MONTANE ROCK OUTCROPS: ISLANDS OF BIODIVERSITY ON BANKS PENINSULA

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Many New Zealand landscapes are highly modified and retain little of their original native vegetation. Banks Peninsula is no exception, for example approximately 2/3 of its landscape was forested when Europeans arrived and just over 1% of the original old-growth forest persists today (Wilson 1998). From an aesthetic perspective, one of the more striking natural features of Banks Peninsula is the dramatic bluff and cliff systems of exposed ancient volcanic rocks. These habitats have retained a diverse range of plants representing the native flora.

I have been leading a study on the distinctive plant communities found on the montane outcrops of Banks Peninsula, that is those above ~550 m. Our goal is to better understand the persistence of biodiversity on natural habitat islands, such as these, that occur in highly modified landscapes. Over the past three summers a group of us, Rowan Buxton, Phil Suisted, Nadia Zvigina, Deb Zanders and I have documented total higher plant composition on 39 bluff systems (Fig. 1). Rowan and Phil put their rock-climbing skills to work allowing us to sample the most steep, and usually inaccessible, locations. These outcrops occur on public reserves and private productive lands. The 'matrix' of vegetation in which they occur varies widely — some outcrops border old-growth forest, others border second-growth forest or scrub, and others are surrounded by grazed tussock grasslands or areas dominated by exotic grasses. To better understand the influence of this 'matrix' on the nature of outcrop plant communities we also sampled the surrounding vegetation.

Across all of the outcrops studied we recorded 363 vascular plant species. These are mostly native (281 species or 77%). This represents over one third of the Peninsula's flora which is comprised of 550 native and 511 naturalised exotic species; this is notable given that montane outcrops comprise less than 5% of the total area (Wilson 1992). We found substantially more species on the outcrops than we found in any of the surrounding habitats. For comparison, we found a total of 266 species in surrounding grasslands, 256 species in surrounding shrublands and 225 species in surrounding forests. Some species were found on virtually all montane outcrops. These are the natives *Griselinia littoralis* and *Polystichum vestitum* and the exotics *Anthoxanthum odoratum*, *Hypochoeris radicata*, *Dactylis glomerata*, and *Holcus lanatus*.

What kinds of plants occur on the outcrops? Three-fourths of the outcrop flora is herbaceous (Fig. 2). Over half of the herbaceous species are forbs with most of the remaining herbaceous species being graminoids and ferns. There are a few species of cushion plants (i.e. three *Colobanthus* species) and large-leaved monocots (e.g. *Phormium cookianum*). The remaining quarter of the outcrop flora is comprised of woody species. About half of these are shrubs; the rest are trees (usually stunted), vines and a few species of prostrate shrubs (e.g. *Gaultheria depressa*, *Pentachondra pumila*) and mat-formers (e.g. *Kelleria dieffenbachii*, *Raoulia glabra*).

How unique is the outcrop flora? Seventy-two of the 363 plants observed were only found on the outcrops (Table 1, Fig. 2). This is far greater than the number of species that were found exclusively in one of the surrounding habitat types — 23 species occurred only in the grasslands, 11 species occurred only in forest and 4 species occurred only in the shrublands. Among growth forms, ferns (e.g. *Asplenium trichomanes*, *Grammitis poeppigiana*, *Cystopteris tasmanica*) and prostrate shrubs (e.g. *Myrsine nummularia*, *Pentachondra pumila*, *Sophora prostrata*) are more likely to be restricted to the outcrops, whereas only a few trees or vines are restricted (Fig. 2). Six outcrops harboured six or more restricted species. These occurred on the lower slopes of Mt. Herbert, at the Kaituna Spur reserve, on Mt. Fitzgerald, at Peraki Saddle, at Devil's Gap and on the west face of Mt. Bradley. These are all on the western side of Akaroa Harbour.

One of the noteworthy features of the outcrops is the high number of rare plant species they support (Table 1). We observed four of the eight taxa endemic to Banks Peninsula on outcrops we studied. These are *Festuca actae*, *Heliohebe lavaudiana*, *Hebe strictissima* and *Myosotis* 'australis var. lytteltonensis'. Although we observed these more commonly on outcrops, they all occurred in surrounding habitats as well. In the course of our study we re-discovered populations of *Poa kirkii*, *Dolichoglottis lyallii* and *Stenostachys gracilis* (formerly *Elymus narduroides*) on Mt. Herbert outcrops. *Poa kirkii* had not been recorded since 1920 and the others since 1953. Wilson (1992) lists a further 126 species that occur on Banks Peninsula as either nationally rare, or rare or uncommon on the Peninsula. We observed 33 of these on the outcrops (Table 1). It was especially exciting to find populations of 4 species not previously recorded on the Peninsula. These are *Aporostylis bifolia*, *Carex goyenii*, *Cystopteris tasmanica* and *Grammitis patagonica*. These are also listed as "rare" in Table 1. It is worth noting that the two outcrop sites with the highest numbers of rare species are not formally protected.

The 82 exotic species observed are dominated by forbs and grasses, which together comprise 93% of the species. While only six of the exotic species are woody, these may be a more serious concern than the others. Individuals of *Pinus nigra* and *Pinus radiata* occurred on three of the 39 outcrops studied. Pines are well adapted to colonise sites, such as these, with skeletal soils. As planting of pines increases on the Peninsula, it is likely that the frequency of pines on these outcrops will also increase. There are four species of exotic shrubs that occur on the outcrops. These are gorse (11 outcrops), broom (2 outcrops), blackberry (1 outcrop), and boxthorn (1 outcrop). In areas that have the potential to revert to forest, gorse and broom may serve as nurse crops for forest species (Williams 1983; Wilson 1994). Eventually, these light-demanding species will be overtopped by native woody plants and should disappear. On outcrops, however, they are more likely to become permanent features of the flora. Plants on outcrops are generally competing for establishment sites, not light; shade intolerance is often a feature of rock outcrop endemics (Baskin and Baskin 1988). If long-lived exotic woody species capture any of the scarce establishment sites they are likely to preclude establishment by other species. Because establishment of competitors is prevented, these usually successional species will not become overtopped and shaded out as in succession to forest. Managing this problem, however, is very difficult. Fire or release of goats, which are tools commonly used to control woody weeds in pastoral situations, would be a disaster for the outcrop vegetation. One reason that many interesting plants are now restricted to outcrops is

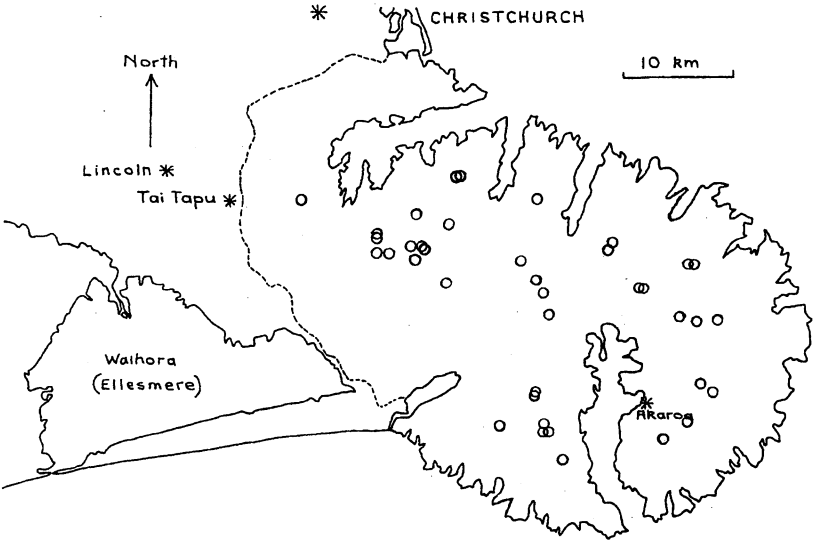

Fig. 1. Location of 39 outcrop systems sampled in this study (overlain on Hugh Wilson's convenient template).

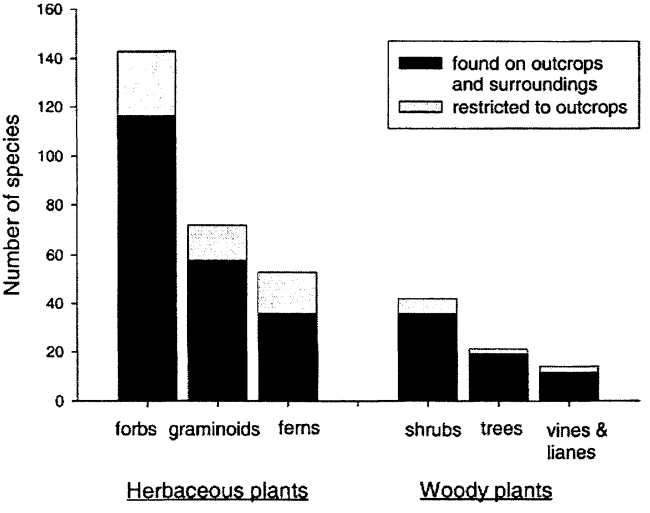

Fig. 2. Growth forms of species observed on outcrops studied.

that steep bluffs provide protection from grazing and fire. Herbicides can be effective, but must be applied with a high level of care so as not to damage nearby plants. On one outcrop, we observed that spray drift from a nearby gorse control operation had killed many native plants on the outcrop itself (e.g. *Gaultheria depressa*).

Montane outcrops are important natural habitats on Banks Peninsula. They provide a refuge for many native species, including endemics and regionally rare species. They also have provided a refuge for species that have been eliminated in surrounding habitats by grazing and fire. These residual populations then can potentially provide a source of propagules for re-establishment of native plants back into nearby areas when fires are prevented and grazing ceases. The inaccessibility that provides a refuge for native plants, however, provides an equally effective refuge for exotic species. In fact, eleven of the exotic species we observed were restricted to the outcrops. This summer we plan to initiate long-term monitoring on some of the more significant outcrop sites to allow us to better understand the interactions between exotic and native plants in these habitat conditions. We hope this will allow us to better predict the likelihood of the long-term integrity of these interesting plant communities.

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Table 1. Outcrop species that were restricted to outcrops in this study or are rare on Banks Peninsula. Species restricted to outcrops are indicated by an "x"; those observed on only one outcrop are indicated by "x(1)". Rarity status on Banks Peninsula follows Wilson (1992) where R = regionally rare or local and V= regionally vulnerable. * Naturalised exotic species.

Taxon	Restricted to outcrops	Rarity Status	Taxon	Restricted to outcrops	Rarity status
Adiantum cunninghamii	x		*Asplenium lyallii*	x(1)	
Anogramma leptophylla	x(1)	R	*Asplenium trichomanes*	X	R
Aporostylis bifolia	x(1)	R	*Brachyscome radicata*	X	
Arthropodium candidum	x		**Bromus diandrus*	x(1)	

Taxon	Restricted to outcrops	Rarity Status
**Capsella bursa-pastoris*	x(1)	
Carex coriacea	x(1)	
Cardamine corymbosa	x	
**Carex demissa*	x	
Carex goyenii	x(1)	R
Cheilanthes humilis	x	
Colobanthus muelleri	x(1)	
Coprosma cuneata	x(1)	
Coprosma tenuifolia	x(1)	
Coprosma virescens	x(1)	
Coriaria arborea	x	
Cordyline indivisa		R
Carmichaelia kirkii	x	V
Cystopteris tasmanicum	x(1)	R
Deschampsia tenella		R
Dolichoglottis lyallii	x(1)	R
Dracophyllum uniflorum	x(1)	
Earina autumnalis	x	
Earina mucronata	x	R
Epilobium rotundifolium	x(1)	
Gaultheria crassa	x	R
Gentiana serotina	x	R
**Geranium pusillum*	x(1)	
Geranium retrorsum	x(1)	
Geum uniflorum	x(1)	
Gingidia enysii		R
Gingidia montana	x	R
Grammitis ciliata		R
Grammitis givenii	x	R
Grammitis magellanica subsp. *nothofageti*	x(1)	R
Grammitis patagonica	x	R
Grammitis poeppigiana	x	
Hebe odora	x(1)	
Hierochloe novae-zelandiae	x(1)	
Hymenophyllum atrovirens		R
Hymenophyllum cupressiforme	x	R
Hymenophyllum demissum	x(1)	R
Hymenophyllum minimum	x	R
Hymenophyllum rarum	x	R
Hymenophyllum sanguinolentum		R
Hymenophyllum villosum		R
**Lycium ferocissimum*	x(1)	
Lycopodium volubile	x	
Muehlenbeckia axillaris	x	R
Myosotis australis var. *lytteltonensis*	x	R (endemic)
Myosotis pygmaea var. *drucei*	x(1)	
Myrsine nummularia	x	V
Neomyrtus pedunculata		R
Oxalis magellanica	x(1)	R
Parahebe lyallii		R
Pelargonium inodorum	x	
Pentachondra pumila	x	R
**Pinus nigra*	x	
Pneumatopteris pennigera	x(1)	
Poa anceps	x(1)	
Poa imbecilla	x	
Poa kirkii	x(1)	R
**Poa labillardierei*	x(1)	
Pyrrosia eleagnifolia	x	
Rytidosperma buchananii		R
**Sagina apetala*	x(1)	
Scandia geniculata	x(1)	
Schoenus pauciflorus		R
Scleranthus uniflorus	x	
Senecio glaucophyllus	x	
**Senecio jacobaea*	x(1)	
**Solanum tuberosum*	x(1)	
Sophora prostrata	x	
Thelymitra decora	x	R
Thelymitra hatchii		R
Thelymitra pauciflora	x(1)	
Tmesipteris tannensis	x	R
Trisetum lepidum	x	R
Trichomanes strictum	x(1)	
Uncinia banksii	x	R
Uncinia filiformis	x	
Uncinia scabra	x	
**Vicia tetrasperma*	x(1)	