3. WEED PENETRATION, EDGE EFFECTS AND REHABILITATION STRATEGY SUCCESS IN WEEDY SWATHES OF THE PALMERSTON POWERLINE CLEARING

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3.1 SUMMARY

This study has shown that the rainforest restoration plantings across the Palmerston powerline clearing that were undertaken by the Centre for Tropical Restoration (QPWS) in 2000, using three framework species, has demonstrated early success. Grasses, which include molasses grass *(Melinis minutiflora*) and Guinea grass *(Panicum maximum*),that can help to maintain a grassy swathe by promoting fires and by preventing the germination of native rainforest species, have been reduced or almost eliminated under the low relatively open canopy that is now present. These grasses dominate in the clearing at sites that have not been rehabilitated, together with woody weeds such as Lantana (*Lantana camara*) and Giant Bramble (*Rubus alceifolius*). Herbaceous species, including Bluetop (*Ageratum conyzoides*) and Thickhead (*Crassocephalum crepidiodes*), have replaced the grasses in the ground cover where light penetrates but are also gradually being eliminated as the canopy spreads. As yet, very little recruitment of rainforest species was recorded in these early stages of growth.

Edge-induced changes in floristic composition were shown to penetrate the rainforest to a distance of between three and seven metres from the rainforest edge, with a few weeds present in this edge zone. Early successional stage rainforest species appeared more prevalent in this band, whereas a slight trend suggested that late successional species may be more common further inside the rainforest. However more data are required to confirm these results. Hierarchical agglomerative classification and ordination techniques both demonstrated that floristic composition was altered further into the rainforest to distances between twenty and forty-five metres. These alterations suggest a more insidious, longer-term and more widespread effect of wide linear clearings on floristic composition. Such changes could have a flow-on effect to other flora and fauna of the rainforest. The distance from the edge where these changes can be recognised suggests that a larger area of habitat within the Wet Tropics World Heritage Area may be floristically altered due to linear clearings through the rainforest than was previously thought. Further data will clarify these results.

3.2 INTRODUCTION

In Section 1, the distribution of weeds within the Palmerston powerline corridor was described. Weeds may also penetrate the rainforest, generally only to short distances (Siegenthaler *et al.,* 2000). Penetration of alien flora constitutes one type of edge effect. Edge effects are a diverse array of ecological changes occurring at and in the vicinity of the abrupt artificial margins of natural habitat and the linear clearing. Edge effects comprise both abiotic and biotic changes. On rainforest edges, abiotic edge effects can include elevated wind speed, turbulence and vorticity (Laurance 1997) and changes in microclimate. Increased solar penetration during the day and reradiation at night result in greater diurnal air and soil temperature fluctuation than found under the interior forest canopy (Murcia 1995). Consequent increases in vapour pressure deficit and evaporation occur while relative humidity and available soil moisture decrease (Turton and Freiburger 1997). Biotic edge effects can be direct changes in abundance and distribution of species caused by these changes in physical conditions. Indirect biotic effects arising from the direct changes in floristic and faunal species composition can include variations in species interactions such as predation, competition, herbivory and seed dispersal.

Laurance (1991b) showed that edges of rainforest fragments had greater canopy and subcanopy damage and increased abundances of woody lianes, climbing rattans and other disturbance-adapted plants. Such forest disturbance was discernible to distances of two hundred to five hundred metres. By comparing species richness and abundance of weeds, colonising plant species and rainforest core species in rainforest remnants of NSW, Fox *et al.* (1997) were able to delineate edge dimensions in terms of the changes in community composition of each of these groups. They observed a decrease in rainforest core species towards the edge with a concomitant increase in weeds and colonisers. However, grazing was prevalent in these remnants, creating a greater weed load than might otherwise be expected (Fox *et al.* 1997). Siegenthaler *et al.* (2000) demonstrated edge effects in floristic composition and vegetation structure along the Palmerston powerline clearing and an associated road, penetrating into the rainforest to distances of at least thirty metres for some factors and dependent on the width of the clearing. Canopy openness was increased at the rainforest edge, as were weeds and pioneer species. Weeds were found to penetrate to a distance of three metres from the edge (Siegenthaler *et al.,* 2000). Sapling and seedling abundances were elevated to greater distances, suggesting greater disturbance at the edge. Seedlings (probably of rainforest rather than disturbance species) were also more abundant further into the forest (thirty to one hundred metres).

Although 'edge effects' on floristic composition and vegetation structure have been examined previously, there has been no comparison of powerline corridors, highways and narrow roads and rehabilitation success has yet to be examined. One objective of this study was to examine the success of rehabilitation plantings in prevention of weed germination. A second objective was to compare the penetration of weeds and weed seeds into the forest from powerline corridors with and without rehabilitation plantings, as well as from highway and narrow road edges. The third objective was to examine edge effects in vegetation floristic composition at these three treatments.

3.3 METHODS

3.3.1 Study Sites

In 1999 / 2000, three 60 metre x 50 metre sites in the lower section of the Palmerston powerline corridor were prepared for restoration plantings by the Centre for Tropical Restoration (Dellow 2000); these sites are more than two hundred metres apart. In preparation, the sites were twice slashed for weeds (September and November 1999), one pig trap was installed at each site (October 1999) and glyphosate was applied using a 'Weedbug' (December 1999 and February 2000). Three rainforest species, *Acacia celsa, Alphitonia petriei* and *Elaeocarpus grandis* were planted in February 2000 at three metre spacings in rows perpendicular to the powerline clearing. These three species were chosen to provide a framework for later direct seeding trials under the canopy they establish. Three control sites where woody weed or grassy swathe occurred in the clearing were established at a distance of at least fifty metres from each of the rehabilitation sites.

The rainforest vegetation of the area comprises Complex Mesophyll Vine Forest (Type 1a *sensu* Tracey 1982). The canopy is uneven with a height ranging from twenty-five to thirty-five metres. Vegetation within the powerline clearing at the control sites consists either of a grassy swathe of *Panicum maximum* (Guinea grass), *Melinis minutiflora* (Molasses grass) and occasional *Brachiaria decumbens* (signal grass) as well as herbaceous weeds with occasional rainforest pioneer species establishing. Woody weeds including *Lantana camara* (Lantana) and *Rubus alceifolius* (wild raspberry) often occur along the edge and are, in places, out-competing the exotic grasses to form an almost complete woody weed swathe across the clearing (see Section 1).

3.3.2 Floristic Survey Methods

Mr Robert Jago, a well-respected botanist and plant identification expert with many years of experience within the Wet Tropics was employed to identify all plant species present. Surveys of four transects were undertaken in June 2002. Unfortunately, Mr Jago will not be available for further work in this project but Mr Rigel Jensen, another plant identification expert has continued with identifications. The height of the rehabilitation site canopy is shown in Figures 3.1 and 3.2.

Transects

Each of the six sites included two by one hundred metre long line transects, one on either side of the clearing, that were laid perpendicular to the linear clearing from a zero point at five metres inside the clearing to a distance of one hundred metres into the rainforest (Siegenthaler and Turton 2000). Ten data sampling points were established at the following intervals along the line transects: 0, 5 (rainforest edge), 8, 12, 16, 20, 25, 30, 50 and 100 metres. Additionally, three or four sampling points (depending on clearing width at the transect) were established along the same transect into the powerline clearing at five metre intervals (i.e -5, -10, -15 and -20 metres).

Quadrats

At each sampling point in a circular quadrat of one metre radius, all vegetation was surveyed for all species in five size classes:

a) Canopy and emergents (trees reaching the canopy);
b) Subcanopy (trees not reaching the canopy but forming a layered subcanopy beneath it);
c) Understorey (saplings and shrubs >1 metre in height not reaching the subcanopy);
d) Groundcover (seedlings and shrubs <1 metre in height);
e) Vines (lianes and rattans climbing toward or into the subcanopy and canopy); and
f) Epiphytes (ephiphytic ferns and orchids and hemiepiphytes such as aroids).

Additionally, all species of understorey size or greater as well as dominant groundcovers were surveyed in circular quadrats of five metres radius from each sampling point. The larger sampling area resulted in a more comprehensive coverage of species reaching understorey height in the vicinity.

Species occurrences were classified on an ordinal scale consisting of:

a) Dominant (dominating the area):
b) Common (not dominant but very common within the area);
c) Occasional (at least two occurrences within the 1m quadrat or three occurrences within the 5m quadrat, but uncommon); and
d) Rare (one occurrence within the 1 m quadrat or 1-2 occurrences within the 5 m quadrat)

Figure 3.1: Height of rehabilitation plot canopy in May 2002.
Photograph taken at a distance to allow comparison with the forest edge.

Figure 3.2: Height of rehabilitation plot canopy in May 2002.
Photograph reveals height of trees relative to person height.

Classification of Species into Disturbance Indicators and Successional Stages

Species were classified into groups on the basis of successional stage (Goosem and Tucker 1995, Tucker and Murphy 1997, Tucker 2001), using ecological descriptions from Hyland and Whiffin (1993) and Hyland *et al*. (1999) for species not listed elsewhere, to determine successional stage similarity to cogenerics. Successional stage groupings were:

a) Weeds (exotic species), e.g. *Panicum maximum, Lantana camara, Ageratum conyzoides*;
b) Early successional stage or pioneer rainforest species, e.g. *Breynia stipitata, Omalanthus novoguineensis, Maclura cochinchinensis, Rubus probus, Glochidion harveyanum;*
c) Intermediate successional stage rainforest species, e.g. *Mischocarpus stipitatus,*
d) Late successional stage rainforest species, e.g. *Argyrodendron peralatum, Desmos goezeanus, Sloanea mcbrydei, Syzygium cormiflorum*.

However many species are considered to belong to two or more of these groups (Tucker and Murphy 1997, Tucker 2001):

a) Early to intermediate, e.g. *Darlingia darlingiana, Flagellaria indica, Dysoxylum muelleri, Guioa lasioneura, Oplismenus hirtellus, Polyscias australiana, Sarcopteryx martyana*;
b) Intermediate to late, e.g. *Alpinia modesta, Carronia protensa, Castanospermum australe, Cryptocarya mackinnoniana, Dysoxylum papuanum, Flindersia bourjotiana, Haplostichanthus* sp., *Helicia nortoniana, Litsea leefeana, Melodinus australis, Pitiviasta haplophyllus, Raphidophora australasica, Tetrasynandra laxiflora, Toechima erythrocarpum, Xanthophyllum octandrum;*
c) Early to intermediate to late, e.g. *Asplenium australasicum, Cardwellia sublimis, Chionanthus ramiflora, Ichnocarpus frutescens, Melicope vitiflora, Piper novaehollandiae.*

Those species included in two or more groups are depicted graphically in the combined class. If a species belongs to an early to intermediate stage it was included in the early successional disturbance indicator class (see Figure 3.3). Likewise if a species belongs to an intermediate to late successional stage, it was included in the late successional class when graphing disturbance indicators.

3.3.3 Soil Seed Bank

Three replicate soil samples were randomly chosen within each circular quadrat of one metre radius. Any large leaf litter was removed from the soil; the soil was then sampled in a twenty-centimetre square to a depth of five centimetres. These samples were pooled, mixed, and subsampled by quartering with one random subsample chosen, resulting in a final 1500cm^3 sample. Samples were transferred to a greenhouse and placed on coarse blotting paper to prevent soil loss within free draining seed germination trays. Trays were kept moist by twice-daily watering.

All seedlings were counted, identified and removed after twenty-eight days. Any unidentifiable individuals were potted into larger tubes to permit later identification. The soil surface was then disturbed to a depth of one centimetre to encourage further germination. Seedlings were again counted, identified, removed and soil disturbed at fifty-six and eighty-four days when no further germination was recorded.

3.3.4 Data Analysis

Species lists were compiled for each quadrat size at each sampling point. Species composition was examined for successional stage for each quadrat. Data for both the one metre and five metre radius quadrats (incorporating data from the one metre radius quadrats) were analysed by SPSS Version 10.0. Non-metric multi-dimensional scaling ordinations were performed for each transect using presence / absence data and binary Euclidean distance as the measure of separation of quadrats. Ordination in both two-dimensional and three-dimensional spaces was performed. Dimension coordinate data were back-correlated with species data to determine the major contributors to each dimension. Hierarchical agglomerative clustering analysis was also performed with the presence / absence data for each transect using binary Euclidean distance as the measure of separation and Ward's minimum variance clustering method. Finally, quadrat data for all transects were classified using hierarchical agglomerative clustering.

3.4 RESULTS AND DISCUSSION

A total of two hundred and four plant species were identified within the quadrats along the four transects within the Palmerston powerline clearing and adjacent rainforest that has been examined thus far (Appendix 2.1). Data collection on transects within the powerline clearing and along the highway continued using Mr Rigel Jensen to identify plant species. Appendix 2.2 provides a list of all species found within each quadrat of one metre radius and each quadrat of five-metre radius.

3.4.1 Penetration of Weeds and Disturbance Indicators

Of the two hundred and four species recorded along the four transects, sixteen were exotic (weed) species. The great majority of exotic species were found within the corridor (Figure 3.3a, Figure 3.4). Weed species were dominant in the clearing (-20 – 0 metres) but barely penetrated the rainforest edge, only three or four species were recorded in rainforest edge quadrats (five metre sample) at the control site and one or two at the rehabilitation site edge. Weed species that were dominant within quadrats in the clearing include *Panicum maximum* (Guinea grass), *Melinis minutiflora* (molasses grass), *Lantana camara* (lantana), *Rubus alceifolius* (wild raspberry) and *Ageratum conyzoides* (blue top). One species (*Rubus alceifolius*) penetrated as far as the eight metre quadrat (three metres from the edge) at the control sites (n = two transects per treatment).

Numbers of weed species were reduced in almost all quadrats within the clearing at the rehabilitation sites (Appendix 2.2). This was mainly due to a shift away from grassy weeds such as *Panicum maximum* (Guinea grass), *Melinis minutiflora* (molasses grass) and *Brachiaria decumbens* (signal grass). The abundance of weeds was dramatically reduced, particularly the grasses, with herbaceous weeds such as *Ageratum conyzoides* (blue top) and *Crassocephalum crepidiodes* (thickhead) becoming more common.

This shift in weed species present and their abundance is related directly to the ability of these herbaceous species to out-compete the previously dominant grasses in the greater shade that is provided by the low canopy of the rehabilitation plantings. Eventually, the expansion of the canopy towards closure should completely prevent the germination of these herbaceous species, as is happening directly under each tree where light is more limited.

This canopy expansion should also result in the recruitment of rainforest species below the canopy (Goosem and Tucker 1995, Lamb *et al*. 1997, Tucker and Murphy 1997). Restoration is already achieving some of its objectives by preventing germination of fire promoting grass species such as Molasses grass and Guinea grass (Wallmer 1994, Werren 2001). These fire-promoting grasses have contributed to the self-sustaining grassy swathe within the powerline clearing but have now been reduced, at least in these small areas. In recent history, fires were an annual occurrence within the lower elevations of this linear clearing (personal observation). The presence of these firebreaks should also reduce the likelihood of fires in between the rehabilitation sites.

Although vines are expected to be more common in the disturbed areas of the edge, this was not true of numbers of vine species which tended to be relatively uniform throughout the rainforest sections of the transects (Figure 3.3c). Vine abundance may show a different trend, although the majority of vine species recorded along these transects come from the later successional stages (Appendix 2.1). Abundance of vines was examined when further data were collected in an Honours in Applied Science project (Mr Neil Maver), completed in November 2002.

Early successional stage rainforest species were more common near the edge (Figure 3.3b while those occurring within the clearing at the rehabilitation sites were predominantly the planted trees. However, because several species can occur in early, intermediate and late successional stages, the early species (a combination of early, early to intermediate and early to intermediate to late species) are still relatively common even ninety-five metres into the forest. This is particularly true of one rehabilitation site where the one hundred metre quadrat occurs near a creek which is an area of greater natural disturbance.

Numbers of later successional stage rainforest species tend to increase from the edge to the interior (Figure 3.3d). However much more data are required to determine whether this trend translates to statistical differences. Further transect data are required to analyse this trend.

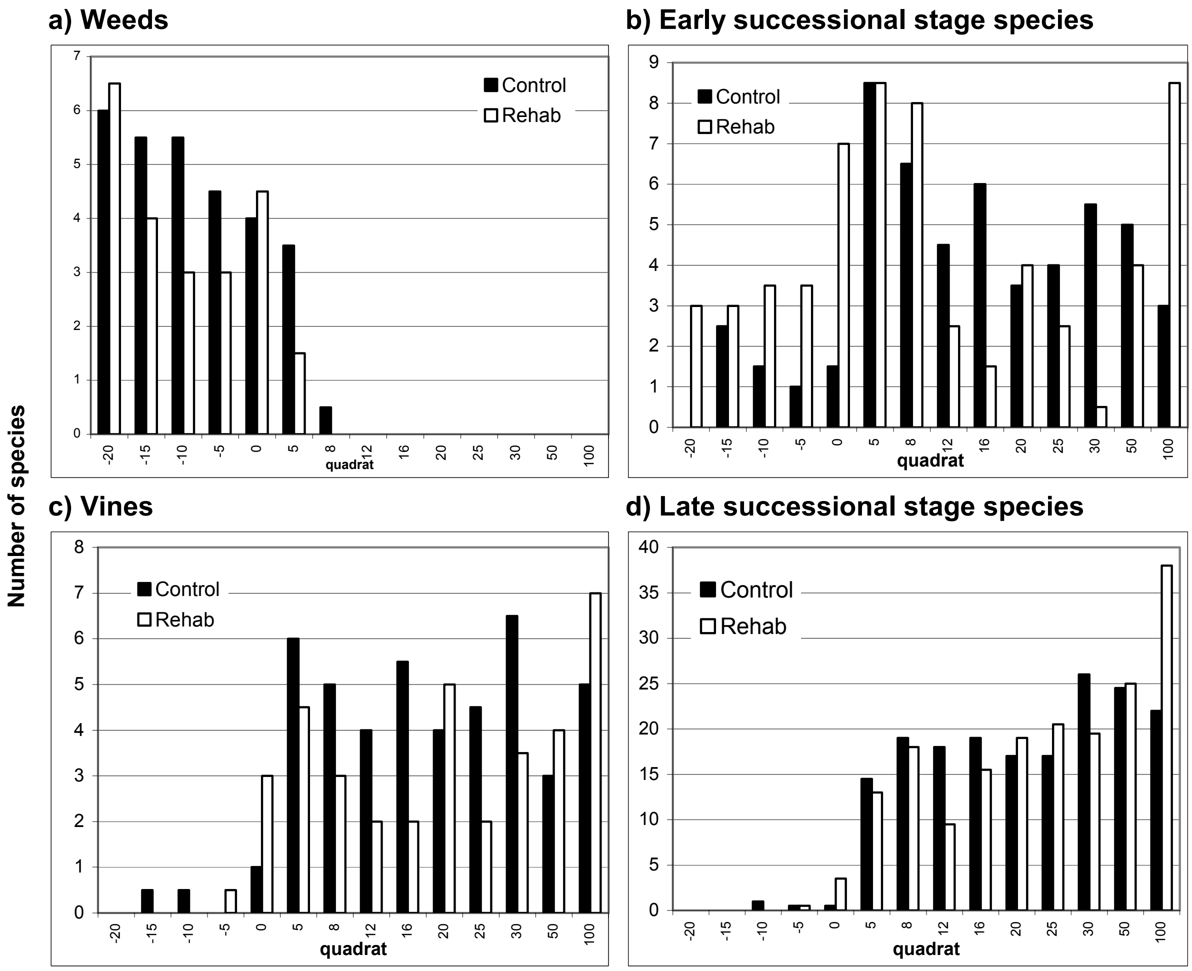


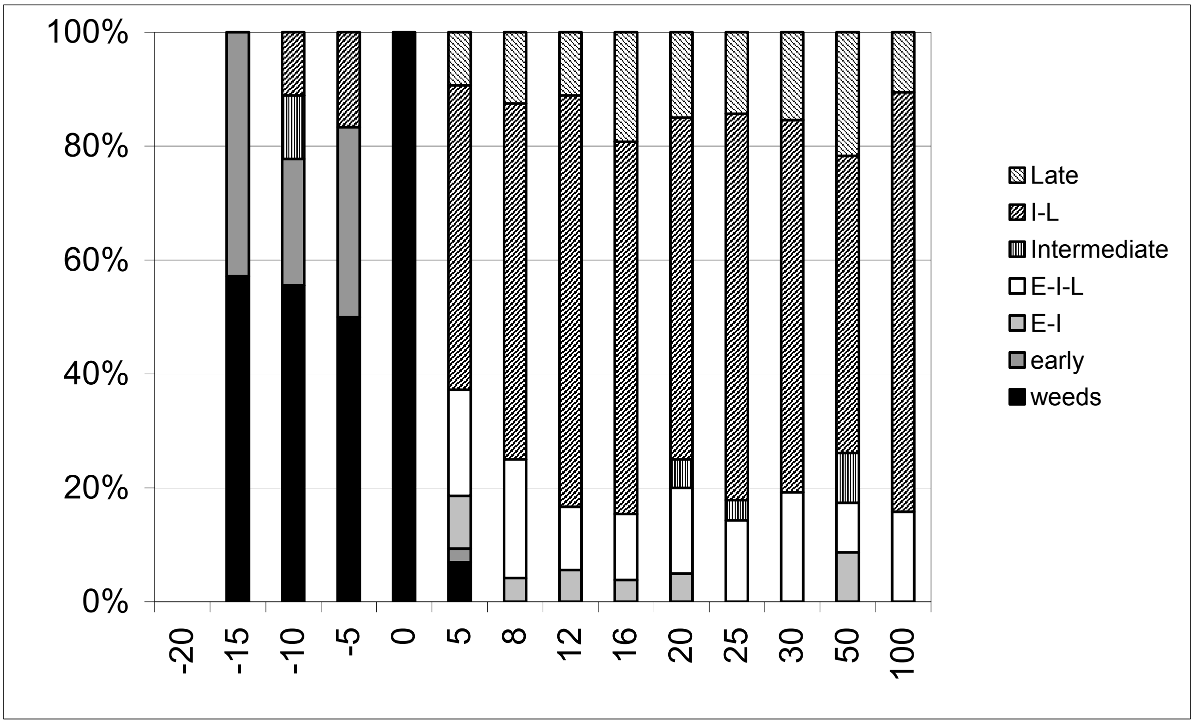
Figure 3.3: Mean numbers of species of weeds, vines, early and late successional species in quadrats along control and rehabilitation site transects.

3.4.2 Edge Effects in Floristic Composition

Edge effects in floristic composition were demonstrated both at control and rehabilitation sites (Figure 3.4, 3.5). The percentage of early, early to intermediate and early to intermediate to late species was elevated in the vicinity of the rainforest edge (five metre quadrat) in terms of number of species and abundance. Once inside the rainforest, the vast majority of species and individuals come from the intermediate to late or late categories (Figures 3.4, 3.5). Figure 3.5 demonstrates the percentage abundance of species in each of the successional stage classifications by weighting dominant species as twenty, common as ten, occasional as three and rare as one. The dominance of weeds in the clearing is obvious, as is their lack of penetration into the rainforest.

Species were not weighted with respect to their dominance of the canopy, but only with respect to their numerical dominance, percentage cover estimates were not obtained. The success of rehabilitation sites in providing canopy cover of rainforest species is not demonstrated in Figure 3.5, as only one of each planted tree species could occur within the five metre circular quadrat and therefore they were considered rare. However, the reduction in weed abundance is impressive and can be seen in the reduction of dominance of *Panicum maximum* (Guinea grass), *Melinis minutiflora* (molasses grass) and *Ageratum conyzoides* (blue top) to merely common or occasional in favour of more shade-tolerant species including native species.

a) Control Site 1



b) Rehabilitation Site 2

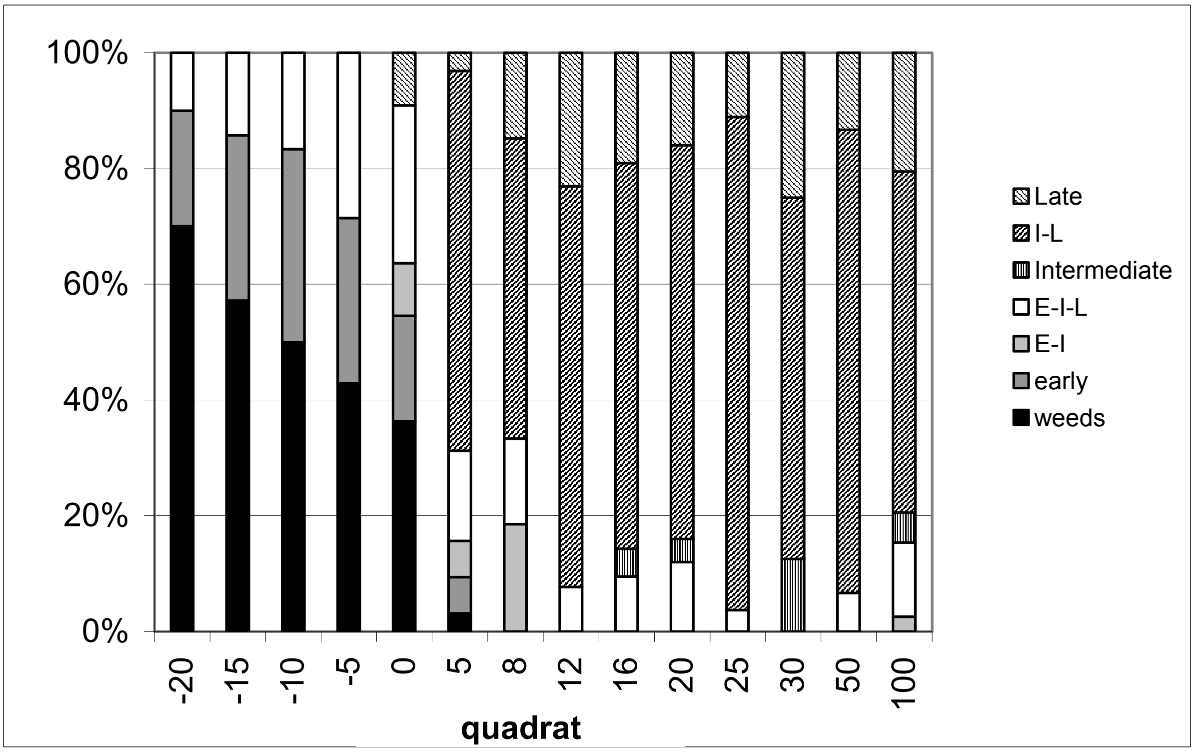
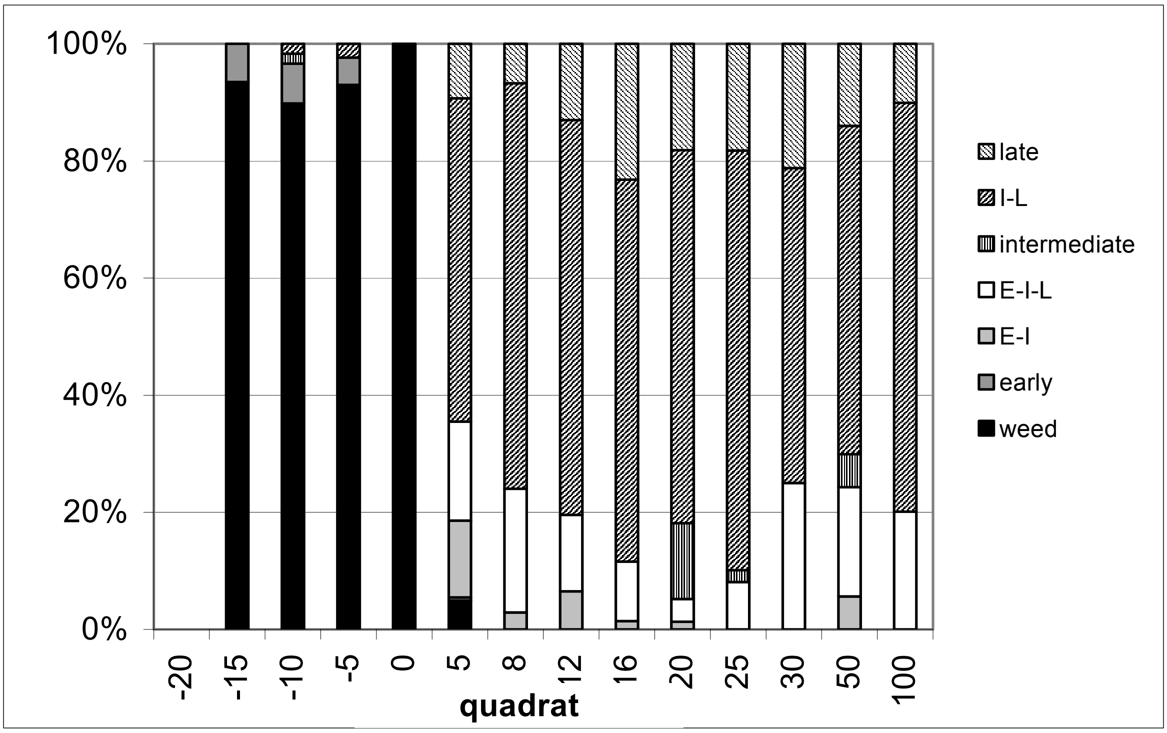


Figure 3.4: Percentage of species number in each successional stage found in each quadrat of 5m radius. Species are classified as occurring as weeds or in early (E), intermediate (I) and late (L) successional stages (Tucker and Murphy, 1995; Tucker 2002).

a) Control Site 1



b) Rehabilitation Site 2

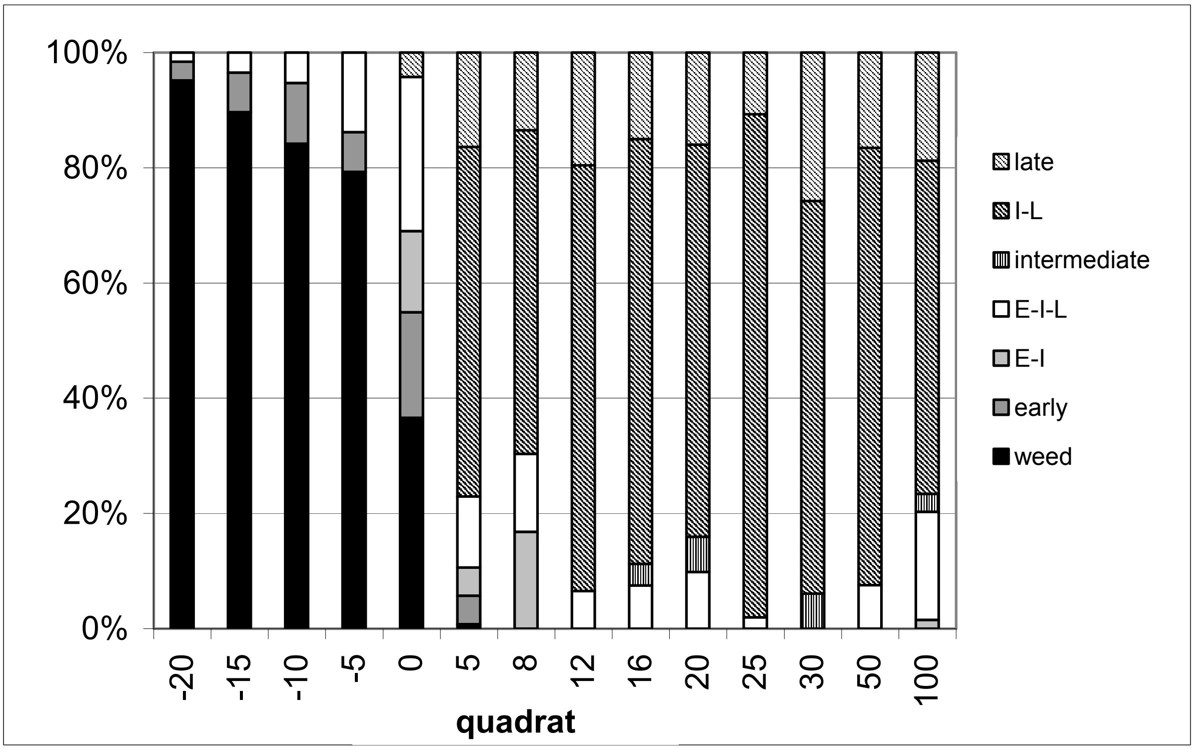


Figure 3.5: Abundance of species found in each successional stage expressed as a percentage of total abundance. Occurrence categories weighted as dominant 20, common 10, occasional 3, rare 1.

3.4.3 Classification and Ordination of Quadrats on Transects

Differences in floristic composition between quadrats on transects were demonstrated by examples of complementary two-dimensional ordination using non-metric multi-dimensional scaling and hierarchical agglomerative classification analysis for Control Site 1 in Figure 3.6 and 3.7 and Rehabilitation Site 2 in Figure 3.8 and 3.9. Results for Control Site 2 and Rehabilitation Site 1 are presented in Appendix 2.3. One metre quadrat data were not found to produce ecologically interpretable ordinations or classifications, probably due to the variability inherent in a quadrat of small size, and thus the five metre quadrat data are presented here.

Hierarchical cluster analyses and ordinations were in close agreement concerning groupings. Each demonstrated four groups of quadrats:

1) A group from the powerline clearing;
2) A group from the edge;
3) A group from the rainforest interior; and
4) One or two groups from the far interior.

Table 3.1: Composition of classification and ordination quadrat groups for the four transects.

	Quadrat Locations Included in Group			
Group	**Clearing**	**Edge**	**Interior**	**Far Interior**
Control 1	-15, -10, -5	0, 5, 8, 12	16, 20, 25, 30	50, 100
Control 2	-20, -15, -10, -5, 0	5, 8	12, 16, 20	50, 100; 25, 30
Rehabilitation 1	-20, -15, -10, -5, 0	5, 8, 12	16, 20, 25, 30	50, 100
Rehabilitation 2	-20, -15, -10, -5	0, 5, 8	12, 16, 20, 25, 30, 50	100

The composition of these groups was similar across the four transects but varied slightly between transects, particularly with respect to the edge and far interior groups (Table 3.1). At two of the sites (Control 1 and Rehabilitation 1), the edge group included the twelve metre quadrat. This suggests that edge changes in floristic composition extend to seven metres in distance from the edge, rather than the three metres found at the other two transects. A second group that may relate to less obvious edge effects in floristic composition include those of the near interior. Again the extent to which these possible edge effects penetrate varies. In one case the far interior group included only the one hundred metre quadrat, whereas in another, the far interior group included quadrats from twenty-five metres inwards.

Key to Figure 3.6 – Figure 3.10

- CON1 = control site 1; N5 = -5 metre quadrat; M0 = 0m quadrat; B – data from quadrats of 5m radius;
- REH2 = rehabilitation site 2; N20 = -20m quadrat; M12 = 12m quadrat; M5 = 5m quadrat i.e. edge.

Hierarchical Agglomerative Clustering, Ward's Method:
Rescaled Distance Cluster Combine

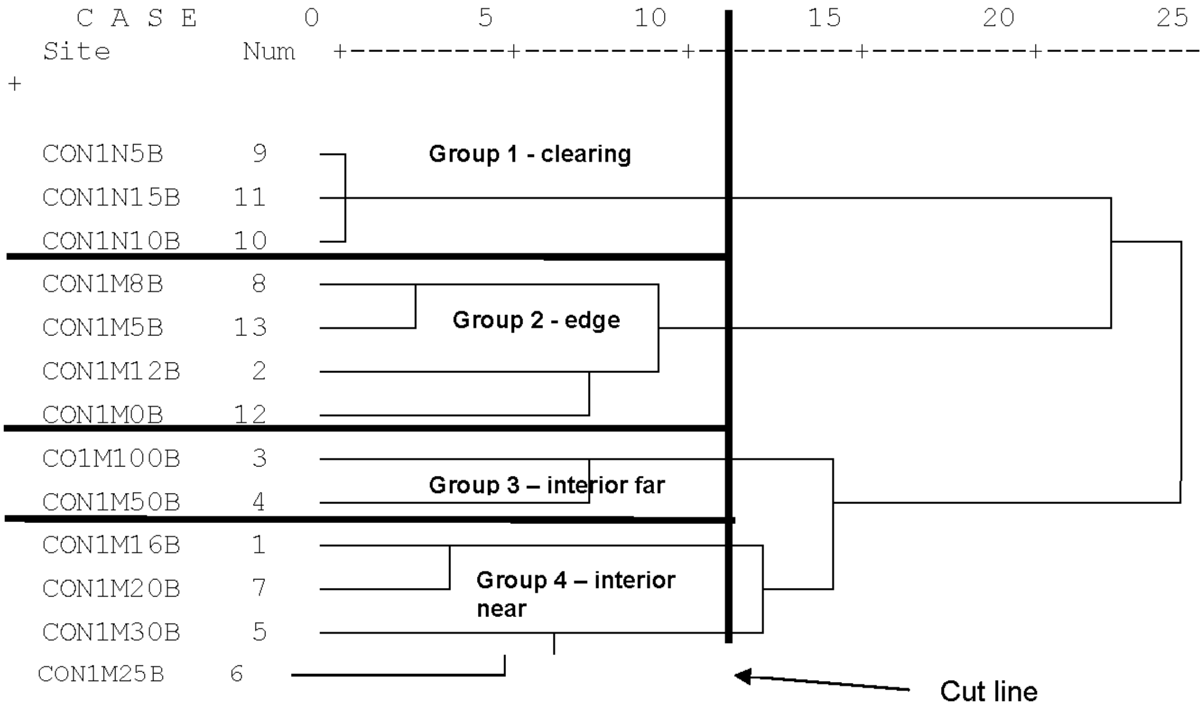


Figure 3.6: Classification of presence / absence data for quadrats from Control Site 1.

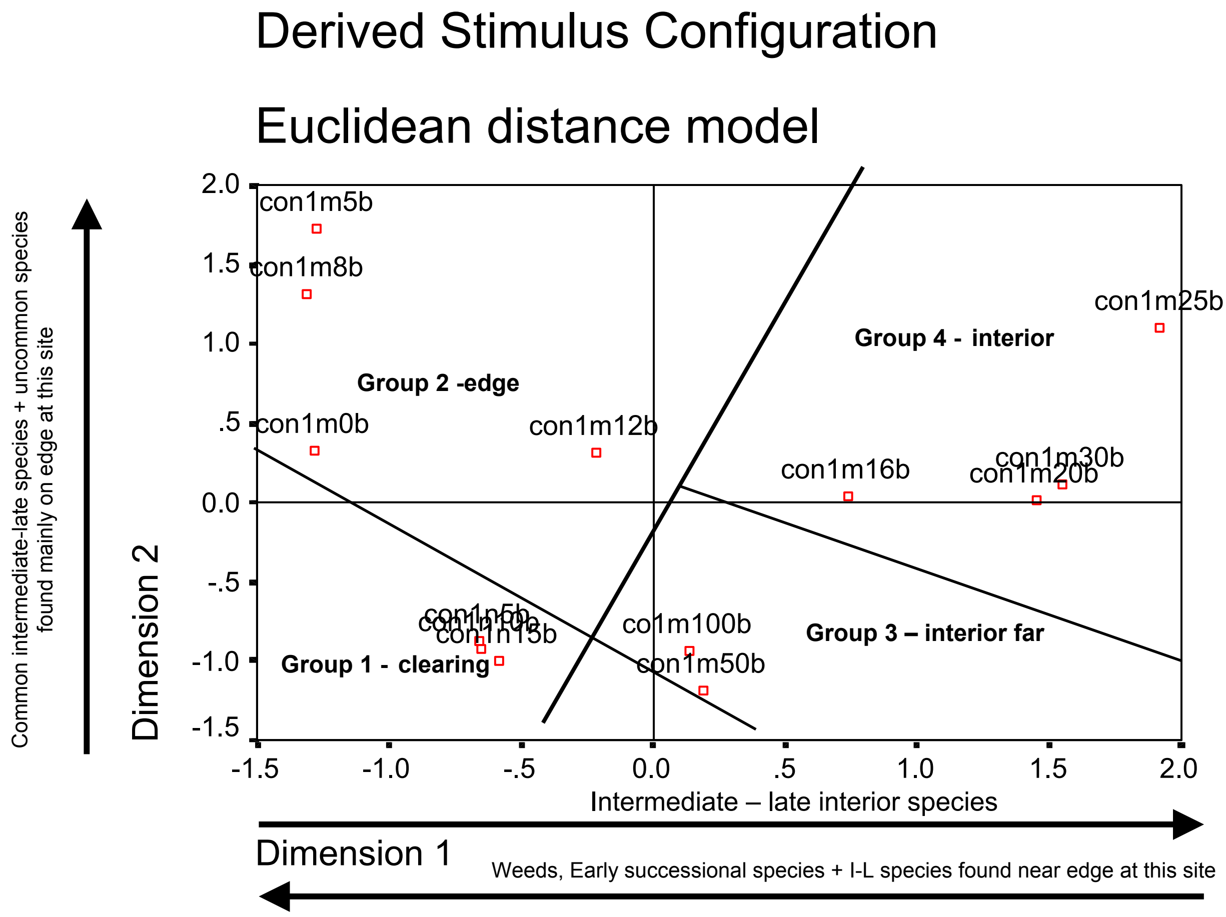


Figure 3.7: Non-metric multidimensional scaling of presence / absence data from Control Site 1.

Hierarchical Agglomerative Clustering, Ward's Method
Rescaled Distance Cluster Combine

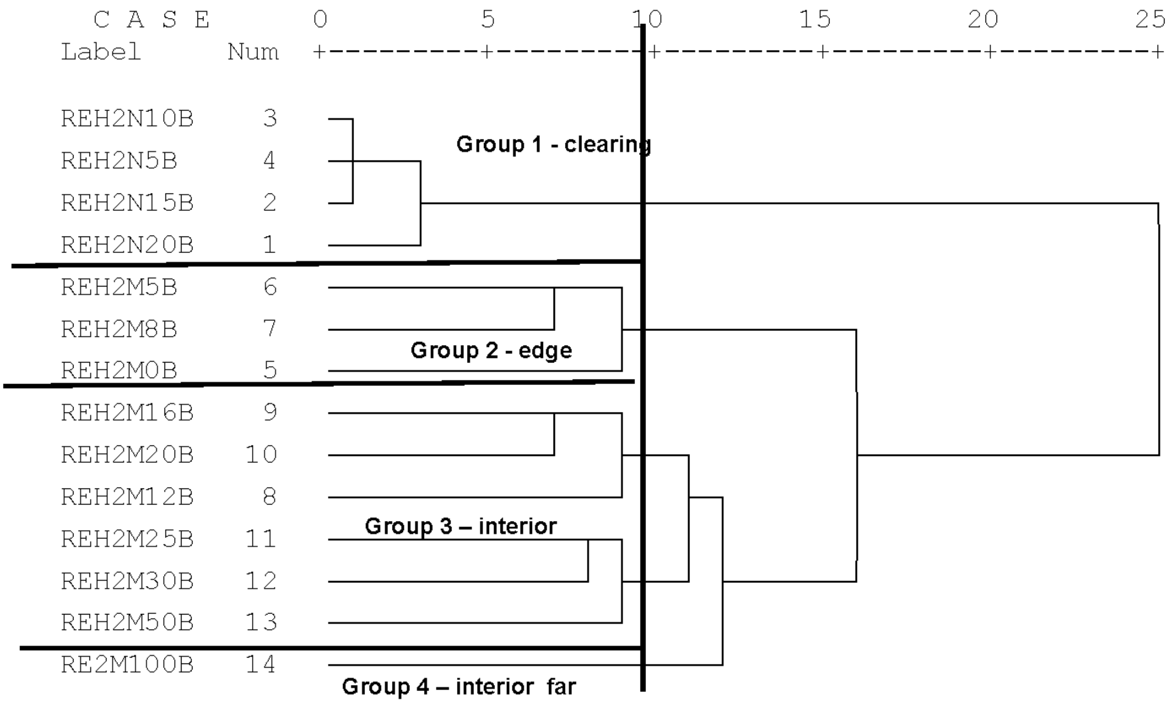


Figure 3.8: Classification of presence / absence data for quadrats from Rehabilitation Site 2.

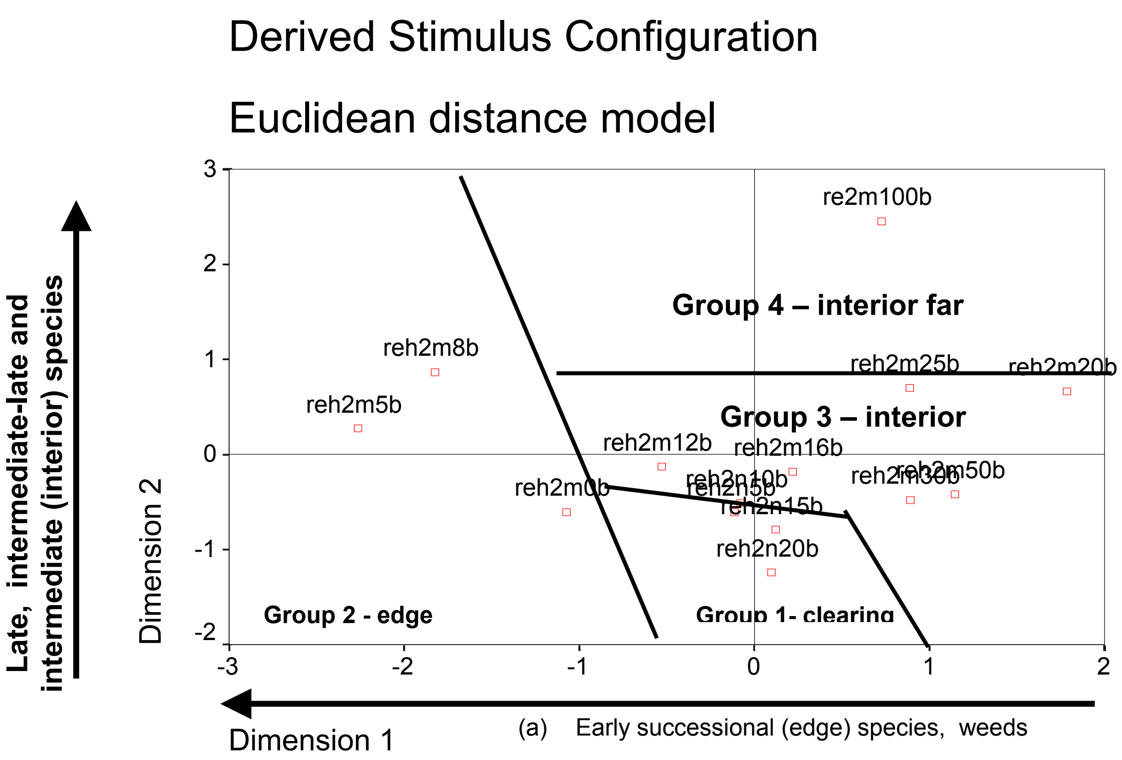


Figure 3.9: Non-metric multidimensional scaling of presence / absence data from Rehabilitation Site 2.

The age of this powerline corridor, constructed in the 1950's, suggests that edge effects from linear clearings may cause long-term changes in floristic composition. It appears that rainforest at the edge of the corridor has gradually expanded into the clearing over the past ten years in some places (personal observation), where such expansion was not completely prevented by shading or competition from weeds. Thus we would expect the current edge to demonstrate an altered floristic composition and to include many more early successional stage rainforest species, as these are the species likely to survive occasionally in competition with the dominant weeds. However, the floristic composition appears to be altered to greater distances when a quadrat of five metre radius at ninety-five metres into the forest is used as the point of comparison. At one site, this alteration in floristic composition appeared only to occur within twenty metres of the edge, whilst in others it may reach forty-five metres or more. However, collection of data from a greater number of transects will produce a much more reliable estimate of this distance.

When all five metre radius quadrats were classified using hierarchical agglomerative clustering, the obvious differences between quadrats within the clearing and those within the rainforest was demonstrated by the first major division of the dendrogram (shown by dashed line in Figure 3.10). Within the clearing, the two treatments (rehabilitation Group 2 and control Group 1, Figure 3.10) were separated on the basis of the presence of the three species of planted early successional tree species and the reduction in grassy weed species. Rainforest interior sites tended to cluster together on the basis of site, rather than on distance from edge. However the rehabilitation site edges were relatively similar (Groups 8 and 9), as were the control site far interior quadrats (Group 4) and rehabilitation site far interior quadrats (Group 7, Figure 3.10). Thus, inter-site variability in this diverse Complex Mesophyll Vine Forest at present partially obscures edge effects in floristic composition when examined on a larger scale, although edge and far interior quadrats do cluster together in some cases. Further sites will serve to clarify these less obvious divisions.

3.4.4 Soil Seed Bank

Little data was obtained from this section of the study, though species germinating in soil samples from the clearing appeared to be only weeds, mainly herbaceous weeds rather than grasses. Soil samples from the rainforest interior have a variety of species germinating, again many appear to be weeds together with some early successional species. Few weeds germinated beyond a distance of about twenty-five metres from the rainforest edge. However, the majority of rainforest species were difficult to identify and suffered damage in the greenhouse before the experiment was complete.

3.5 CONCLUSION

Weeds dominated the clearing at the sites where rehabilitation has not been undertaken. At the rehabilitation sites weeds were still common under the low canopy but the type of weed has changed to include more herbaceous species and fewer grass species. The abundance of weeds has also been dramatically reduced, particularly the grasses which dominate in the clearing elsewhere; they are only common or occasional under the rehabilitation canopy. Although the age of the rehabilitation plantings is still relatively young, rehabilitation is having a positive impact on the weeds of the clearing. Reduction in the abundance of fire-promoting grasses, such as Molasses grass and Guinea grass, must be considered as demonstrating early success of the rehabilitation plantings

Hierarchical Agglomerative Clustering, Ward's method:
Rescaled Distance Cluster Combine

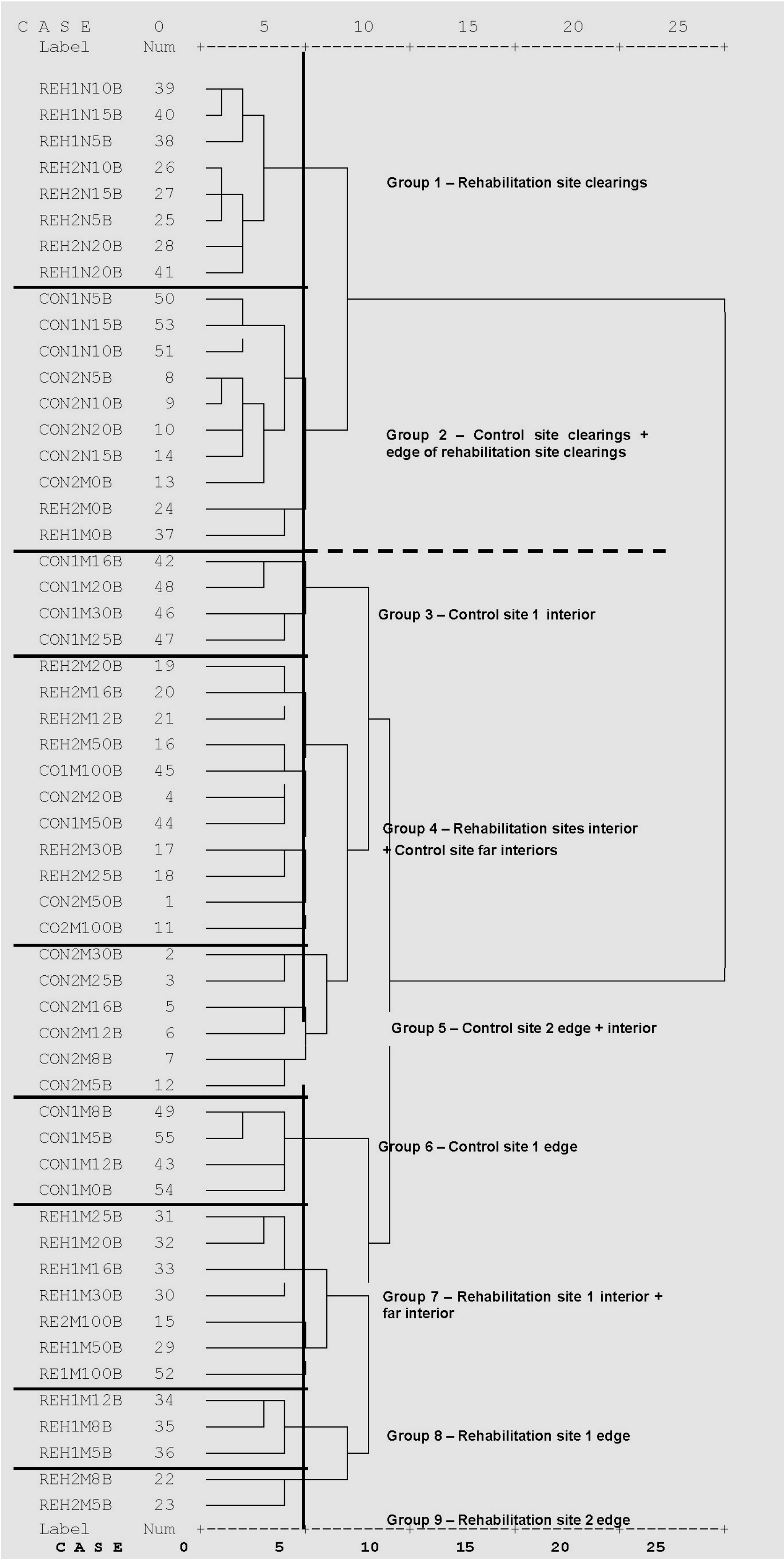


Figure 3.10: Classification of presence / absence data for quadrats from all four transects.

Edge effects in floristic composition have been demonstrated at the four sites along the Palmerston powerline corridor sampled to date. Floristics have been altered in favour of early successional (pioneer or edge) species in a band adjacent to the clearing that varies between three metres and seven metres in width. At the edge, the rainforest may be expanding into the clearing in some areas; however, a second group of floristic changes have been detected using classification and ordination techniques. These floristic alterations penetrate to distances varying between twenty and forty-five metres, demonstrating much longer-term and more insidious changes than those on the edge. These changes appear to show that the presence of a weedy linear clearing passing through rainforest can result in alterations to floristic composition adjacent to the edge for considerable distances. Such alteration in habitat may have flow-on effects for other floral and faunal species in terms of indirect biotic changes such as alterations in species interactions (pollination, predation, competition, herbivory, seed dispersal etc).

3.6 RECOMMENDATIONS

- Completion of the study to include several more transects with differing edge aspects on the control and rehabilitation sites at the Palmerston powerline clearing.
- Completion of the study to include a similar number of transects from the Palmerston highway near to the powerline clearing sites to provide a direct comparison.
- Completion of the study to include analysis of soil seed bank results..

3.7 MANAGEMENT IMPLICATIONS

- Success of the rehabilitation works has already started to manifest itself after only two and a half years in terms of reduction in fire-promoting grassy weeds.
- If the powerline is to remain *in situ* for several more years (rather than be removed as was mooted when these rehabilitation works were first undertaken), removal of trees should only be contemplated where their growth is a source of imminent danger to the powerline. Lopping should be considered as an alternative to removal as these rehabilitation plantings are already serving a useful ecological function.
- The dominance of weeds within the powerline clearing almost eliminates the possibility of native species recolonisation without assistance in terms of restoration works. Where fires have been less frequent over recent years, woody weeds including *Lantana camara* (lantana) and *Rubus alceifolius* (Giant bramble) are spreading across the clearing. These weeds can also prevent recolonisation by native species. Further restoration works within the powerline clearing are necessary if the recovery of native habitat is the goal.
- Edge effects that penetrate from the rainforest edge to distances of three to seven metres were expected in this study. However, the floristic alterations demonstrated to distances of between twenty to forty-five metres suggest a more insidious, long-term and widespread effect of wide linear clearings on floristic composition. Such changes could have a flow-on effect to other flora and fauna of the rainforest.
- The distance of these changes may mean that a larger area of the Wet Tropics World Heritage Area than was previously thought may be altered due to linear clearings through the rainforest. As this powerline clearing was created in the 1950s, reduction of these changes after removal of linear clearings may be a long-term process.