland) and *Euphorbia lathyris* (danger to people) are three examples. Three species of *Hieracium* were seen, none of them common and all capable of control at their present status. *H. pilosella* is, however, an excellent ground cover and may be valuable for protecting unstable gold-tailings unless a more acceptable species can be found. Political reasons may dictate its removal immediately, but this should not be done without establishing a new ground cover in its place.

The native grasses are most impressive. *Rhynchospora* sp is the most widespread, forming open swards of individual "tussocks". Silver tussock has potential to cover the more stable surfaces (i.e., those not actively eroding), and both *Elymus solandri* (blue wheat grass) and *Dichelachne crinitum* are forming medium-sized "tussocks" in scattered, semi-stable places. In general, grasses dominate the older surfaces such as remnants of terrace. St John's Wort is a major threat to this native grassland and will prevent regeneration and, by being unpalatable, will focus greater rabbit pressure on existing tussocks. Wherever sheltered bare ground occurs, the unattached yellow lichen *Chondropsis semiviridis* is common and forms a useful initial barrier to raindrop impact and frost heave.

Indigenous shrubs have considerable potential to expand into stable micro-sites now that the brier has been removed: all the species mentioned previously are drought-resistant, divaricating, thorny or leafless species, extremely well adapted to the harsh environment. At one time, they were the main food of moa, so their occurrence is a further opportunity for interpretation.

Management recommendations

The vegetation is a complex mosaic, dominated by exotic weeds which not only have inherent interest of their own but also play positive and negative roles in the park. For instance, brier, although generally to be extirpated, may have localised, temporary uses in excluding access to mine shafts or preventing disturbance of particularly sensitive places.

A detailed survey of the whole local landscape, including the surrounding mountainland (the rocks, terraces, tailings and riparian zone), could result in a vegetation management plan that is maintained over a long period so that gradual trends become established.

Ongoing careful management of the vegetation and land-forms is essential. Vegetation can be used for erosion control and surface protection. Some weed species should be removed. Some native plants, such as the grasses, could be propagated and deliberately planted to enhance the indigenous component, leading to greater stability. A nursery could be part of the park facilities, providing tourism interest as well. Caution is needed if plants are introduced. For instance, flax and a cabbage tree have been planted at the park entrance. Neither are native to the area, and the flax has regenerated into the park (a single plant seen). Native plants should be natural to this very specific landscape.