Return to previous file: drds294a.pdf

Figure 6. A. Mean total herb numbers (± 1 SEM), and B. Mean herb species richness (± 1 SEM) in grassland (top panel), ecotone (middle panel) and forest (bottom panel) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Control (hatched bars) and exclosure (open bars) treatments are nested within sites.

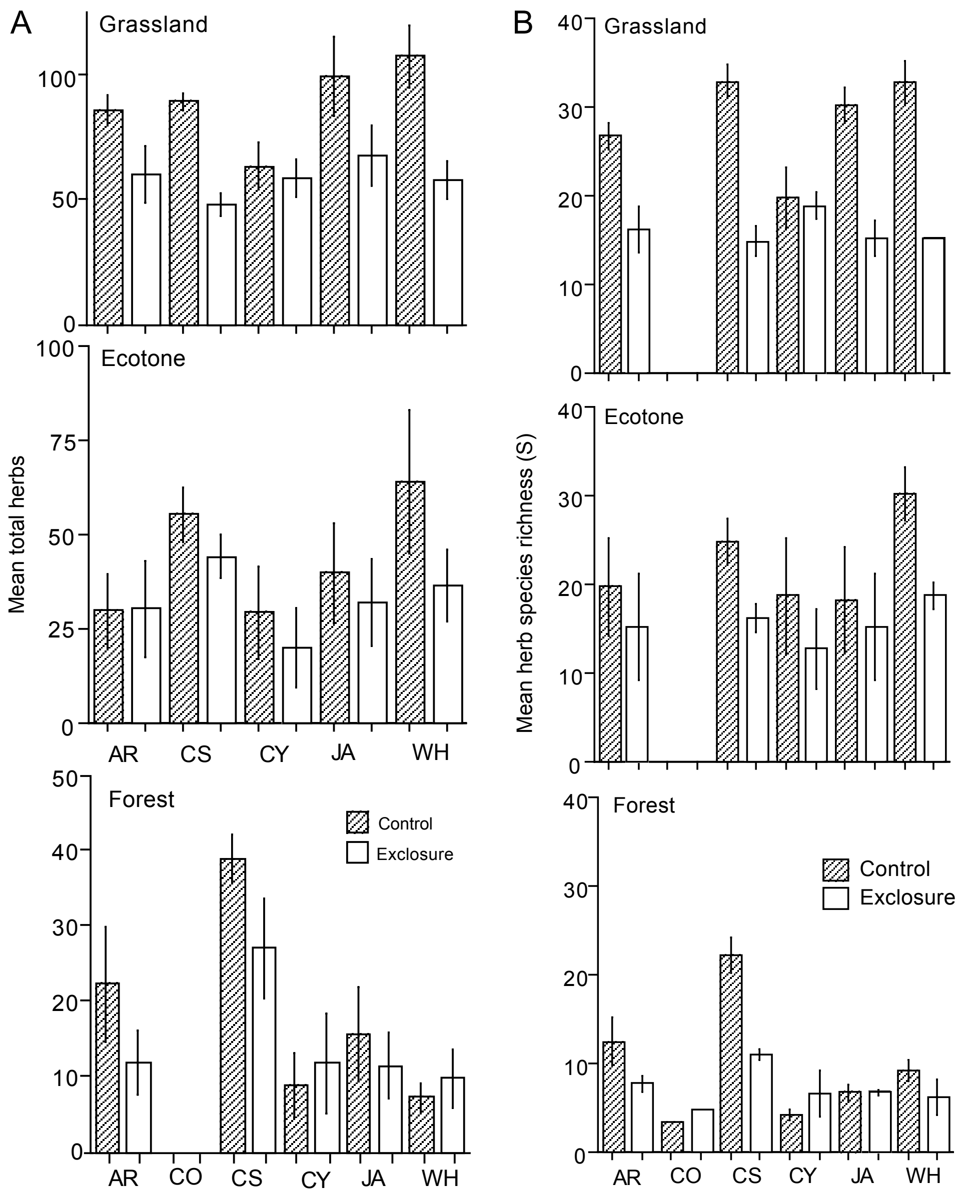
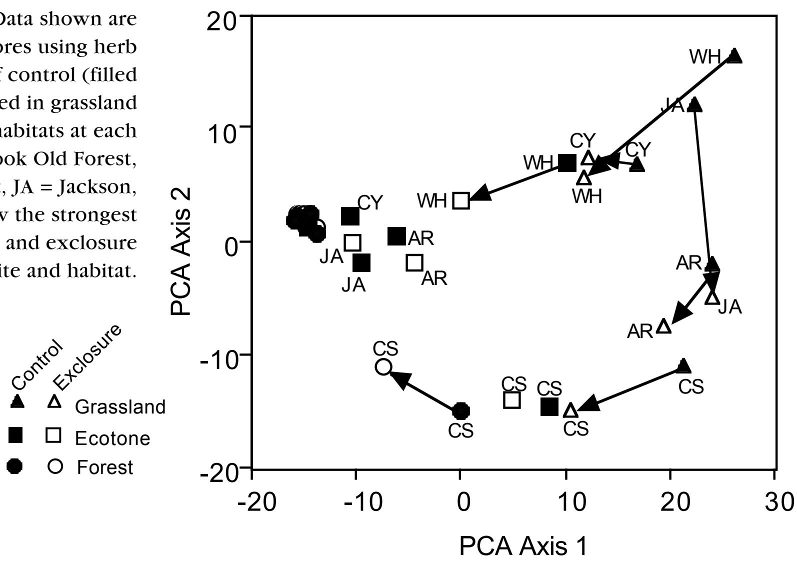


Figure 7. Shifts in herb species composition. Data shown are Principal Components Analysis (PCA) centroid scores using herb counts for the most recent remeasurement of control (filled symbols) and exclosure (open symbols) plots located in grassland (triangles), ecotone (squares) and forest (circles) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Lines with arrows show the strongest compositional shifts between pairs of control and exclosure treatments within study site and habitat.



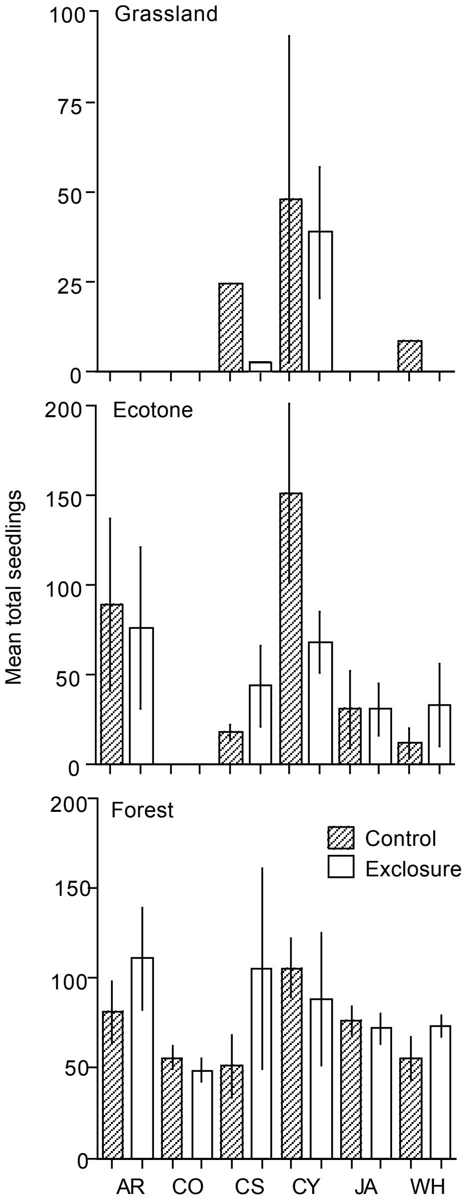


Figure 8. Mean total seedling abundance (± 1 SEM) in grassland (top panel), ecotone (middle panel) and forest (bottom panel) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Control (hatched bars) and exclosure (open bars) treatments are nested within sites.

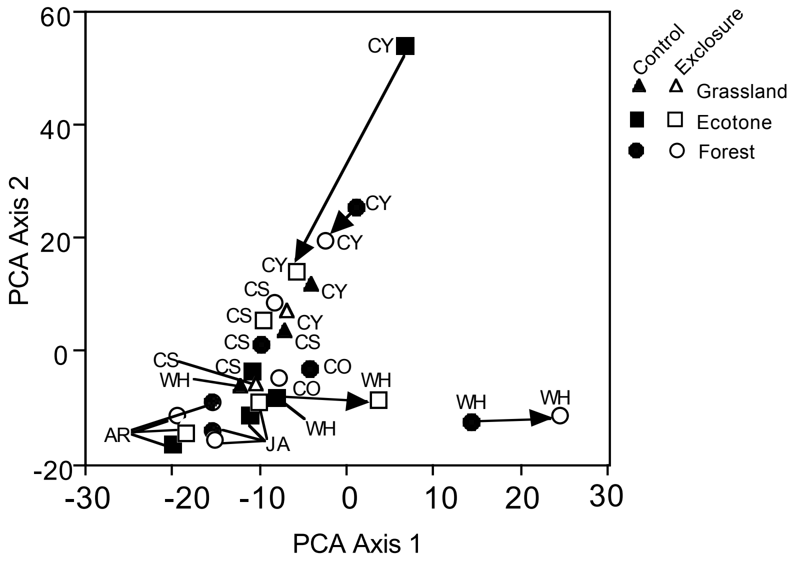


Figure 9. Shifts in seedling species composition. Data shown are Principal Components Analysis (PCA) centroid scores using seedling counts for the most recent remeasurement of control (filled symbols) and exclosure (open symbols) plots located in grassland (triangles), ecotone (squares) and forest (circles) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Lines with arrows show the strongest compositional shifts between pairs of control and exclosure treatments within study site and habitat.

as the increase in the control (492 plants) was greater than that in the exclosure (124). There was some convergence in species composition, particularly in forest habitats at the Jackson River and Cook Young Forest sites (Fig. 11).

4.7.4 Shrubs (0.3–2 m)

At most sites, there were larger increases or decreases in shrub numbers in exclosures than in unfenced controls (Fig. 12). A notable exception was the Cook Swamp grassland, where shrub numbers increased substantially in the control plot. Other exceptions were the Jackson River grassland, Whataroa Valley grassland and Whataroa Valley ecotone.

Tree ferns showed greater increases in numbers in all exclosures than in their corresponding controls, with the exception of *Dicksonia squarrosa* in the Jackson River ecotone (Fig. 13), where only seedlings were initially present in the control plot, *Cyathea smithii* numbers in the Jackson River forest, and the forested portion of the Whataroa Valley, where the increase of *Cyathea smithii* numbers in the control (Fig. 14) marginally exceeded the increase of *Dicksonia squarrosa* in the exclosure (Fig. 13). Otherwise, most changes in tree fern numbers resulted from changes in *Dicksonia squarrosa*, which increased in virtually all exclosures and decreased in many controls, especially in the Cook Valley sites and forest of the Jackson River. The large percentage change in the forested portion of the Arawhata exclosure was due to the recruitment of *Dicksonia squarrosa*, which only occurred as seedlings when the initial measurements were made.

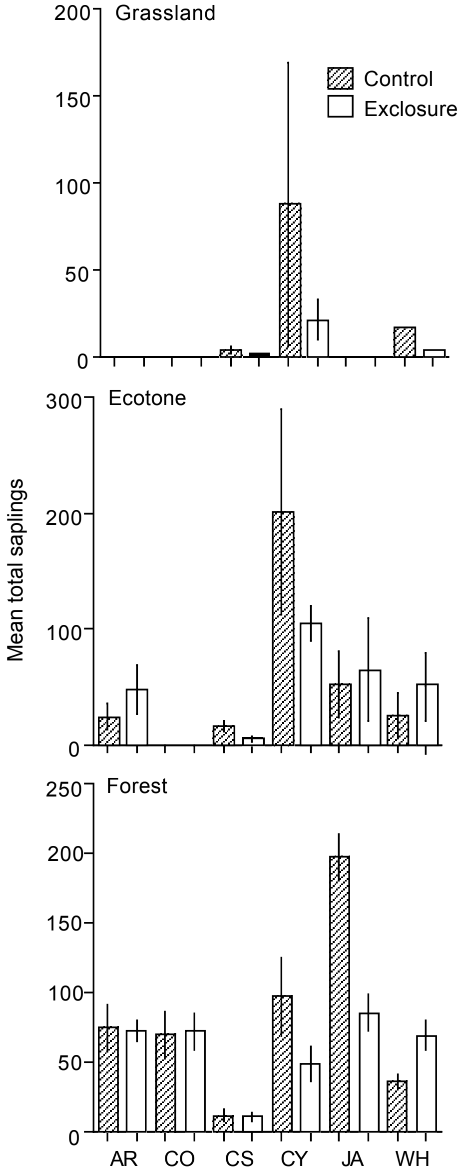


Figure 10. Mean total sapling numbers (± 1 SEM) in grassland (top panel), ecotone (middle panel) and forest (bottom panel) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Control (hatched bars) and exclosure (open bars) treatments are nested within sites.

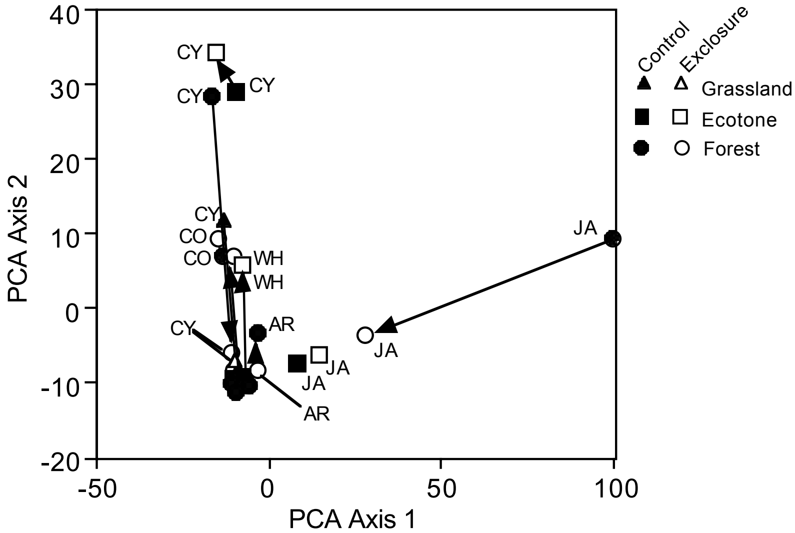


Figure 11. Shifts in sapling species composition. Data shown are Principal Components Analysis (PCA) centroid scores using sapling counts for the most recent remeasurement of control (filled symbols) and exclosure (open symbols) plots located in grassland (triangles), ecotone (squares) and forest (circles) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Lines with arrows show the strongest compositional shifts between pairs of control and exclosure treatments within study site and habitat.

Tree ferns did not have a strong influence on compositional shifts, having very small loadings on Principal Components (PCA) axes. A summary of PCA axes for shrub compositional data, using first and latest measurement data, is given in Appendix 2. The first three axes explained 82% of the variation in shrub species composition. Species that did influence compositional changes were *Pseudowintera colorata* and *Dacrycarpus dacrydioides*, *Coprosma rotundifolia* and *Raukaua anomalus*. However, compositional changes varied between sites and there was no consistent effect of fencing (Fig. 15).

Several species consistently reponded positively to the removal of stock (Appendix 2), including *Melicytus ramiflorus*, *Schefflera digitata*, *Carpodetus serratus*, *Coprosma lucida*, *C. rhamnoides*, *Griselinia littoralis*, *Nothofagus menziesii*, *Pseudopanax crassifolius*, *Weinmannia racemosa*, and, at Cook Swamp, *Phormium tenax*. Some shrub species responded positively to the removal of grazing at one or two sites and negatively at other sites, e.g. *Myrsine divaricata*, *Coprosma tayloriae*, *C. rotundifolia*, *Hedycarya arborea*, and *Pennantia corymbosa*. *Podocarpus totara* var. *waihoensis* had a negative response to the removal of grazing.

4.7.5 Numbers of palatable species in the shrub layer

Forsyth et al. (2002) classified the palatability of common native forest species into three groups (preferred, not selected, and avoided) based on ungulate preferences. 'Preferred' is defined as those plant species eaten more than expected from their availability; 'not selected' is those plant species that are eaten in proportion to

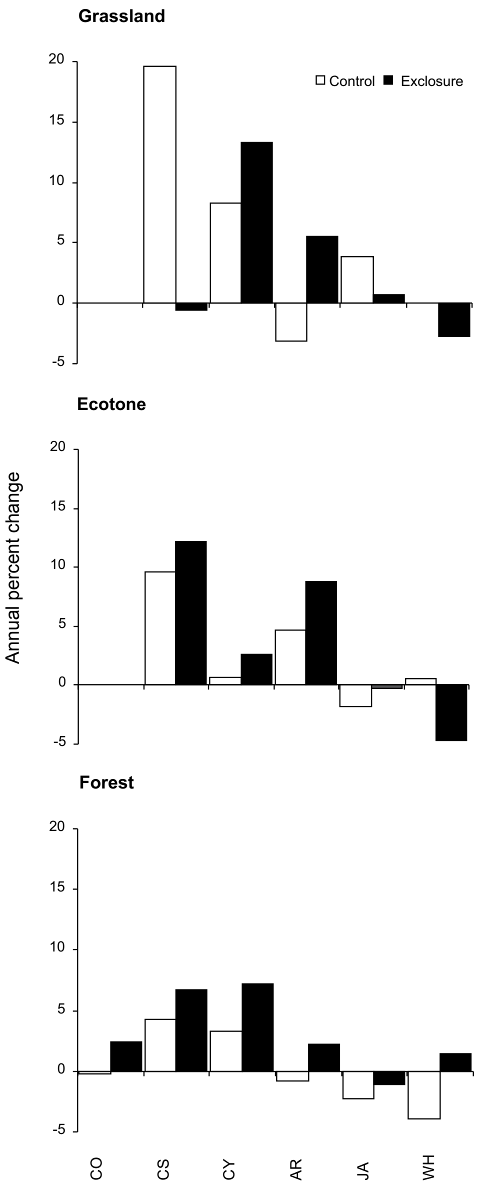


Figure 12. Annual percent change in shrub numbers between initial and most recent remeasurements in grassland (top panel), ecotone (middle panel) and forest (bottom panel) habitats within the control (open bars) and exclosure (filled bars) plots at each of six study sites (CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, AR = Arawhata, JA = Jackson, and WH = Whataroa).

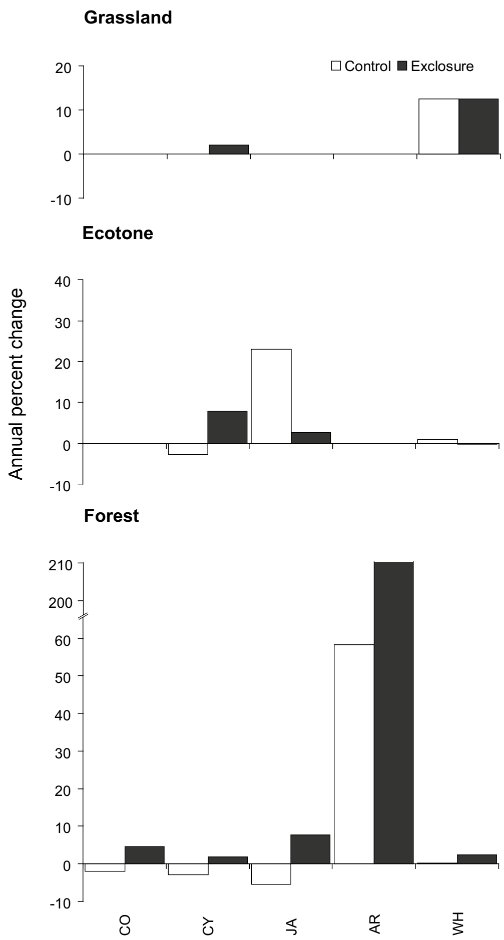


Figure 13. Annual percent change in *Dicksonia squarrosa* numbers between initial and most recent remeasurements for grassland (top panel), ecotone (middle panel), and forest (bottom panel) habitats within the control (open bars) and exclosure (filled bars) plots at each study site in which they occur. CO = Cook Old Forest, CY = Cook Young Forest, JA = Jackson, AR = Arawhata, and WH = Whataroa.

their availability; and 'avoided' is those plant species that are eaten less than expected based on their availability. There were fewer palatable species in ecotone and grassland than in forest habitat (Table 4, Appendix 3). The number of shrubs preferred by stock only increased with fencing or between measurements in some locations, suggesting that previous or ongoing browsing by mammals other than domestic stock was continuing to have an effect on palatable species in places (Fig. 16).

4.7.6 Trees (> 2 m)

There was some recruitment of new stems of tree species at some sites (Cook Swamp and Cook Young), with the biggest changes occurring in the Cook Swamp ecotone and forest areas (Fig. 17). However, stock exclusion did not have a consistent, strong effect. Not surprisingly, tree species composition did not change much between control and exclosure plots, with the exception of Cook Swamp, where ecotone and forest habitat composition were converging more quickly with stock exclusion (Fig. 18).

TABLE 4. SUMMARY OF ANOVA RESULTS FOR THE ABUNDANCE OF INDIVIDUALS IN THE SHRUB LAYER.

The five sites were Cook Young Forest, Cook Swamp, Whataroa, Arawhata and Jackson. Cook Old Forest was excluded because it contained only forest habitat.

Factors include Site, Treatment (fenced, no fencing), Habitat (forest, ecotone, grassland), Year (initial, most recent) and Palatability (palatable, not palatable). Higher order interactions are not included here because of sample size limitations. Model overall error df = 34, SS = 59916.9.

SOURCE	df	SUM OF SQUARES	*F* RATIO	PROB > *F*
Site	4	30196	5.31	0.000
Treatment	1	4546	3.20	0.075
Habitat	2	136067	47.9	< 0.0001
Year	1	1038	0.73	0.393
Palatability	1	503827	354.5	< 0.0001
Site × Treatment	4	43170	7.59	< 0.0001
Site × Habitat	8	114163	10.0	< 0.0001[a]
Site × Year	4	14871	2.62	0.036
Site × Palatability	4	41350	7.27	< 0.0001[b]
Treatment × Habitat	2	2174	0.77	0.466
Treatment × Year	1	461.9	0.33	0.569
Treatment × Palatability	1	90.7	0.064	0.801
Habitat × Year	2	152.8	0.054	0.948
Habitat × Palatability	2	94159	33.1	< 0.0001
Year × Palatability	1	37.65	0.027	0.871

[a] The significant Site × Treatment interaction is driven by fencing, resulting in increased shrub numbers at Whataroa Valley compared with other sites.

[b] The significant Site × Palatability effect is driven by palatable species having greater declines in numbers at Jackson River than at other sites.

4.7.7 Exotic species

Woody exotics were not present in the shrub layer at any of the sites. Fencing suppressed both herbaceous exotics and native herbs (Appendix 4). The percent frequency and species richness of exotics declined more than native herbs in forest (–4.6%/y) and ecotone (–4.1%/y) habitats.

4.7.8 Summary of effects

Results from the South Westland exclosures showed that the removal of stock grazing had distinct effects on the vegetation. However, these effects:

- Were site-specific and varied with habitat (Table 5)
- May take several decades to eventuate
- Did not promote unpalatable canopy species
- Resulted in a lower abundance of herbaceous species
- Resulted in an increased abundance of seedlings and saplings at some sites

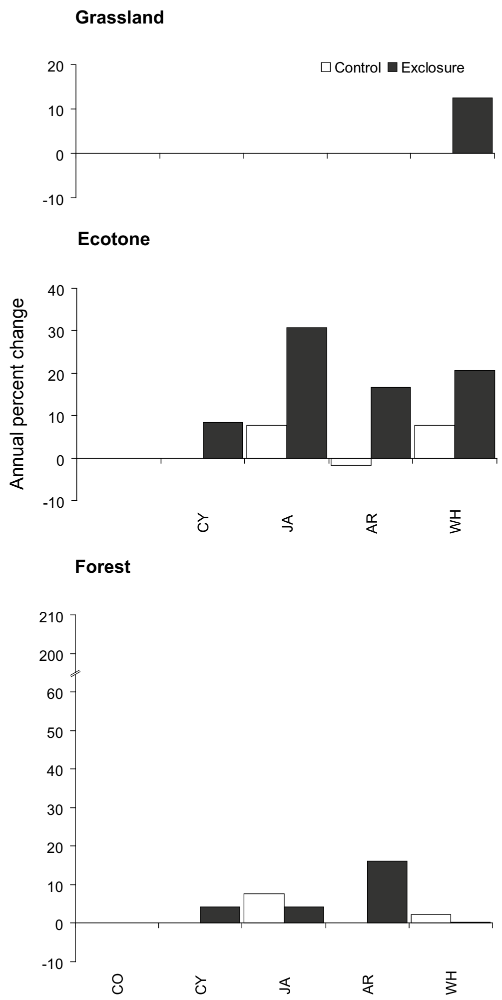


Figure 14. Annual percent change in *Cyathea smithii* numbers between initial and most recent remeasurements for grassland (top panel), ecotone (middle panel), and forest (bottom panel) habitats within the control (open bars) and exclosure (filled bars) plots at each study site in which they occur. CO = Cook Old Forest, CY = Cook Young Forest, JA = Jackson, AR = Arawhata, and WH = Whataroa.

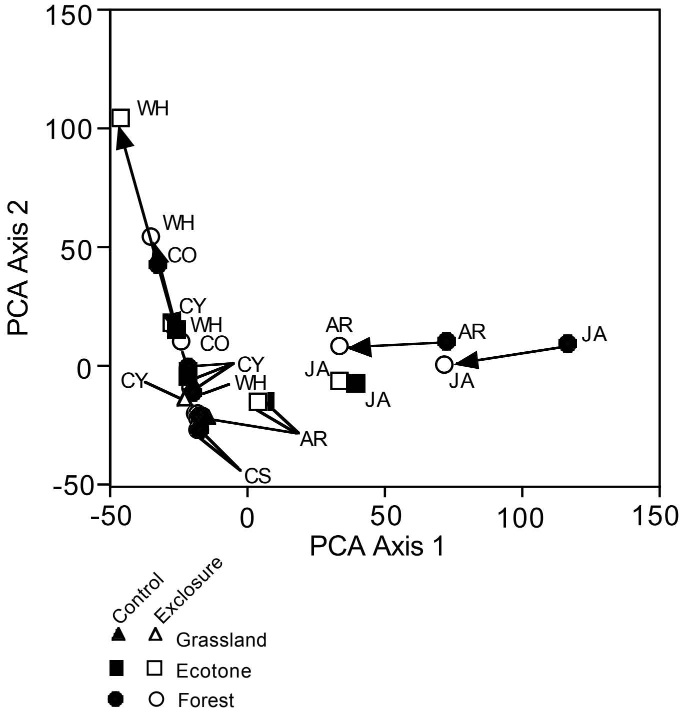


Figure 15. Shifts in shrub species composition. Data shown are Principle Components Analysis (PCA) centroid scores using shrub abundance for the most recent remeasurement of control (filled symbols) and exclosure (open symbols) plots located in grassland (triangles), ecotone (squares) and forest (circles) habitats at each of six study sites (AR = Arawhata, CO = Cook Old Forest, CS = Cook Swamp, CY = Cook Young Forest, JA = Jackson, and WH = Whataroa). Lines with arrows show the strongest compositional shifts between pairs of control and exclosure treatments within study site and habitat.

5. Discussion

Several attributes of plant species influence the degree of damage that they will sustain from grazing, including growth form, palatability, associations with other plant species and competitive ability (e.g. Hearn 1995). This makes it difficult to make generalised statements about the susceptibility of plants to stock grazing. Furthermore, natural processes can alter, interact with or obscure the impact of extensive stock grazing on vegetation change (see Buxton et al. 2001). Consequently, few plant species show consistent, directional responses to grazing or the cessation of grazing, so care must be taken when extrapolating results to other sites or species. Our results showed that vegetation responses to grazing exclusion varied greatly both in rapidity and direction according to vegetation and habitat type.

Continue to next file: drds294c.pdf