Recommendations for vegetation monitoring of Redbank Conservation Area, Otago

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ABSTRACT

A vegetation monitoring programme is recommended for both tor and inter-tor tussock vegetation of Redbank Conservation Area, Macraes Ecological District, north Otago, which contains threatened grand skinks (*Oligosoma grande*) and Otago skinks (*O. otagense*). Fruiting plants on the rock tors are an important food source for skinks, and good inter-tor tussock cover may also be beneficial. Vegetation monitoring is needed identify the effects of grazing removal on the vegetation of the Conservation Area, and to compare changes to those in a grazed control block. Effects of vegetation changes on the skink populations will be used to guide the management of skinks throughout their current range. For tor vegetation, methods are recommended for the selection and measurement of eight key tor-plant species, using permanently marked sampling units. Periodic monitoring of tor vascular plant species richness is also recommended. Modification of an existing monitoring scheme is recommended for inter-tor tussock vegetation monitoring. It is suggested that the existing tussock transects are also used for annual measurements of tussock flowering.

Keywords: Tussock grassland, fruiting shrubs, skinks, vegetation monitoring methods, grazing impacts, mast flowering.

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1. Introduction

Redbank Conservation Area is approximately 300 ha of mid-altitude tussock grassland situated near Macraes township, inland north Otago (Fig. 1). This area is protected as home to significant populations of the threatened grand skink (*Oligosoma grande*) and scattered populations of Otago skink (*O. otagense*). However, it is also a valuable addition in terms of vegetation alone to lands managed by the Department of Conservation (DOC).

The Conservation Area is a low tor-dotted ridge running roughly south-west to north-east. The entire Conservation Area has been oversown and topdressed in the past, but the two tussock blocks still retain tall tussock cover (red tussock *Chionochloa rubra* and snow tussock *C. rigida*), with hard tussock (*Festuca novae-zelandiae*) grading into mouse-ear hawkweed (*Hieracium pilosella*) mats on sunny shallow-soil ridge and spur side-slopes. *H. pilosella* is abundant in the inter-tussock vegetation. The numerous schist tors have acted as fire- and grazing-refugia for a range of fruiting woody plants, which are important sources of food and shelter for skinks.

A low intensity of grazing by domestic sheep and cattle is currently managed within Redbank Conservation Area, and feral possums, rabbits, hares, pigs, goats and deer are also present. Grazing by sheep and cattle is thought to jeopardise the integrity of the grasslands there (Whitaker & Loh 1995; Whitaker 1996). In particular, browsing and removal of fruiting shrubs deprives skinks of an important food source (Whitaker 1996; Eifler & Eifler 1999, S. Walker & M.D. Tocher unpubl. data), and removal of tussock cover makes skinks more vulnerable to predators when moving between rocks tors (Whitaker 1996; Houghton 2000; Marshall 2000). The gradual degradation of indigenous vegetation under grazing may also affect skinks indirectly, in ways that are difficult to quantify. For example, the loss of tussock cover may favour rabbits and rabbit predators, increasing the risk of prey-switching when rabbit numbers are low (Norbury & Heyward 1997).

Not all of the effects of indigenous vegetation may be positive. Heavy (mast) tussock flowering and seed production occurs at intervals of several years in New Zealand tussock grasslands, and this phenomenon heralds increases in introduced rodents and their predators. In Redbank Conservation Area, cats and ferrets are important predators of grand skinks. Their increase is a possible adverse outcome of grazing cessation, which is likely to lead to greater tussock cover and hence greater production of tussock flowers and seeds in mast years.

Management objectives for Redbank Conservation Area and other skink sites in Otago are outlined in the Grand Skink Recovery Plan (Whitaker & Loh 1995). The Conservation Area is divided into three blocks: the Pasture Block, which has little inter-tor tussock cover, and the South Tussock and North Tussock Blocks, which have a greater tussock cover (Fig. 1). It is planned to remove grazing from part of Redbank Conservation Area on an experimental basis within the next few (i.e. 1–5) years. Vegetation monitoring within Redbank Conservation Area is required to identify the effects of this proposed grazing cessation on the indigenous and exotic vegetation in one of two tussock blocks,

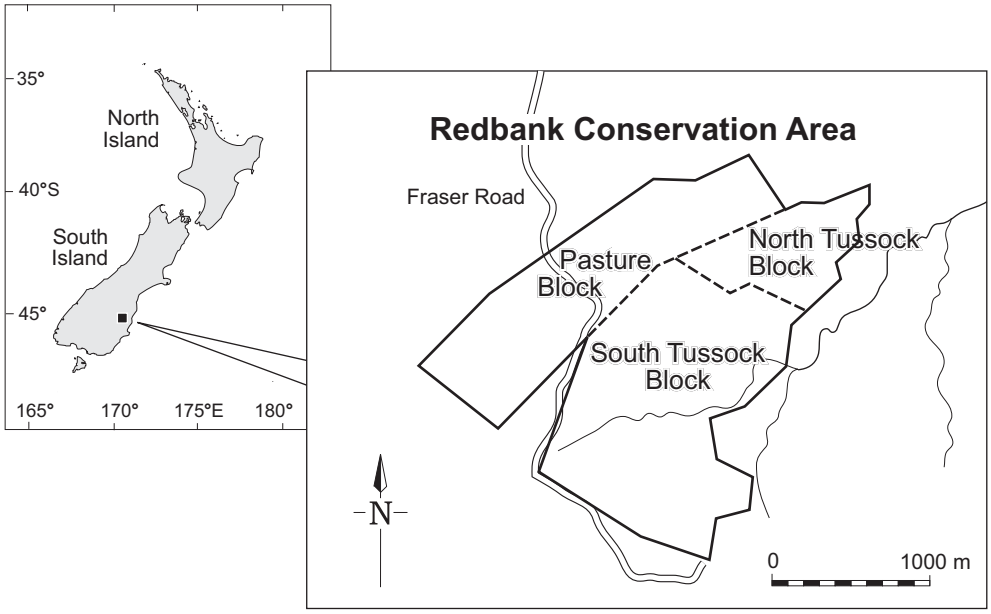

Figure 1. Map of Redbank Conservation Area, north Otago, New Zealand.

and to compare changes in an ungrazed tussock block with those in a continually stock-grazed tussock block. The effects of grazing removal on the populations of skinks in the Redbank Conservation Area also requires detailed quantification, so that these results can guide management of Otago skinks and grand skinks throughout their current range (Macraes/Middlemarch and Lindis Pass). Other concurrent research will benefit from an understanding of which components of the vegetation respond to release from grazing, what time frames are involved, and what the response of skinks and vertebrate biota to these changes are.

1.1 BACKGROUND

DOC has already initiated and carried out some vegetation monitoring over Redbank Conservation Area. Whitaker (1996) first detailed the vegetation species richness of 60 individual rock tors there. These same 60 study tors are surveyed annually by DOC for grand skink numbers. In Autumn 1998, Scott height–frequency transects (Wiser & Rose 1997) and plots to measure flowering were set up in tussock grassland communities and sampled by Kate Wardle. In November 1998, Elaine Wright conducted an informal review of the vegetation monitoring, and recommended an increase in replication of the transects. Accordingly, extra transects were established and sampled in Autumn 1999.

1.2 OBJECTIVE

In her review, Elaine Wright also recommended that a more comprehensive review of monitoring be carried out by a botanist, and that advice should be sought on appropriate monitoring methods for both tussock grassland and rock tor vegetation.

This report presents a recommended vegetation monitoring programme for both tor and inter-tor vegetation of the Redbank Conservation Area.

2. Monitoring constraints

Vegetation monitoring at Redbank Conservation Area should concentrate on those vegetation attributes that are most likely to influence changes in the vertebrate fauna. Ideally, a feasible monitoring programme should be carried out regularly (i.e. annually, or at least biannually) and rigorously, but should not be unduly demanding of staff time. It should focus on easily recognisable plant attributes, and be simple enough to be reliably carried out by persons with a minimum of botanical training. Aspects of the monitoring should be carried out at the same time of year in each resurvey, to remove the possibility of variations arising from time-of-year differences.

3. Tor monitoring scheme

3.1 STUDY TOR SELECTION

The 120 study tors included in the grand skink monitoring programme should be placed into one of six classes depending on tor volume (estimated from tor horizontal area and tor height, from Whitaker 1996). One representative tor in each of six size classes should be selected in each of the northern and southern areas of the tussock block, and in the pasture block for monitoring (18 tors; Table 1).

3.2 TOR PLANT SELECTION AND MONITORING

Abundance, rate of browse, and fruit production on tor plants should be recorded annually or at least biannually, at least in the initial years of grazing exclusion. Tor plant surveys should be timed to coincide with peak fruiting in the majority of the shrubs (i.e. late summer).

Eight tor plant target species are recommended for sampling. Seven are correlated with skink abundance (*Coprosma taylorae*, *Pimelea oreophila*,

TABLE 1. RECOMMENDED VEGETATION MONITORING PROGRAMME FOR REDBANK CONSERVATION AREA.

	SPECIES OR ATTRIBUTE	METHOD	DATA COLLECTED	SAMPLING FREQUENCY
Tors	*Leucopogon fraseri* *Pimelea oreophila* *Pentachondra pumila* *Gaultheria macrostigma* *G. antipoda* *G. depressa*	Local frequency, using permanently marked divided 50 × 50 cm quadrats on selected tors	Presence of shoots, flowers and fruits of target species	Annual or biannual
	Other vascular plants Crustose lichens Foliose lichens Bryophytes		Presence of plant categories	
	Melicytus alpinus *Coprosma taylorae*	Remeasuring of permanently marked sampling units (branches) on selected tors within North and South Tussock Blocks and the Pasture Block	Length of sampling unit. Number of fruit and flowers on sampling unit. Evidence of mammalian browsing. Evidence of invertebrate herbivory	Annual or biannual
Tussock grassland	Categories of plant species (as per Table 2)	Modified Scott height–frequency (1 m intervals along 50 m transects) in North and South Tussock Blocks	Shoots, flower and fruit presence in vertically contiguous 5 × 5 × 5 cm volumes	Annually for 4 years or biannually for 6 years, reduced to every 2–4 years thereafter
	Tussock flowering	Count of tussocks flowering along designated transects in North and South Tussock Blocks	Percentage individuals flowering	Annual (Jan–Feb)

Pentachondra pumila, *Gaultheria macrostigma*, *G. depressa*, *G. antipoda*, *Leucopogon fraseri*; S. Walker & M.D. Tocher unpubl. data) while an eighth (*Melicytus alpinus*) may be a good indicator of browsing. The aim will be to sample 4–6 permanently marked 'sampling units' of each target plant species per tussock block, with the sampling units spread as evenly as possible across six study tors within each tussock block.

3.3 TOR PLANT SAMPLING UNITS

3.3.1 Subshrubs

The subshrubs *Pimelea oreophila*, *Pentachondra pumila*, *Gaultheria macrostigma*, *G. depressa*, *G. antipoda* and *Leucopogon fraseri* are monitored in quadrats of 0.5 × 0.5 m (a quadrat for this purpose is a sampling unit). The quadrats are placed in areas of the rock tors where the target species is present at the initial sampling date, with the corner positions permanently marked with nails and plastic tags in order to reposition the quadrat relatively accurately for repeated sampling over time. A single quadrat may be the sampling unit for more than one target species if these are present within the same 0.5 × 0.5 m area on a tor. Quadrats are not necessarily positioned horizontally, but presence

is always recorded from a viewing position perpendicular to the angle of the quadrat. A local frequency estimate of the target species is obtained by recording its presence in each of 25 subquadrats of 10 × 10 cm. The presence of shoots, flowers, and fruits of the target species, and of other vegetation in the categories 'other vascular plant species', 'foliose lichens', 'crustose lichens' and 'bryophytes' is recorded in each subquadrat of each quadrat. Identification of individual non-vascular species is not attempted: this is considered too laborious.

3.3.2 Shrubs

The larger shrubs *Coprosma taylorae* and *Melicytus alpinus* are monitored by remeasuring selected branches (sampling units for this purpose). Where possible, although not always, these units are on different plants, and as far as possible they are positioned within range of browsing on the sunny (north or west) sides of tors where the use of the tors by grand skinks is greatest. The length of the sampling unit depends on shrub size. These are permanently tagged using wire with flagging tape and tags (abrasion may be a problem). The base position of the unit is permanently marked so that it may be re-measured from year to year. Individual photographs are retained to assist the re-location of each shrub in subsequent sampling years.

Data recorded for each large-shrub sampling unit should include:

- size: i.e. maximum length of shoot from a base marker to a growing tip;
- browse: i.e. sign of mammalian browsing (I suggest using a scale of 0–10, based on a visual estimate of the proportion of damaged leaves);
- invertebrate herbivory: i.e. sign of invertebrate herbivory (use similar scale);
- fruiting/flowering: i.e. count of fruits and/or flowers present on the sampling unit. Where numerous, these may also be estimated on a scale of 0–10;
- A written schedule describing the ranks 0–10 should be created and thereafter adhered to, in order to reduce the subjectivity of the above measures.

3.4 VASCULAR PLANT SPECIES RICHNESS ON TORS

In order to detect trends in species richness, lists of all vascular plant species present on each of the 120 study tors should be updated by a thorough search at intervals of 3–5 years.

4. Inter-tor tussock grassland monitoring

4.1 EXISTING VEGETATION MONITORING

Existing 50 m study transects are positioned in pairs in four communities, representing vegetation types identified subjectively in the northern and southern tussock blocks (*Chionochloa rigida* on shallow soils, *C. rigida* on deeper soils, *C. rubra,* and stock camps). Stock camps, characterised by short vegetation and high nutrient inputs from dung, are located on the north-west side of tors. They are expected to show particularly rapid initial changes following stock removal.

An initial intensive sampling of some transects has been carried out using the Scott height–frequency method (Wiser & Rose 1997) and sampling at 0.5 m intervals, recording all species. Other transects have been sampled using a restricted number of plant categories. To measure tussock flowering, square quadrats have been subjectively placed and marked out near existing or proposed Scott height–frequency transects, and the present methods for recording flowering follow the advice of David Kelly (pers. comm.).

4.2 RECOMMENDED MONITORING OF TUSSOCK TRANSECTS

Regular sampling should continue at a subset of existing transects, but others should be abandoned. Modified Scott height–frequency sampling is the most suitable method for monitoring inter-tor vegetation, because this method reveals changes in grassland stature as well as plant species frequency. Visual estimation of percentage ground cover of different species and/or different plant categories is problematic and is not recommended.

The tussock grassland vegetation is fine-textured and species-rich at many sites. Height–frequency sampling to the level of individual species is therefore very laborious, and a significant number of taxa cannot be identified to species level in the field. Data at the individual species level is more than is needed to detect gross changes in the community. Moreover, detailed sampling is probably not repeatable by different observers within an acceptable range of error (my experience is that this is difficult to achieve in even a simple community).

The existing monitoring regime should be modified as follows:

- The return frequency of monitoring should be annual or at least biannual for the first 4 years, and conducted every 2–4 years thereafter. The justification is that certain changes are likely to occur rapidly following grazing cessation (e.g. increases in exotic species), but thereafter change is likely to be more gradual.

- Sampling frequency along transects may be reduced to 1 m intervals (50 points per transect).
- The attributes recorded in each contiguous height–frequency sampling should be reduced according to the list given in Table 2. Some categories from this list may be amalgamated at the next sampling date, but this list should then be used consistently at all subsequent sampling dates. Where categories are difficult for the less experienced observer to tell apart (e.g. 'other native grass' and 'other exotic grass'), but are nonetheless perceived to be important, the best approach will be to familiarise the observers with the exotic grass flora, and to ensure that unknown grass species encountered are noted (on paper) and collected for identification.
- Flowering or fruiting in the recorded categories should be recorded at each sampling point on the transect.
- Vegetation data collected to date should be condensed into these categories.
- The use of a digital vegetation logger can reduce the amount of time devoted to data collection and is highly recommended for efficiency of input and output of data. Commercially available palmtop computers are worth investigating for the purpose.

TABLE 2. TUSSOCK VEGETATION MONITORING CATEGORIES AND EXAMPLES OF SPECIES INCLUDED IN EACH CATEGORY.

Substrate	soil
	rock
Substrate cover	litter
	dead vegetation
	dung
	moss
	liverwort
	foliose lichen
	crustose lichen
Native species	*Chionochloa rigida*
	C. rubra
	Festuca novae-zelandiae
	Poa colensoi
	Elymus
	Other native grass (e.g. *Deyeuxia, Rytidosperma, Dichelachne* spp.)
	Native fruiting shrub (e.g. *Gaultheria antipoda*, *G. macrostigma*, *Pentachondra pumila*)
	Leucopogon fraseri
	Other (i.e. non-fruiting) native shrub (e.g. *Pimelea oreophila*)
	Native 'rush' (e.g. *Carex, Luzula, Uncinia, Schoenus, Oreobolus* spp.)
	Orchid
	Other native herb (e.g. *Epilobium, Geranium*, *Ranunculus, Herpolirion, Bulbinella* spp.)
Exotic species	Exotic shrub (these should be recorded species by species)
	Dactylis glomerata
	Other exotic grass (e.g. *Poa pratensis*, *Agrostis capillaris*, *Anthoxanthum odoratum*)
	Hieracium pilosella
	H. praealtum
	H. lepidulum
	Clover
	Exotic rosette herb (e.g. *Hypochaeris radicata*, *Crepis capillaris*)
	Other exotic non-grass species

It is difficult to gauge whether the existing transects cover an appropriate range of vegetation types and are similar in northern and southern blocks. There is a relatively large number of them (21, according to the information on the map provided by G. Loh), and further replication (by placing new transects in subjectively similar vegetation types to those already represented) is probably not sensible. The existing number of *C. rubra* transects listed (i.e. 4) is adequate, and numbers of stock camp transects (8) and *C. rigida* transects (9) are more than adequate. Two transects per vegetation category (*C. rigida* on shallow soils, *C. rigida* on deeper soils, *C. rubra,* and stock camps) in each block will suffice. The preference is to continue with existing transects where possible and to establish as few new transects as possible to meet these requirements.

4.3 RECOMMENDED MONITORING OF TUSSOCK FLOWERING

I suggest that flowering measurement should be done on the tussock transects, and flowering measured along them, using methodology similar to that carried out for over 20 years in Takahe Valley (Kelly et al. 2000). In this method, the presence or absence of flowering in the first 100 tussocks encountered of each species (*Chionochloa rubra*, *C. rigida* and *Festuca novae-zelandiae*) is recorded along the designated transect line. Transects should be sampled once annually in January or February. To enable repeated sampling, tussocks along each transect should be individually numbered, marked by tying string around their base, and their centre position on the transect noted.

Alternatively, previously established methods of counting flowering stems within demarcated quadrats of varying size may be continued. In this case, the number of quadrats should not exceed that which can be practicably monitored annually: one quadrat matched to each of the continued Scott height–frequency transects should suffice. The drawback of this method is that it will give more unreliable results if flowering is patchy across the Conservation Area.

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