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VEGETATION CHANGE 1980-1985 WAIKARE CATCHMENT, TE UREWERA NATIONAL PARK

by

Sarah M. Beadel

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VEGETATION CHANGE 1980-1985 WAIKARE CATCHMENT,
TE UREWERA NATIONAL PARK

by

Sarah M. Beadel[1]

Wildland Consultants Ltd, Okere Road, R D 4, Rotorua.

ABSTRACT

In the summer of 1985/86 fifty-seven permanent vegetation plots and six enclosure and control plots were measured in the Waikare catchment, a tributary of the Whakatane River, Te Urewera National Park, five years after their establishment.

The main aim of this study was to assess changes in vegetation structure and species composition.

Field methodology followed that described in Allen and McLennan (1983) for 20 x 20 m vegetation plots.

The plots were analysed in two groups. The fifty-seven permanent plots (Group A) were classified into nine vegetation types using TWINSPAN. The six enclosures and control plots (Group B) were divided into four vegetation types.

Basal area and stem density changes for each vegetation type were summarised by species and size class.

Group A. Changes in basal area in all vegetation types were relatively slight (all less than 10%)and at this stage no major trends can be identified. Results from stem density changes indicate that the proportion of deer-preferred species is decreasing overall relative to deer non-preferred species.

Group B. Basal area increased in all vegetation types in both exclosure and control plots. In all cases except one (possum-preferred species in tawa forest) the increases were greater in the exclosure plots than in control plots. This probably reflects the exclusion of browsing animals.

Seedling density of deer-preferred and deer non-preferred species increased in all vegetation types. For three vegetation types the density of deer-preferred seedlings and saplings increased more in the exclosure plots than they did in the control plots.

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[1] Report prepared for Department of Conservation

1. INTRODUCTION

Following the establishment of the Department of Conservation in April 1987, a commitment was made to complete a number of outstanding projects in the Eastern Region. One of these was the analysis of the data collected from the 71 permanent vegetation plots located in the Waikare Catchment, Te Urewera National Park (established and measured in 1980/81 and remeasured in 1985/86).

The main aim of this study was to assess changes in vegetation structure and species composition based on the two sets of data obtained (1980/81 and 1985/86) and, if possible, relate these changes to browsing animal impact.

The study area is located in the Waikare catchment, a tributary of the Whakatane River, and is composed of deeply dissected forest-clad greywacke ridges. It is approximately 50 km south of Whakatane township (refer to Figure 1) and is within Waimana Ecological District (Appendix 5). McEwen (1987) provides a description of the district.

Geology (Source: Healy *et al.* 1984).

Two main rock formations comprise the exposed geology of the study area:

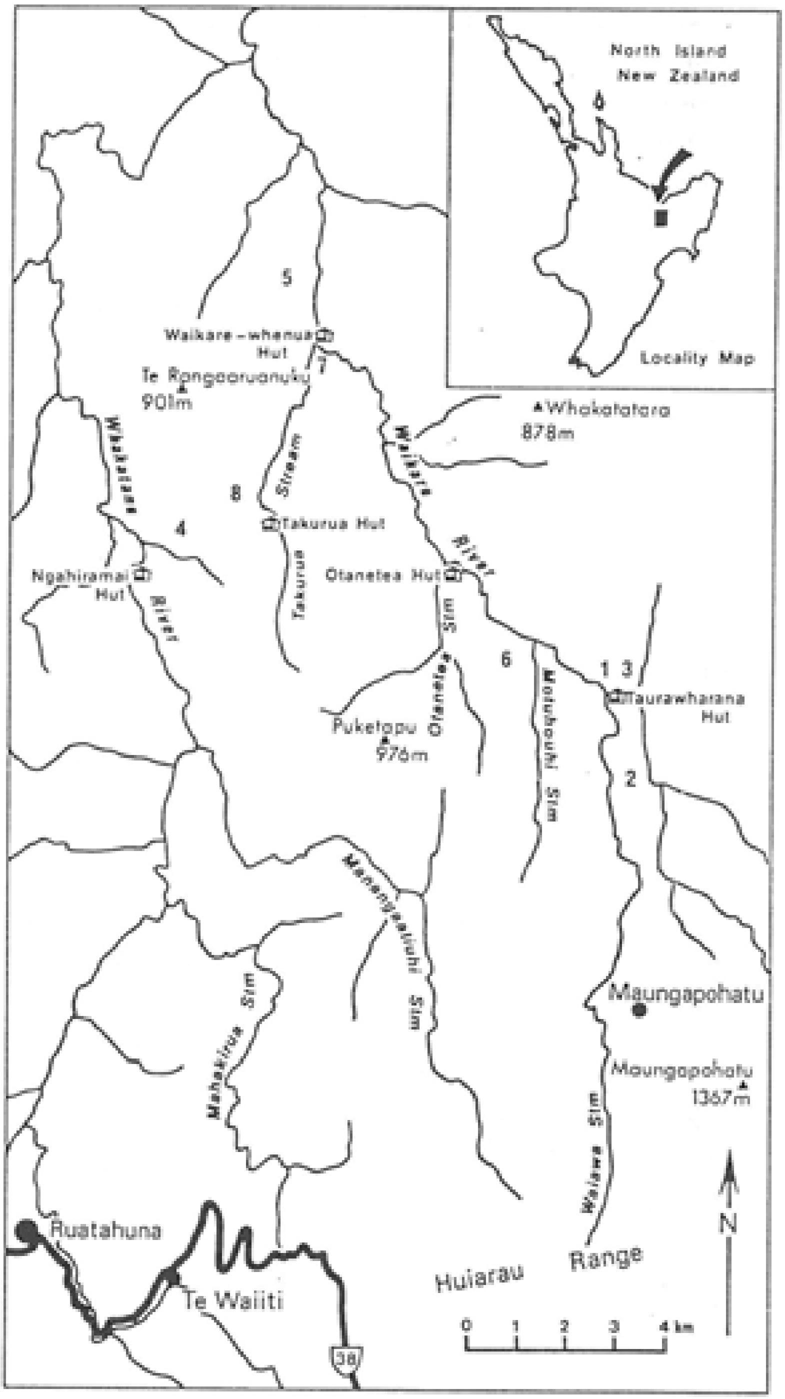
(a) Urewera greywacke (Herangi series)

(b) Basal massive dark green volcanic sandstone calcareous argillite, overlain by dark grey to black contorted argillite with sandstone boudins (Taitai series).

Urewera Greywacke underlies the entire study area, but is not exposed over the whole area. It is of Jurassic age and comprises banded argillite, alternating siltstones and sandstones, conglomerates, and in places fine-grained basic volcanic rocks. The second type (b) occurs on the west bank and slightly to the east of the Waikare River and is of Lower Cretaceous age.

Figure 1

LOCATION MAP: WAIKARE CATCHMENT,
TE UREWERA NATIONAL PARK



from Payton *et al.* (1984)

Soils (Source: W.C. Rijkse, unpubl. data)

The soils in the lower portion of the catchment are mainly Urewera Steepland Soils, strongly leached, well-drained soils related to podzolised yellow-brown pumice soils and podzols. There are small areas of Ruakituri Hill soils which are well-drained, strongly leached, strongly podzolised yellow-brown pumice soils.

The soils upstream of Otaneatea hut are more varied. They include the above soils as well as Matawai Hill Soils (a strongly-leached, well-drained podzol), Ruakituri Soils (strongly-leached, strongly podzolised yellow-brown pumice soils) and Rangitaiki Soils (weakly leached, rapidly accumulating recent soils).

Landform

The survey area is deeply dissected by numerous streams which flow into the Waikare River. Gorges are frequent along streams and also occur in the Waikare River.

Vegetation

Nicholls (1969a and b) mapped the vegetation in the Waikare catchment as part of the New Zealand Forest Service Type Map Series. A detailed description of the vegetation and flora of the park is presented in Shaw (in press) which also includes a review of the literature on the vegetation.

The vegetation is diverse, comprising tall forest and secondary 'fire induced' forest at varying stages of succession. Much of the tall forest in the catchment is characterised by the presence of scattered emergent rimu and rata over an often dense tawa canopy with kamahi, miro, hinau and rewarewa (McKelvey, 1973). However, there are also areas of red beech-dominant forest in association with tawa, kamahi, tawari and scattered emergent rimu. Secondary vegetation is mainly fire-induced and covers extensive areas, particularly on ridge crests and spurs. Following severe burning the early colonising species was kanuka, which formed dense thickets. In the past kamahi commonly established in the kanuka stands and along with rewarewa, mahoe and kohuhu eventually replaced it. Following on, tall forest trees established and eventually became dominant. Payton *et al.* (1984) provide detailed discussion and analysis of post-fire succession in the Waikare catchment. Landslide scars are common in parts of the catchment, with associated seral vegetation.

Browsing Animal Distribution

Deer, possums and feral pig are present throughout the study area. Red deer (*Cervus elaphus*) were liberated at a number of points in and near the Urewera forests between 1897 and 1921 (McKelvey 1973). The red deer in the Waikare catchment probably originated from animals liberated at Te Whaiti between 1916 and 1921 (Logan & Harris, 1967) and by 1950 had become well established (Vipond *et al*. 1960).

Rusa deer (*C. timorensis*) are also present and although less common, have become relatively more common and widespread in recent years (W. B. Shaw pers. comm). This colony is derived from animals liberated at Galatea in 1907 (Harris, 1971).

There were several liberations of possums (*Trichosurus vulpecula*) in the Urewera area (Pracy, 1962), however colonisation of the Waikare catchment stemmed from four animals liberated at Te Waiiti (near Ruatahuna) in 1919 (Figure 1). By 1961 there were low numbers in the upper reaches of Stream and there was also some possum sign on the true left side of the lower Waikare river, however, possums were not present on the true right side of the lower Waikare River at this time (L. Pracy, pers. comm. in Payton *et al.* 1984).

Animal Impacts on Vegetation

The effects of ungulates on the forests of the Urewera have been studied using exclosures (Allen *et al*., 1984). This investigation concluded that despite the recent large reduction in ungulate numbers throughout the Urewera forests, introduced browsing animals, particularly deer, were still affecting the structure and composition of most forest types. Overall density and species richness for small diametered trees and for the sapling tier were found to be lower outside exclosures than inside.

2. OBJECTIVES

Group A (63 permanent vegetation plots)

1. To detect any changes in vegetation structure and species composition over the measurement period.

Group B (6 plots and 6 control plots)

2. To detect any changes in the vegetation structure and species composition within the exclosure plots that differ from changes in the control plots.

3. METHODS

Plot Locations

In 1980 an inspection of the Urewera forests was made by the Forest Service (combined FRI and Conservancy staff) to examine the health of these forests (Wardle and Allen, 1980), particularly in relation to:

(a) the impact of introduced browsing mammals; and

(b) to establish the methodology to be used in investigating trends and processes operating in these forests.

Following this inspection the catchment was chosen as a representative catchment to carry out intensive vegetation assessment work to relate to the introduction of a more effective ungulate control method (Anon, 1980). The work plan also stated that "Sixty permanent plots will be subjectively located throughout the catchment to cover the range of vegetation types and stages of stand development. Six exclosures will be established in areas of canopy breakdown to indicate the maximum response attainable".

The plots were located and established by the New Zealand Forest Service (Rotorua Conservancy) and Forest Research Institute, Christchurch.

Plot locations are given in Figure 2 and comprise:

A. Fifty-nine 20 x 20 m permanent vegetation plots; and

B. Six 20 x 20 m permanent vegetation plots sited within animal enclosure fences and six 20 x 20 m vegetation plots sited outside these exclosures as controls.

Two plots from group A (Nos 9 and 44) were destroyed by natural disturbances between 1980 and 1985 and were not remeasured.

Field Methodology

Field methodology followed that described in Allen and McLennan (1983). Summarised briefly, permanent vegetation plots were established and measured in the summer of 1980/81 and remeasured in the summer of 1985/86. Site characteristics were recorded on reconnaissance (recce) sheets in 1980/81 and were checked in 1985/86. The recce sheets were incompletely filled out; no record was made of percentage cover of individual plant species within each height class.

The plots are 20 x 20 m (0.4 ha) and are divided into 16 quadrats. All trees greater than 2 cm dbh (diameter at breast height) are tagged and their dbh recorded. In addition, numbers of saplings (plants greater than 135 cm tall, excluding tree ferns and lianes) of each species were recorded from within each gradient. The understorey was monitored by the establishment of 24 understorey plots, circular in shape with a radius of 49 cm and an area of 0.75 m^2, located half-way along each side of each of the 16 quadrants.

Data Processing and Analysis

Data was processed at the Forest Research Institute using the Forest Survey data processing package, partly on the Burroughs computer system and partly on the computer network.

Data was edited using QUACHECK (for basal areas), SEEDLING CHECK (for seedling plots and saplings) and QUATREND CHECK (to ensure comparability between and 1985186 data) (Hall and Allen 1985).

Figure 2:

PERMANENT VEGETATION PLOT LOCATIONS
WAIKARE CATCHMENT
TE UREWERA NATIONAL PARK

Scale – 1:63360

LEGEND

1-59	Vegetation Plot Locations
1E – 6E	Exclosure and Control Plot Locations

Vegetation Typing

Group A

Each plot is unique. However, particular plots may cover a number of micro-habitats which when grouped together form a recognisable unit or vegetation type. A number of methods are available to group plots and the choice of method was based on its suitability for the available data base and the desire to obtain vegetation types recognisable in the field. In addition, the recce data was incomplete and this restricted the options.

Classification is a means of summarising vegetation data. A species by stand data matrix was formed of species importance value (the sum of tree basal areas). The matrix was converted to condensed format (unpublished data, Graeme Hall, Forest Research Institute, Christchurch), and classified using TWINSPAN (Hill 1979, Hill *et al.* 1975) to obtain nine vegetation types.

Group B

The 6 exclosure and control plots were subjectively grouped into four vegetation types based on the dominant canopy species.

Assessment of Vegetation Change

Changes in vegetation structure were assessed for each vegetation type on the basis of the changes in basal area and density of common species.

Group A

Basal area: Basal area (m^2/ha) of each species was calculated within height classes. This data is presented in two graphs:

(i) A stacked comparison horizontal bar graph showing the basal area of each species in 1980 and in 1985 for two diameter classes1:

(a) Seedlings and Saplings
(b) Poles and Trees

Only species with a basal area greater than 1 m^2/ha in that particular vegetation type were individually graphed. Remaining species were grouped under 'others'.

(ii) Species were grouped into two categories, possum preferred species and possum non-preferred species. The percentage change in basal area of trees and poles in each of these categories is presented in a vertical bar graph.

For graphs (i) and (iii) species have been ordered using percentage change over the survey period, indicated at the right hand side of the graph. For example, species with the greatest positive percentage change are at the top of the graph and species with lowest percentage change, or greatest negative percentage change, are at the bottom of the graph.

Density: Density (no/ha) for each species was calculated within height classes. This data is presented in two graphs:

(iii) A stacked comparison horizontal bar graph showing the density of each species in 1980 and 1985 for two height classes:

(a) Seedlings and Saplings
(b) Poles and Trees

Only species with a density of greater than 500/ha in that particular vegetation type were individually graphed. Remaining species were grouped under 'others'

1. Definitions of diameter classes:

Trees:	> 30 cm dbh
Poles:	10 -30 cm dbh
Saplings:	2.5 – 10 cm dbh
Seedlings:	< 2.5 cm dbh

(iv) Species were grouped into two categories, deer-preferred species and deer non-preferred species. The percentage change in density for three diameter classes:

(a) Seedlings
(b) Saplings
(c) Poles and Trees

within each category is presented in a vertical bar graph.

Group B

Data from Group B was presented in a similar way, but with two differences:

(a) Two sets of data are presented in each graph, one from the exclosures and one from the controls.

(b) Graph (iii). Density - due to the high number of species which had a density of >500/ha, it was decided to present results from woody species only.

NOTE:

Initially it was planned to also compare densities of pig-preferred species (listed in Appendix 4.3) and pig non-preferred. However, two factors prevented this.

(a) Many of the pig-preferred species are 'non-woody' species and densities of these were not reliably collected, in many cases a 'presence' only was recorded.

(b) Only two woody species were identified as pig-preferred, mahoe and tawari. Tawari does not occur in the majority of the plots, and is also a preferred species for deer and possum.

4. RESULTS

4.1 Vegetation Types

Group A (63 Permanent Plots)

The 63 permanent plots in Group A were classified using TWINSPAN (refer to Methods) into nine vegetation types (listed in Table 1). Presented in Appendix 1 is a list of plots within each vegetation type.

Table 1 : Vegetation Types

1. Rimu-(matai)/tawa/mahoe/forest (10 plots)
2. (Rimu)/tawa-kamahi-rewarewa-(hinau)/pigeonwood-mahoe forest (14 plots)
3. (Tawa)/mahoe forest (9 plots)
4. Black beech forest (1 plot)
5. Red beech/kamahi-tawari forest (7 plots)
6. Kamahi-rewarewa-tawa forest (5 plots)
7. Rewarewa/kanuka-kamahi forest (5 plots)
8. Kanuka/mahoe forest (7 plots)
9. Mahoe forest (5 plots)

Vegetation structural classes and type names are first approximation names as described by Atkinson (1985). A glossary of common plant names used in the text is presented in Appendix 6. A list of symbols used in vegetation type names is presented in Appendix 7.

Vegetation Types Described/Mapped in Previous Studies

Nicholls (1969a and b) mapped seven broad vegetation types within the study area. Shaw (in press) uses Nicholls' vegetation type boundaries to describe seven broad vegetation types within the study area, listed below in Table 2.

Table 2 : Vegetation Types

Source: Shaw (in press) with Nicholls (1969a and b) in brackets

1. Rimu-matai-kahikatea/tawa-kamahi forest (M2)
2. (Rimu)-(rata)/tawa-kamahi forest (D1)
3. (Rata)/tawa-kamahi forest (N2)
4. Kanuka forest (only one of the secondary types present, which are all mapped as R2)
5. (Rimu)-red beach/tawa-kamahi-tawari forest (H1)
6. (Rimu)-(miro)-red beech-silver beech/kamahi-tawari forest (12)
7. Red beech-silver beech forest (K6)

The vegetation types identified during this study can be approximately placed within the vegetation types mapped in Nicholls (1969a and b) (described in Shaw in press) to give an indication of the extent of these types in the study catchment. However several of the vegetation types do not cover large contiguous areas and therefore were not mapped separately by either of the above large scale surveys.

Distribution and Features

The plots and therefore vegetation types are all sited in the lowland bioclimatic zone[1]. No plots were sited in submontane and montane bioclimatic zones, although these are represented in the study area.

Rimu (matai)/tawa/mahoe forest and (rimu)/tawa-kamahi-rewarewa-kamahi-(hinau)/pigeonwood-mahoe forest are major components of the broad D1 and N2[2] forest classes identified in Nicholls (1969a and b) which cover large portions of the study area.

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1. Bioclimatic zones for the survey area are defined in Shaw (1986).

2. The majority of N2 forest was formerly D1 that has been modified by crown fires.

Black beech forest and tawa/mahoe forest are minor components of D1 and N2, covering smaller disjunct areas. (Tawa)/mahoe forest is a common feature on old slip sites, whilst Black beech forest occurs locally, generally on exposed, well-drained, often rocky, ridge crests.

Red beech/kamahi-tawari forest is a component of H1 and occurs either on or directly below ridge crests.

Vegetation types 6-8 are all secondary forest types at differing stages of succession. These types occur throughout the lowland bioclimatic zone of the study area, often as small disjunct areas, but occasionally more extensive. These types have not been fully mapped by Nicholls (1966a and b).

Rewarewa/kanuka/kamahi forest commonly occurs on rideg crests, whilst kamahi-rewarewa-tawa forest occurs more commonly on faces and flatter ridge crests. Kanuka/mahoe forest occurs on faces and rolling gullies whilst mahoe forest more commonly occurs in gullies and on old slip faces.

Group B (consists of 6 exclosure plots and 6 control plots)

These plots were subjectively placed in four vegetation types.

1. Tawa forest (1 exclosure and 1 control plot)
2. Kamahi forest (1 exclosure and 1 control plot)
3. Mahoe forest (2 exclosure and 2 control plots)
4. Mahoe-wheki treeland (2 exclosure and 2 control plots)

Kamahi forest is a secondary vegetation type and the plots are sited on a ridge crest. Mahoe forest plots are sited on a face, probably an old landslide scar. The plots in mahoe-wheki are sited on a landslide scar on a river terrace and are at an earlier stage of succession than mahoe forest. The plots in tawa forest are sited on a terrace and is probably an example of modified 'D1' forest (see earlier, Nicholls 1969a and b).

4.2 Data Analysis

Group A
by Vegetation Type

1. Rimu-(matai)/tawa/mahoe forest

No. of Plots	:	10
Altitude Range	:	200-600 m a.s.l
Aspect	:	0-360^{o}
Slope	:	0-50^{o}

Total basal area in this vegetation type has decreased slightly (Appendix 2). A decrease in the basal area of rimu contributed markedly to this overall decrease, whilst basal area of tawa (the species with the highest basal area in the plot) increased slightly (Figures 4.2.1.1 and 4.2.1.3).

There was an increase in the density of seedlings with deer non-preferred seedlings (including rangiora, *Parsonsia* species and hooked sedges) increasing far more than deer-preferred seedlings (including putaputaweta, hangehange and kanono). The density of saplings decreased, with the decrease in deer-preferred saplings (mahoe, hangehange, kanono and putaputaweta) being almost twice as much as the decrease in deer non-preferred species (mainly tawa and rangiora). There was no corresponding increase in density of poles and/or trees associated with the decrease in saplings (Figures 4.2.1.2 and 4.2.1.4.).

Figure 4.2.1.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Rimu-(Matai)-(Miro)/Tawa/Mahoe Forest.

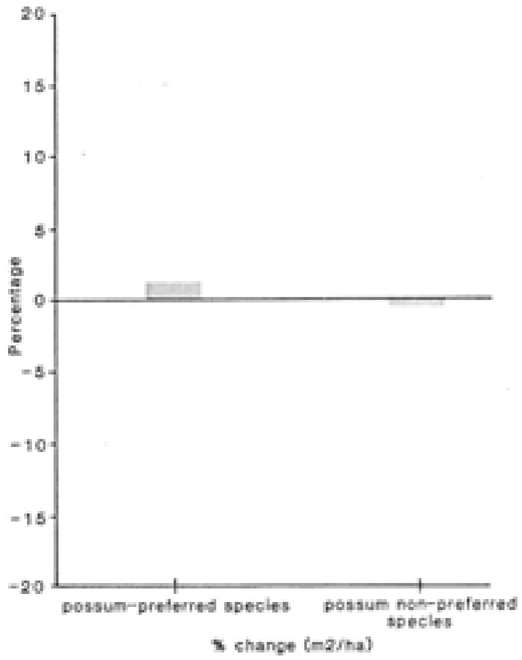


Figure 4.2.1.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Rimu-(Matai)-(Miro)/Tawa/Mahoe Forest.

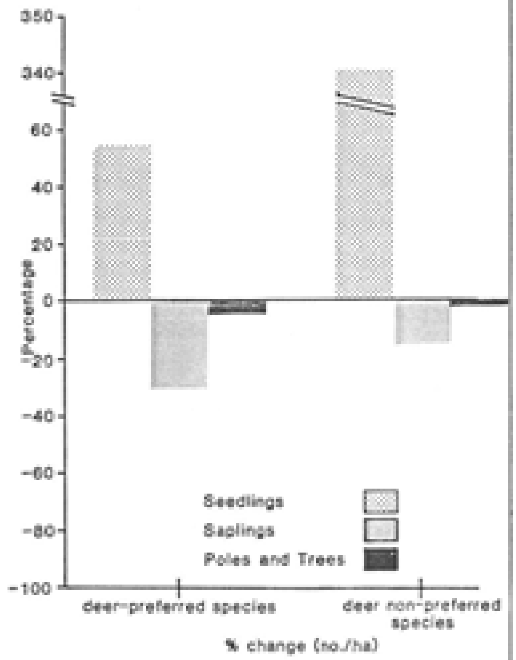


Figure 4.2.1.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Rimu-(Matai)-(Miro)/Tawa/Mahoe Forest.

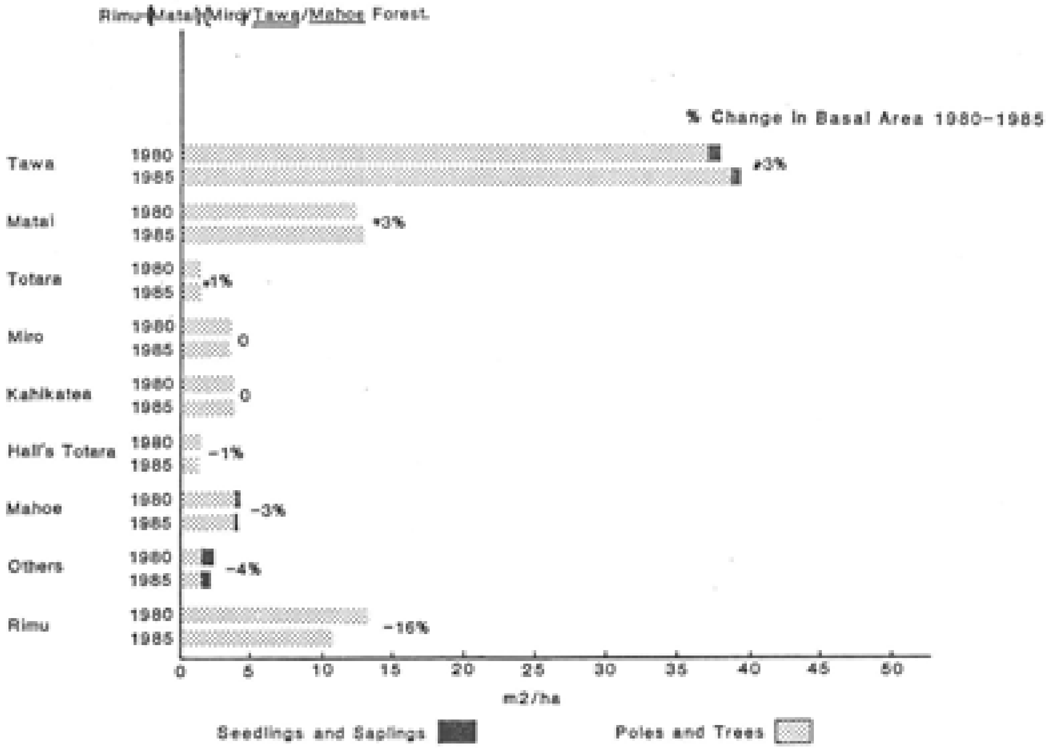
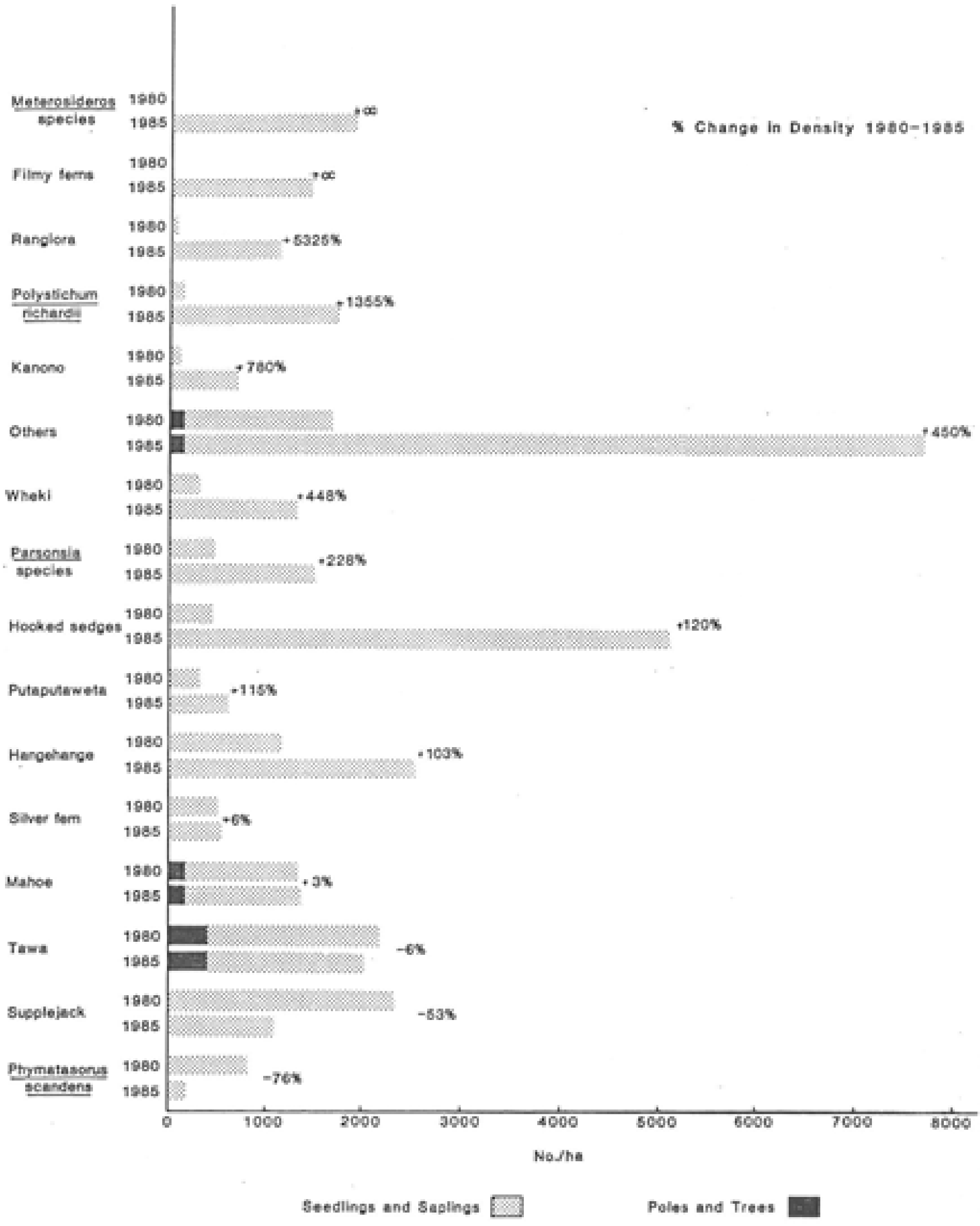


Figure 4.2.1.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Rimu-Matai-Miro/Tawa/Mahoe Forest.



2. (Rimu)-tawa-kamahi-rewarewa-(hinau)/pigeonwood-mahoe forest

No. of Plots	:	14
Altitude	:	200-700m a.s.l
Aspect	:	0-360^{o}
Slope	:	10-50^{o}

A small decrease occurred in total basal area (Appendix 2), far greater in possum-preferred species than non-preferred (Figures 4.1.2.1and 4.1.2.3).

The total number of deer-preferred seedlings decreased (e.g. pigeonwood, supplejack, putaputaweta), whilst the number of deer non-preferred species increased (crownfern, hooked sedges, bush rice grass). However, seedlings of several woody deer-preferred species increased (including hangehange and kanono) (Figures4.1.4.2 and 4.1.4.4).

Figure 4.2.2.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Rimu/Tawa-Rewarewa-Hinau/Kamahi-Mahoe Forest.

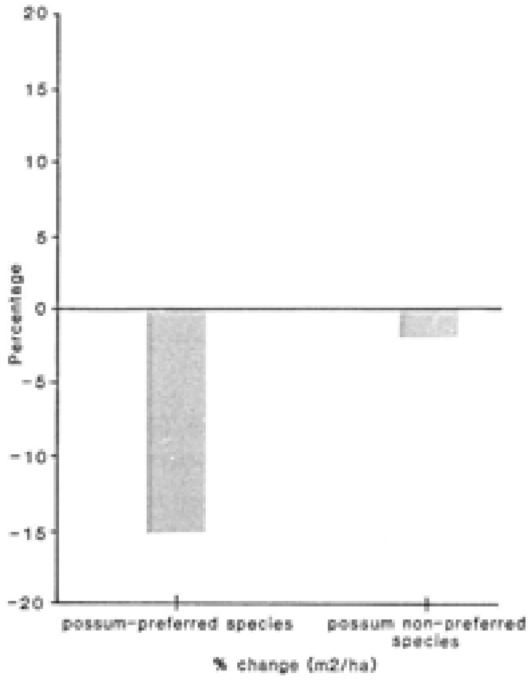


Figure 4.2.2.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985. Rimu/Tawa-Rewarewa-Hinau/Kamahi-Mahoe Forest.

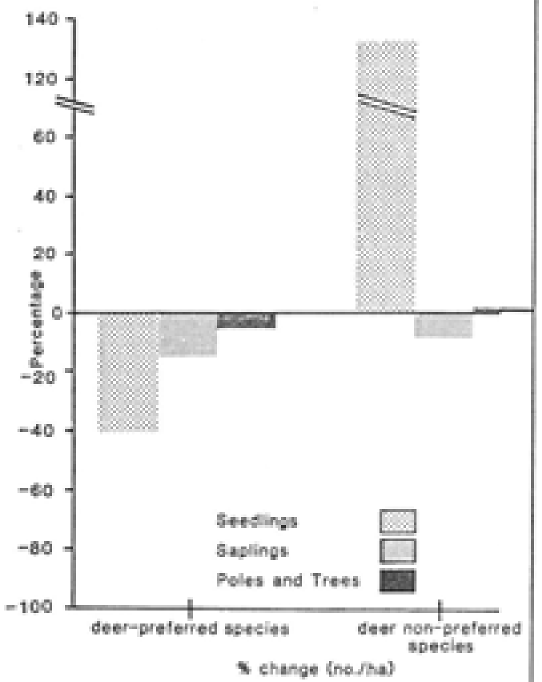


Figure 4.2.2.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985. Rimu/Tawa-Rewarewa-Hinau/Kamahi-Mahoe Forest.

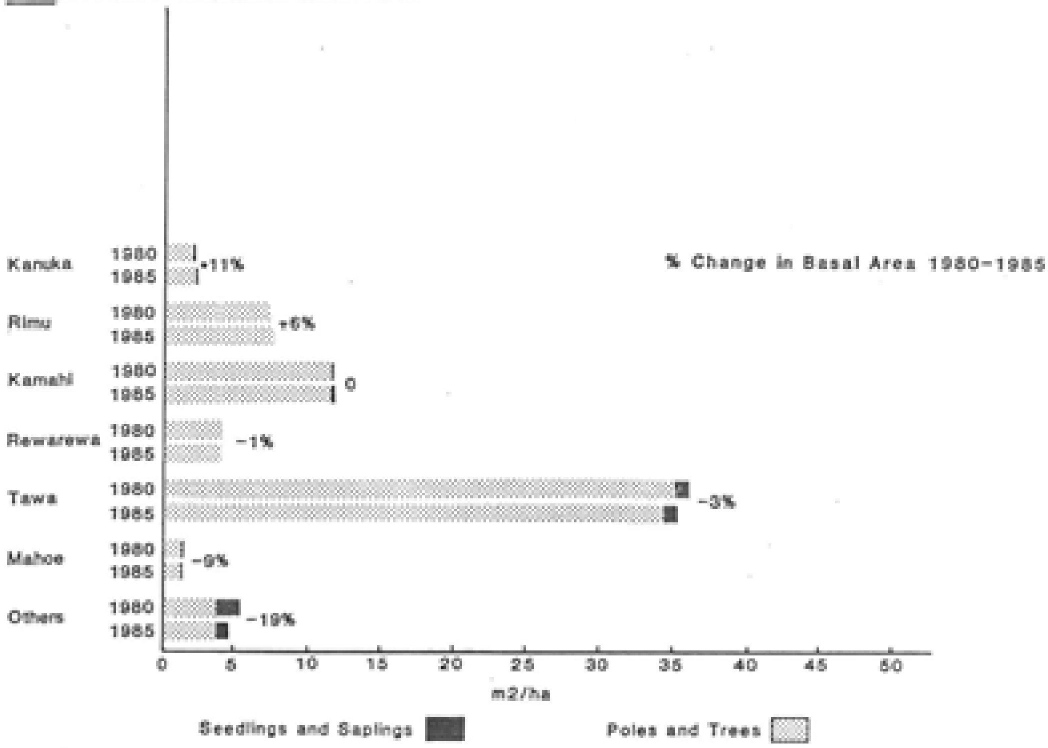
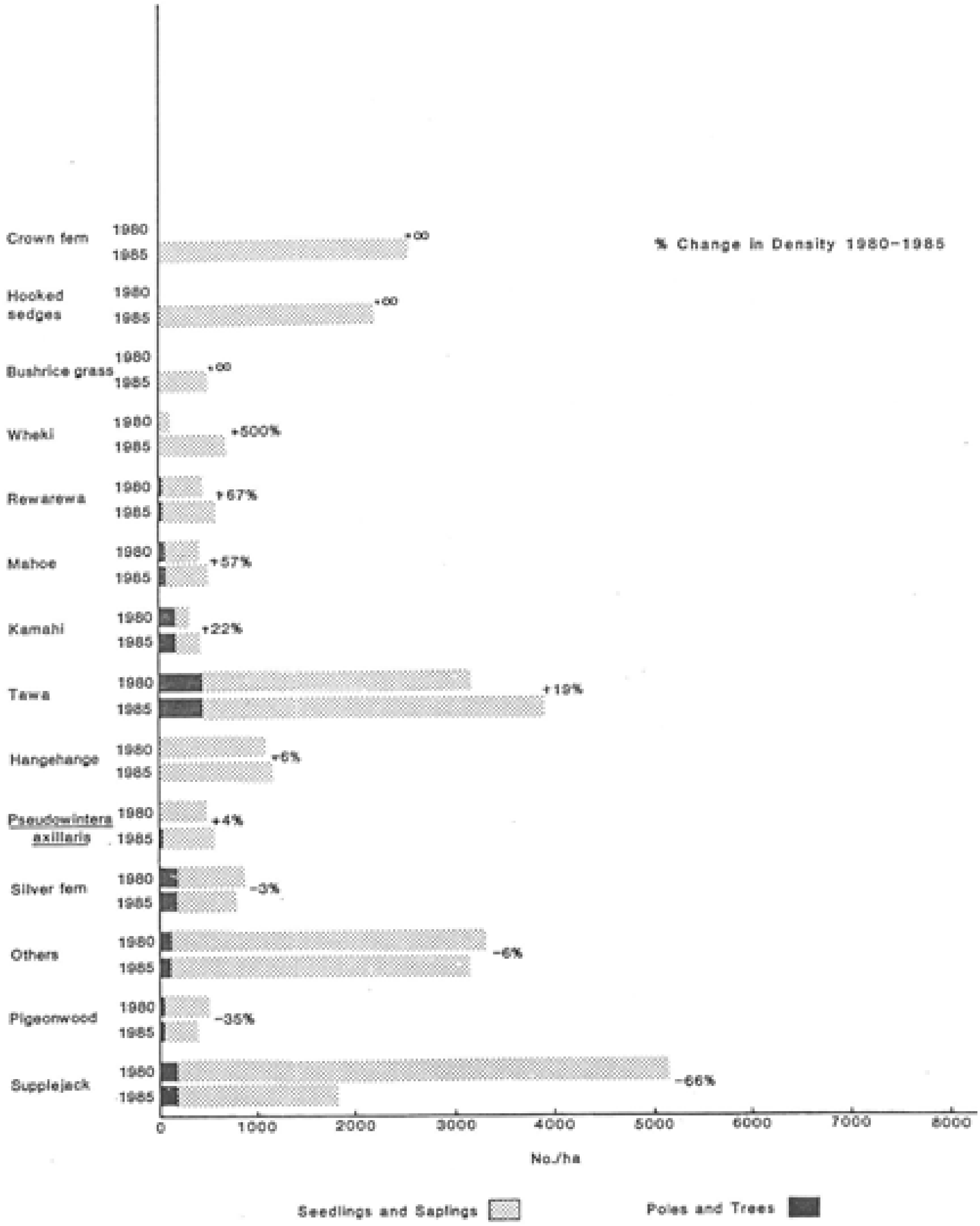


Figure 4.2.2.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Rimu/Tawa-Rewarewa-Hinau/Kamahi-Mahoe Forest.



3. (Tawa)/mahoe forest

No. of Plots	:	8
Altitude	:	200-600m a.s.l
Aspect	:	0-360^o
Slope	:	0-60^o

All major canopy and sub-canopy species increased in basal area (Appendix 2). The total number of seedlings increased, both deer-preferred and non-preferred species. However there was an overall decrease in the number of deer-preferred species (including hangehange, putaputaweta and a key species, mahoe). Although the number of deer non-preferred trees and poles increased the density of deer-preferred trees and poles changed only slightly (Figures 4.1.3.2 and 4.1.3.4).

Figure 4.2.3.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Tawa/Mahoe Forest.

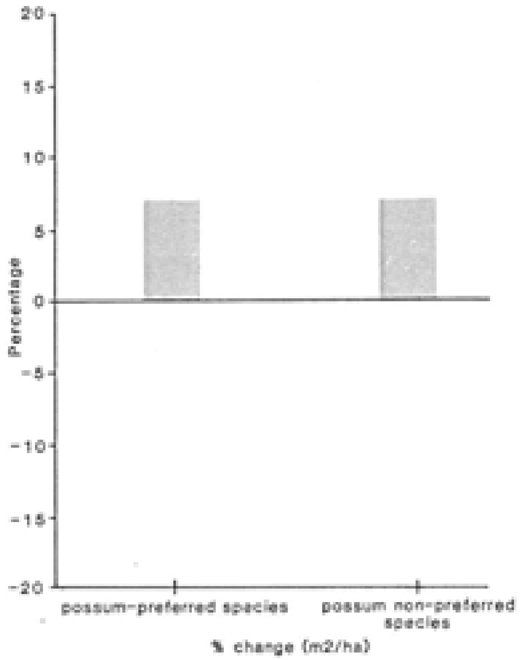


Figure 4.2.3.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Tawa/Mahoe Forest.

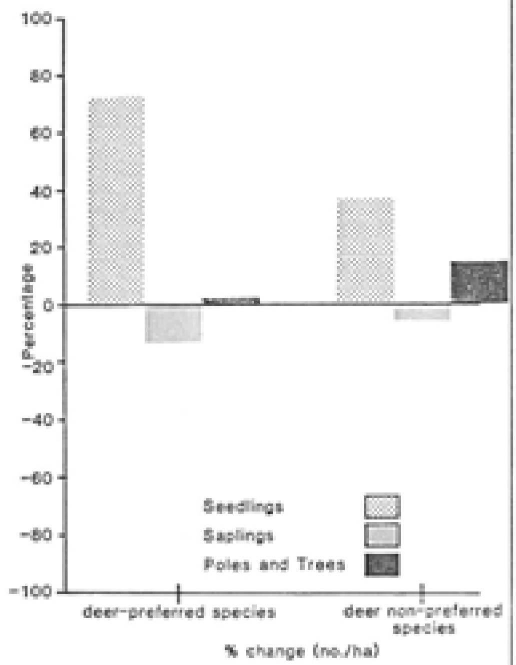


Figure 4.2.3.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Tawa/Mahoe Forest.

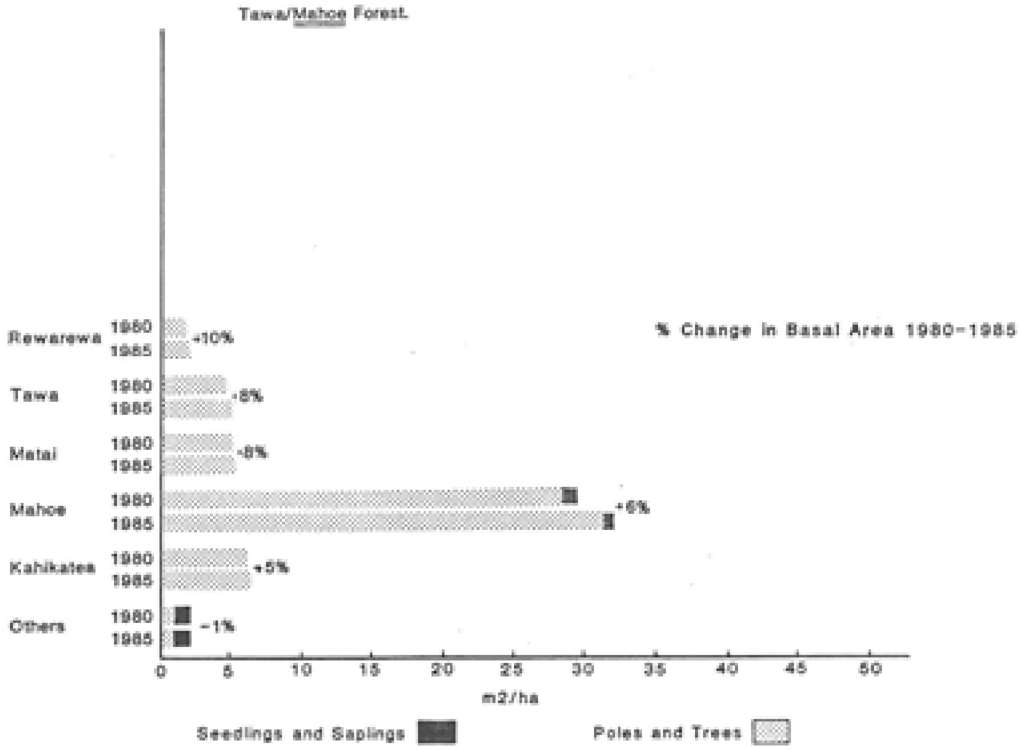
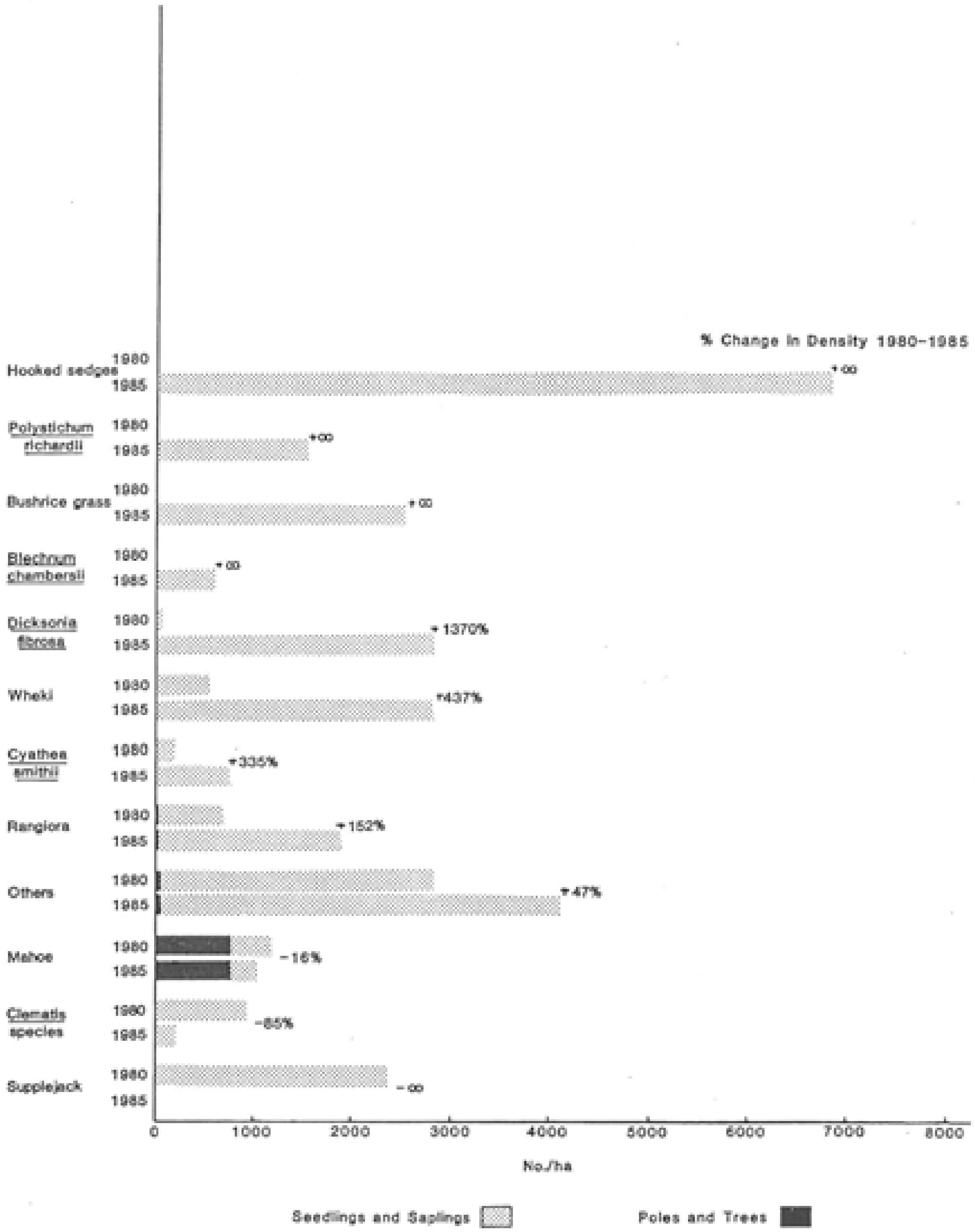


Figure 4.2.3.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Tawa/Mahoe Forest.



4. Black beech forest

No. of Plots	:	1
Altitude	:	apprx. 550m a.s.l
Aspect	:	Northeast (45°)
Slope	:	30°

Overall the basal area has increased slightly (Appendix 2). The density of deer-preferred woody seedlings (*Coprosma robusta*, mahoe, mapou and lancewood) decreased sharply whilst there was a slight decrease in non-deer preferred woody species (tawa, mingimingi and black beech seedlings). However hooked sedges increased in density (Figures 4.1.4.2 and 4.1.3.2).

Figure 4.2.4.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Black Beech Forest.

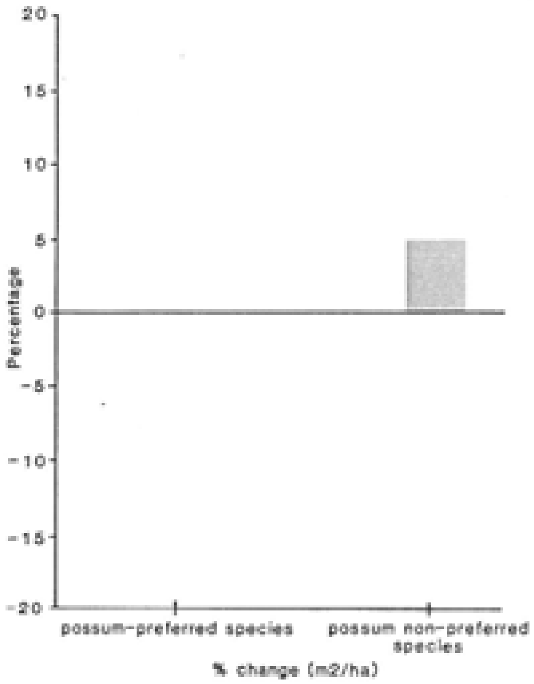


Figure 4.2.4.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Black Beech Forest.

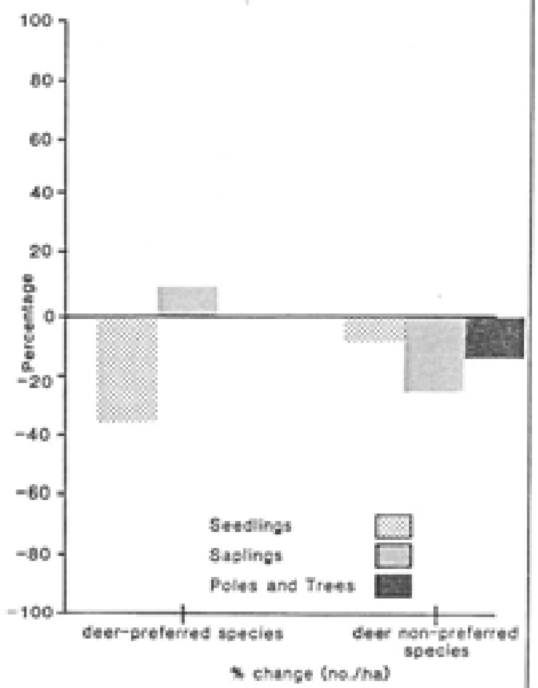


Figure 4.2.4.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Black Beech Forest.

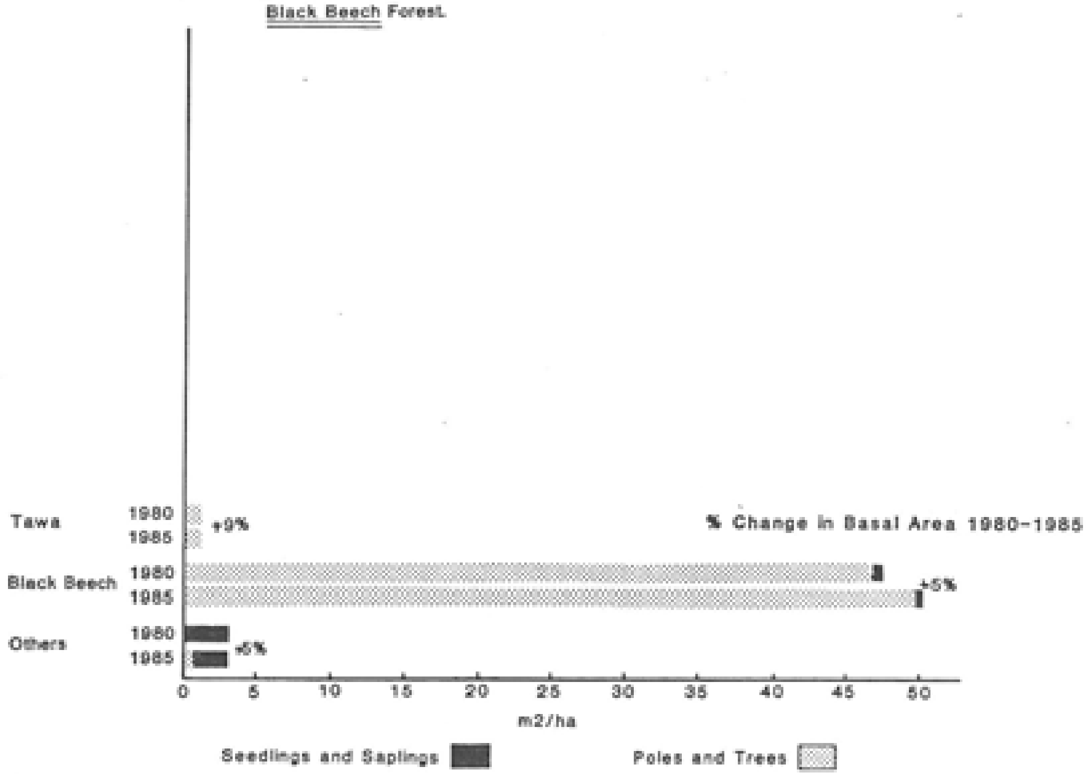
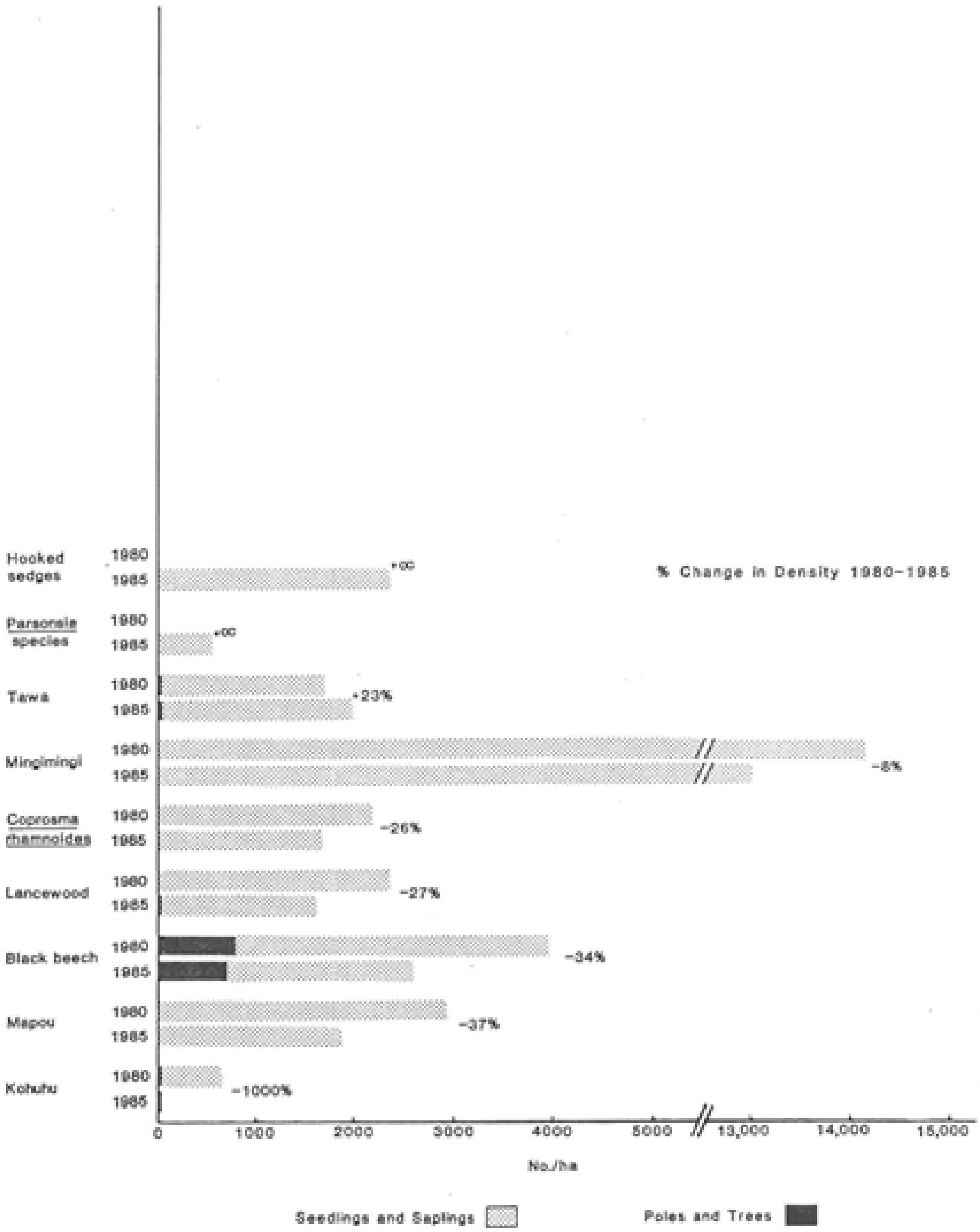


Figure 4.2.4.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Black Beech Forest.



5. Red beech/tawari-kamahi forest

No. of Plots	:	7
Altitude	:	600-900m a.s.l
Aspect	:	45-360°
Slope	:	Slope10-40°

Total basal area (including red beech, hard beech and tawa) increased slightly (Appendix 2 and Figure 4.1.5.3), although there was a slight decrease in the basal area of possum-preferred species (kamahi) (Figure 4.1.5.1).

Total seedlings density of seedlings increased, the density of deer non-preferred species (including tawheowheo, *Pseudowintera axillaris* and mingimingi) increasing more than the density of deer-preferred species. The density of horopito decreased. The density of deer-preferred saplings, trees and poles (kamahi and tawari) decreased. However whilst deer non-preferred saplings decreased (tawa, mingimingi and red beech), there was an increase in the number of poles and trees of these species (Figures 4.1.5.2 and 4.1.5.4).

Figure 4.2.5.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Red Beech/Tawari-Kamahi Forest.

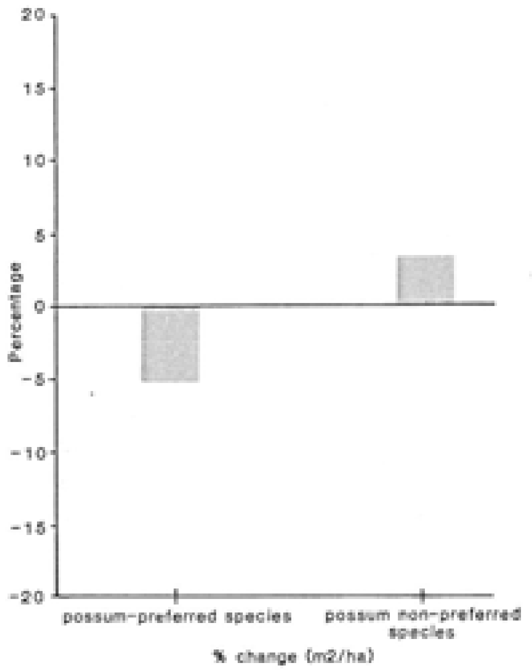


Figure 4.2.5.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Red Beech/Tawari-Kamahi Forest.

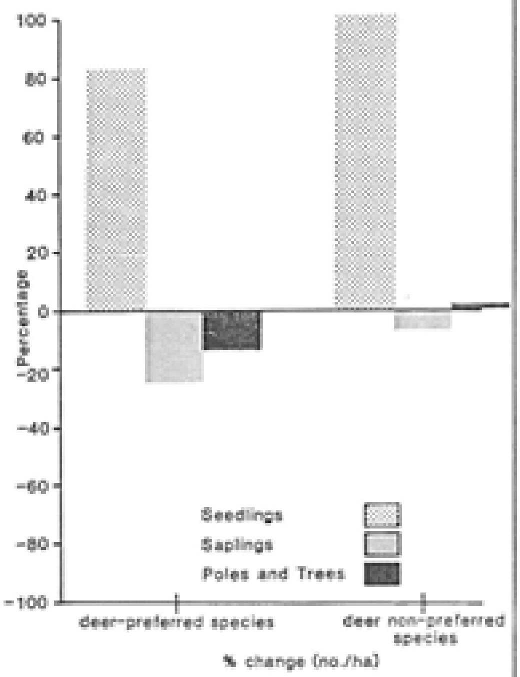


Figure 4.2.5.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Red Beech/Tawari-Kamahi Forest.

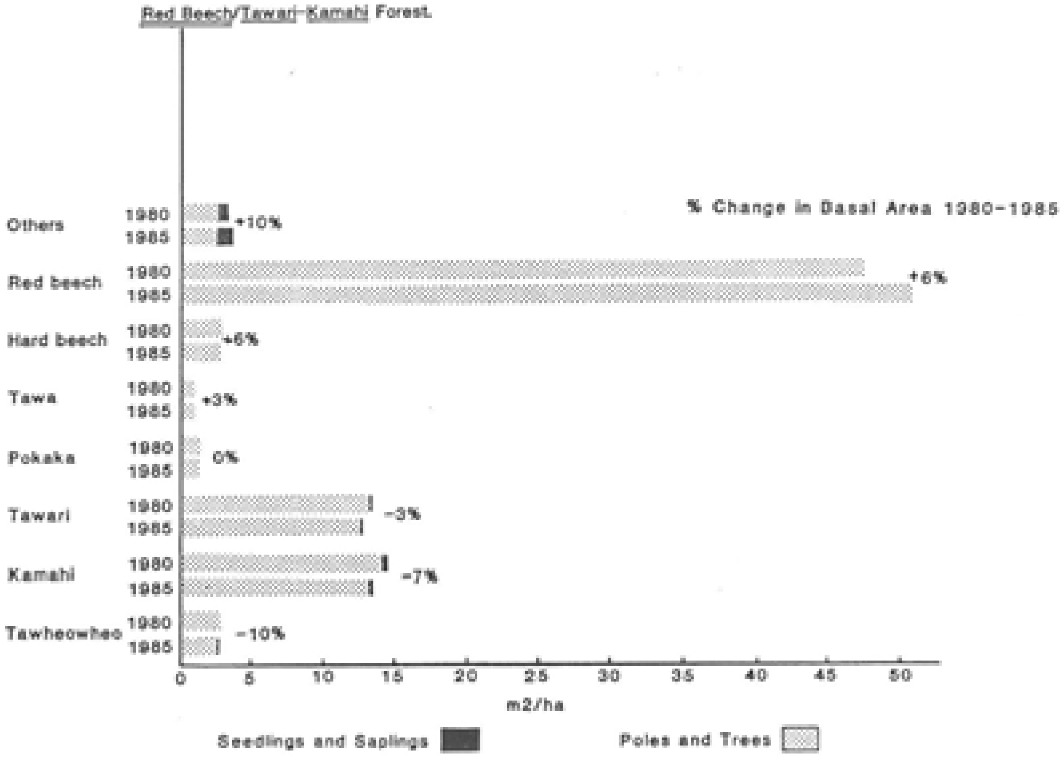
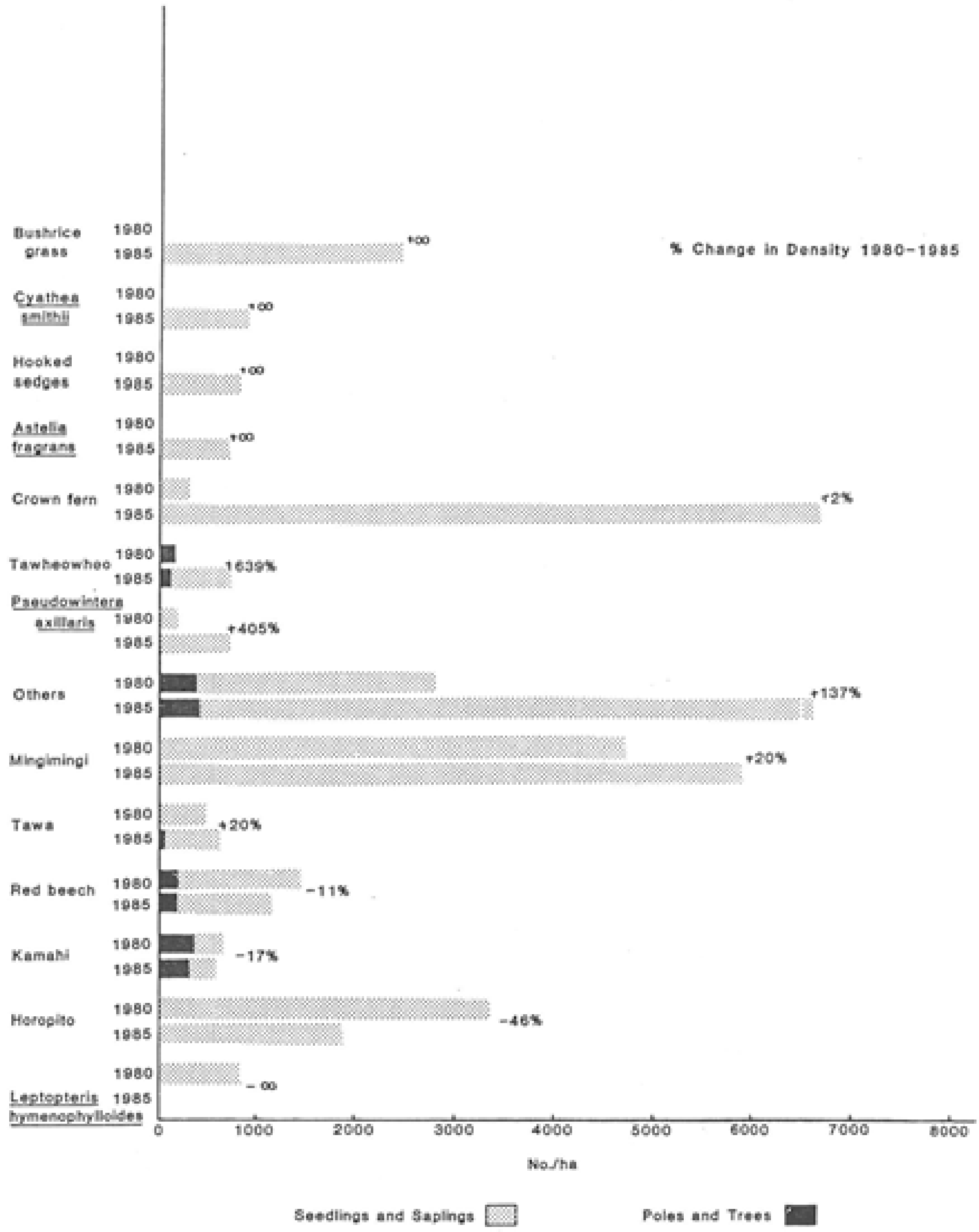


Figure 4.2.6.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Red Beech/Tawari-Kamahi Forest.



6. Kamahi-rewarewa-tawa forest

No. of Plots	:	5
Altitude	:	400-600m a.s.l
Aspect	:	$45\text{-}315^{o}$
Slope	:	$0\text{-}40^{o}$

There was a slight overall increase in basal area in this vegetation type (Appendix 2).

The density of seedlings increased. However, the percentage increase of deer non-preferred species (dominated by hooked sedges and bush ricegrass) was far greater than the increase in deer-preferred species. The increase in deer-preferred species mainly comprised an increase in the incidence of wheki, although kamahi, supplejack, and mapou all recorded slight increases. There was a decrease in deer-preferred saplings (comprising mainly a decrease in kamahi), whilst there was no change in the density of deer non-preferred species (Figures 4.1.6.2 and 4.1.6.4).

Figure 4.2.6.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Kamahi-Rewarewa-Tawa Forest.

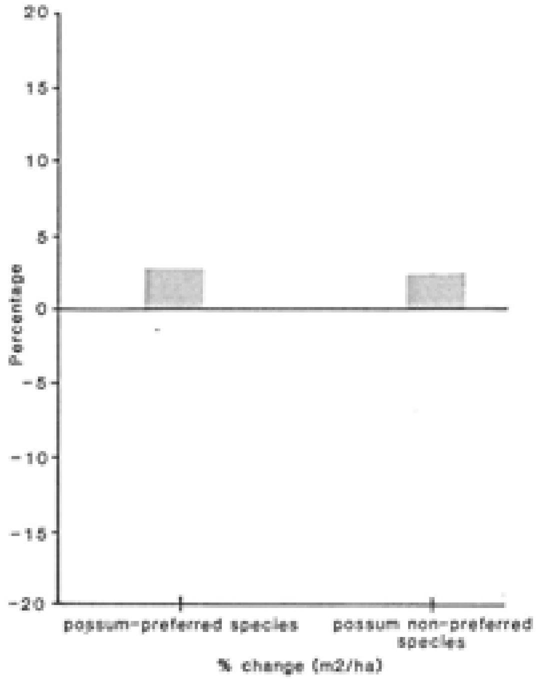


Figure 4.2.6.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Kamahi-Rewarewa-Tawa Forest.

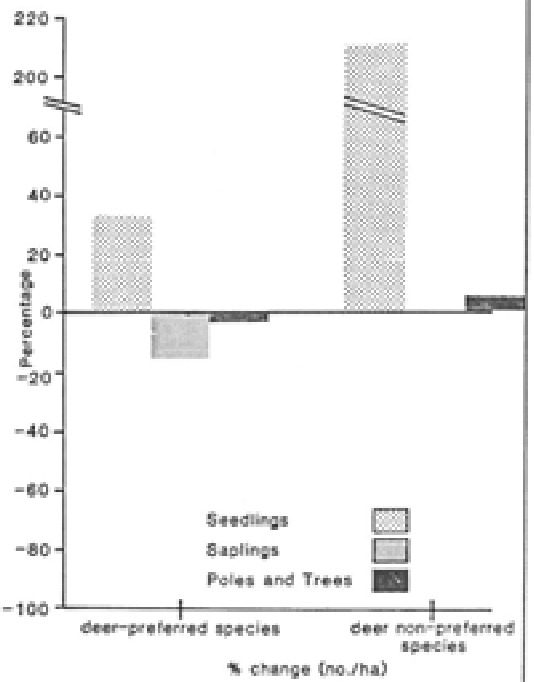


Figure 4.2.6.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Kamahi-Rewarewa-Tawa Forest.

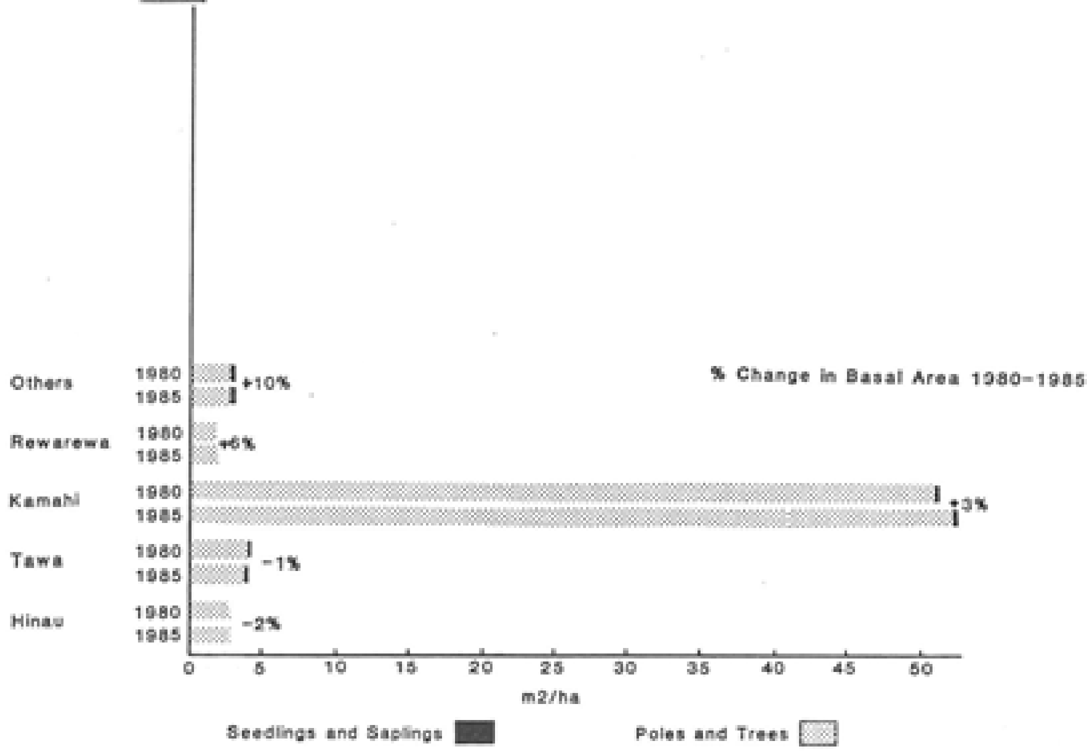
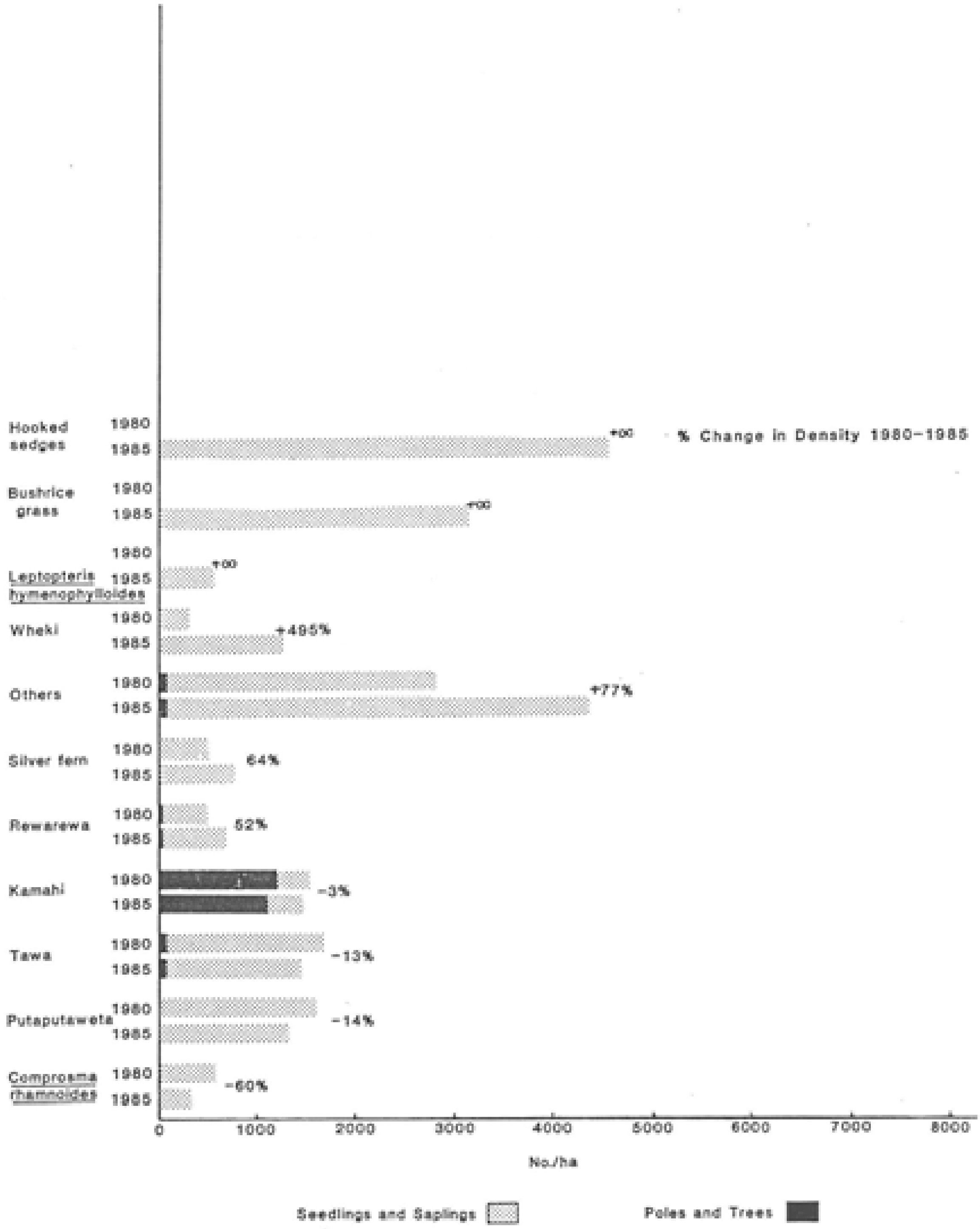


Figure 4.2.6.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Kamahi-Rewarewa-Tawa Forest.



7. Rewarewa/kanuka/kamahi forest

No. of Plots	:	5
Altitude	:	300-500m a.s.l
Aspect	:	0-270^{o}
Slope	:	0-40^{o}

There was a slight increase in total basal area (Appendix 2) and this occurred in three main canopy and sub-canopy species -rewarewa, kanuka and (Figures 4.1.7.1 and 4.1.7.3). There was an increase in the density of seedlings, deer non-preferred species (including rewarewa, rimu, kanuka, silver fern) increasing much more than deer-preferred species (including mapou, kamahi, hangehange and mahoe) (Figures 4.1.6.3 and 4.1.6.4).

Figure 4.2.7.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985. Rewarewa/Kanuka/Kamahi Forest.

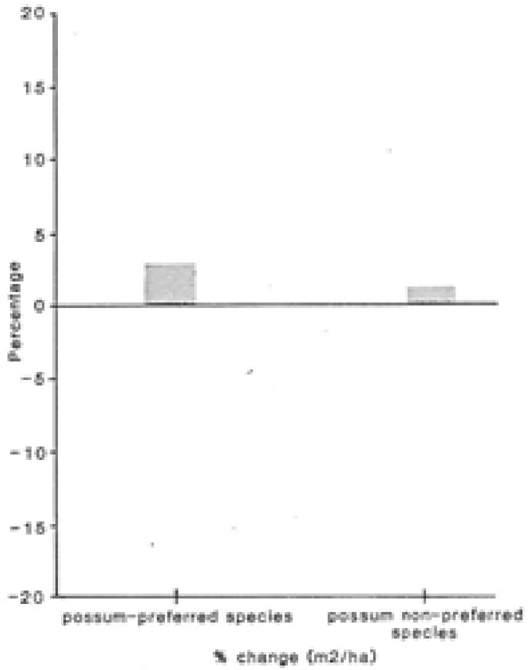


Figure 4.2.7.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985. Rewarewa/Kanuka/Kamahi Forest.

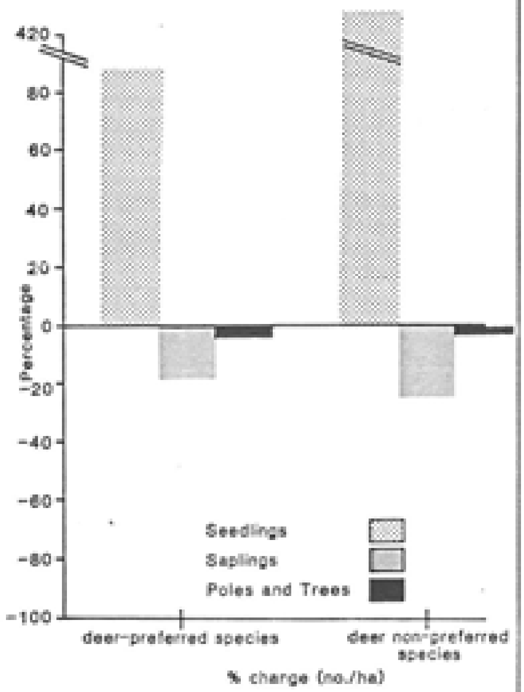


Figure 4.2.7.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985. Rewarewa/Kanuka/Kamahi Forest.

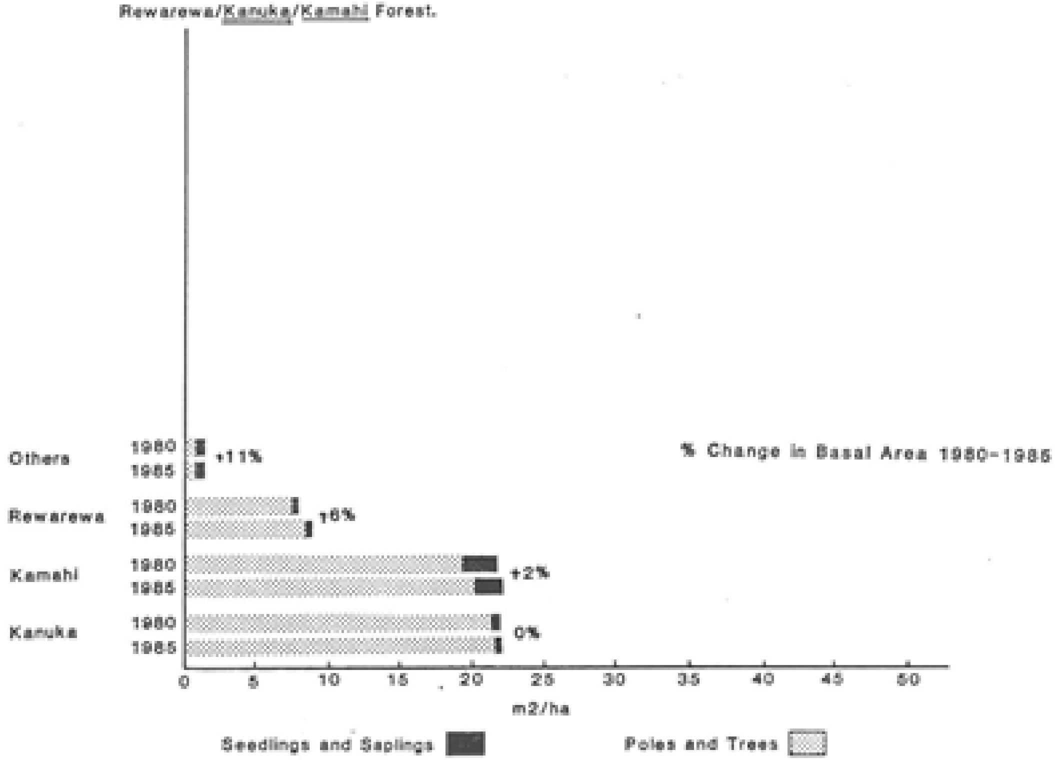
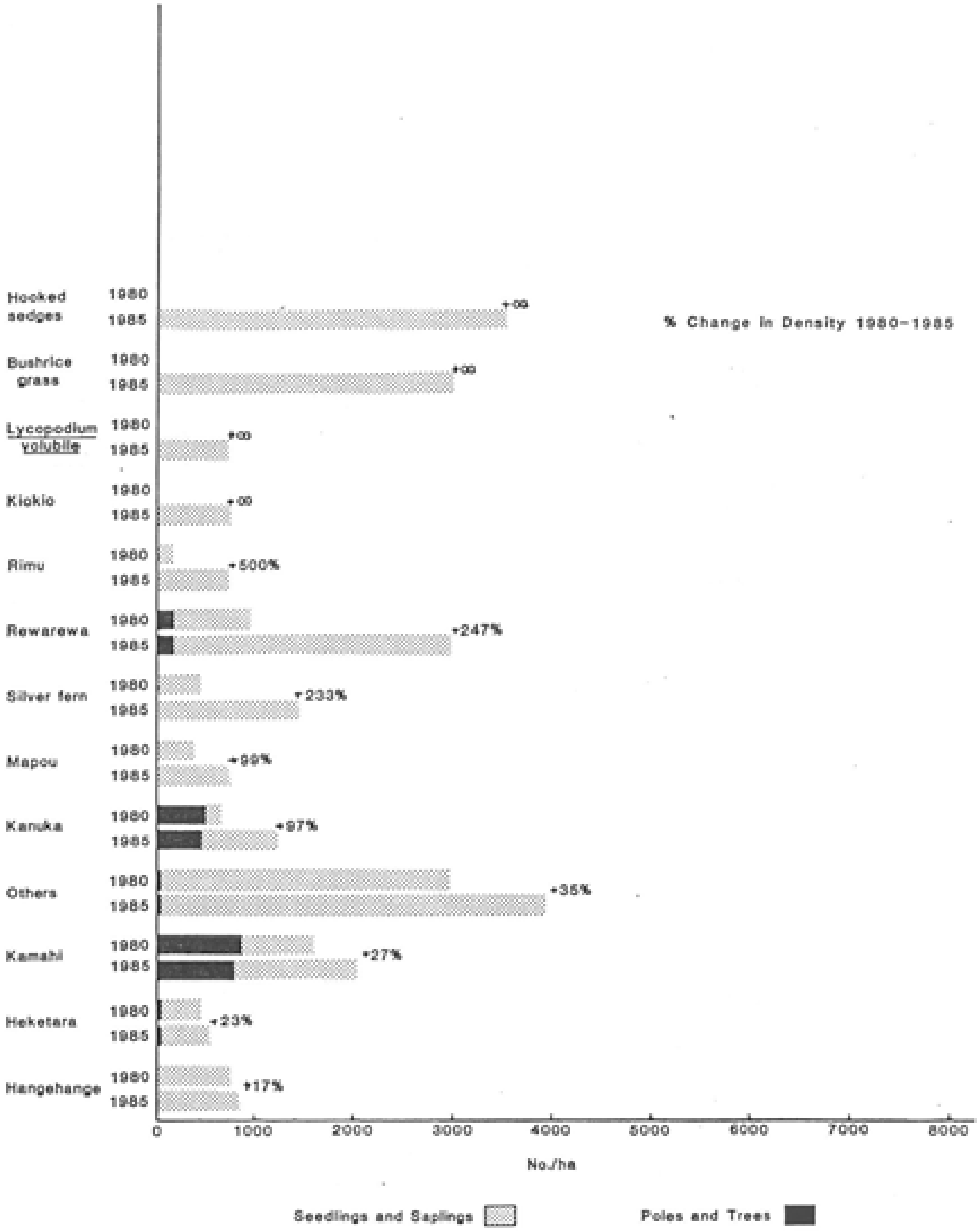


Figure 4.2.7.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985. Rewarewa/Kanuka/Kamahi Forest.



8. Kanuka/mahoe forest

No. of Plots	:	7
Altitude	:	200-700m a.s.l
Aspect	:	0-360°
Slope	:	10-30°

Total basal area increased slightly (Appendix 2). Possum-preferred species (mahoe and putaputaweta) decreased in basal area, whilst possum non-preferred species increased in basal area (kanuka and tarata) (Figures 4.1.8.1 and 4.1.8.3).

The density of seedlings increased, deer non-preferred species increasing much more than deer-preferred species. Several species that increases occurred in were hangehange, mapou, pigeonwood and rangiora, whilst numbers of and kanuka seedlings decreased.

The decrease in deer non-preferred saplings (rangiora and kanuka) corresponded to an increase in deer non-preferred poles (rangiora and kanuka). However, while deer-preferred saplings increased (pigeonwood), deer-preferred poles and trees decreased (pigeonwood and mahoe) (Figures 4.1.8.2and4.1.8.4).

Figure 4.2.8.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Kanuka/Mahoe Forest.

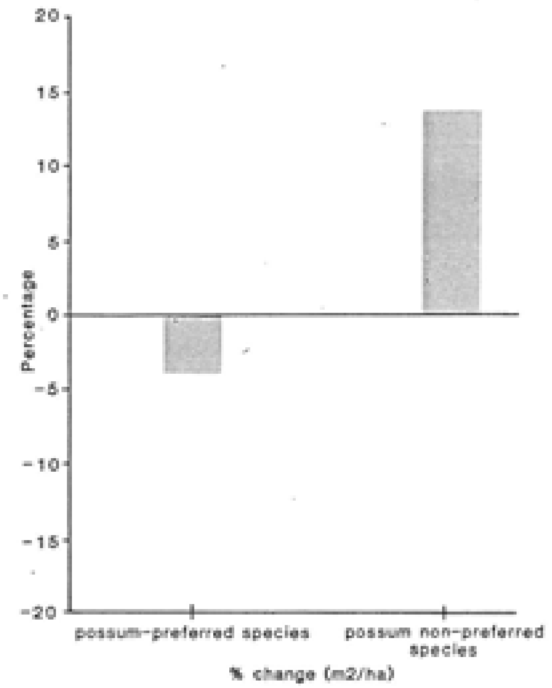


Figure 4.2.8.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Kanuka/Mahoe Forest.

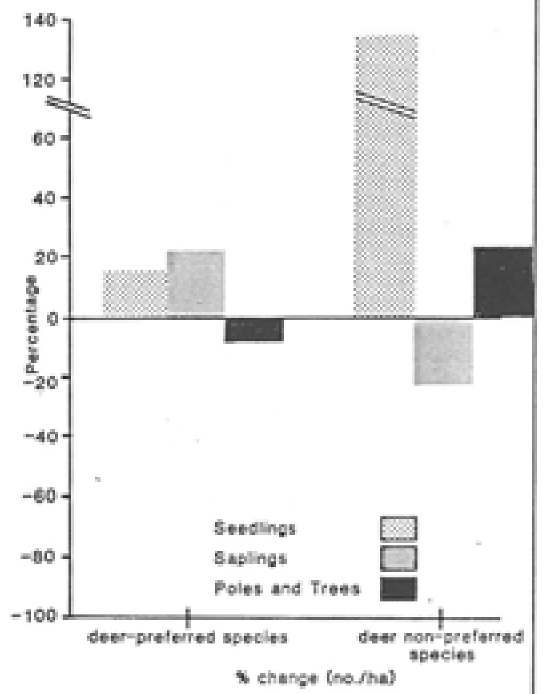


Figure 4.2.8.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Kanuka/Mahoe Forest.

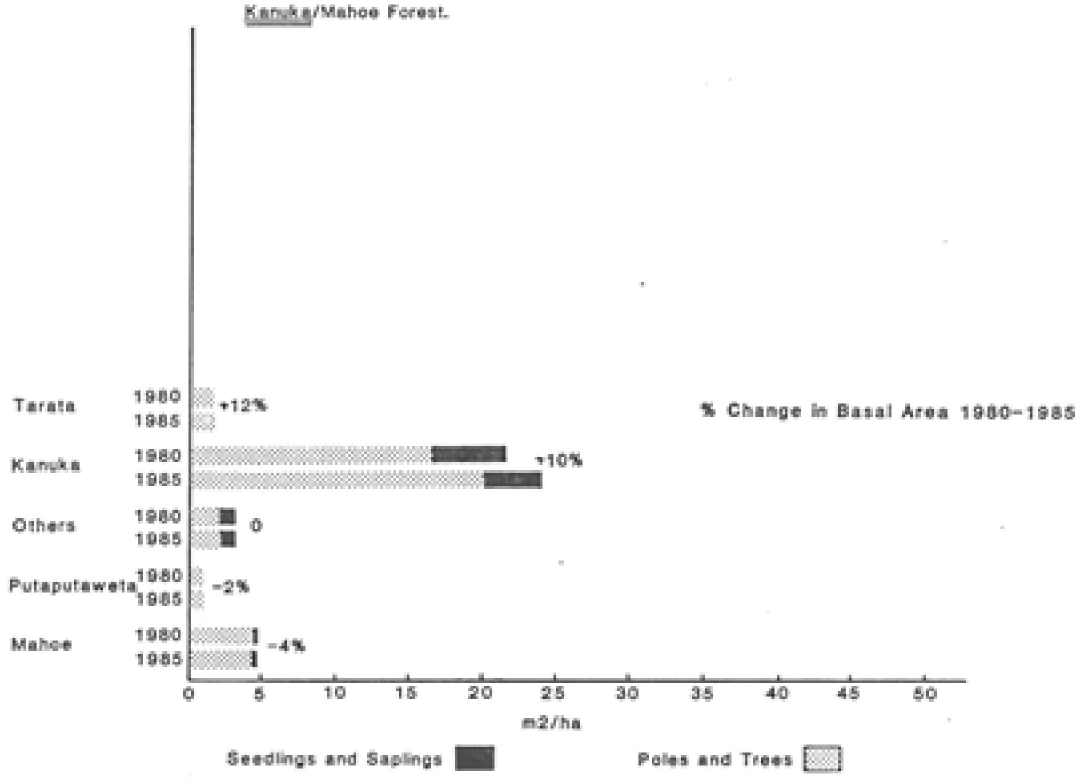
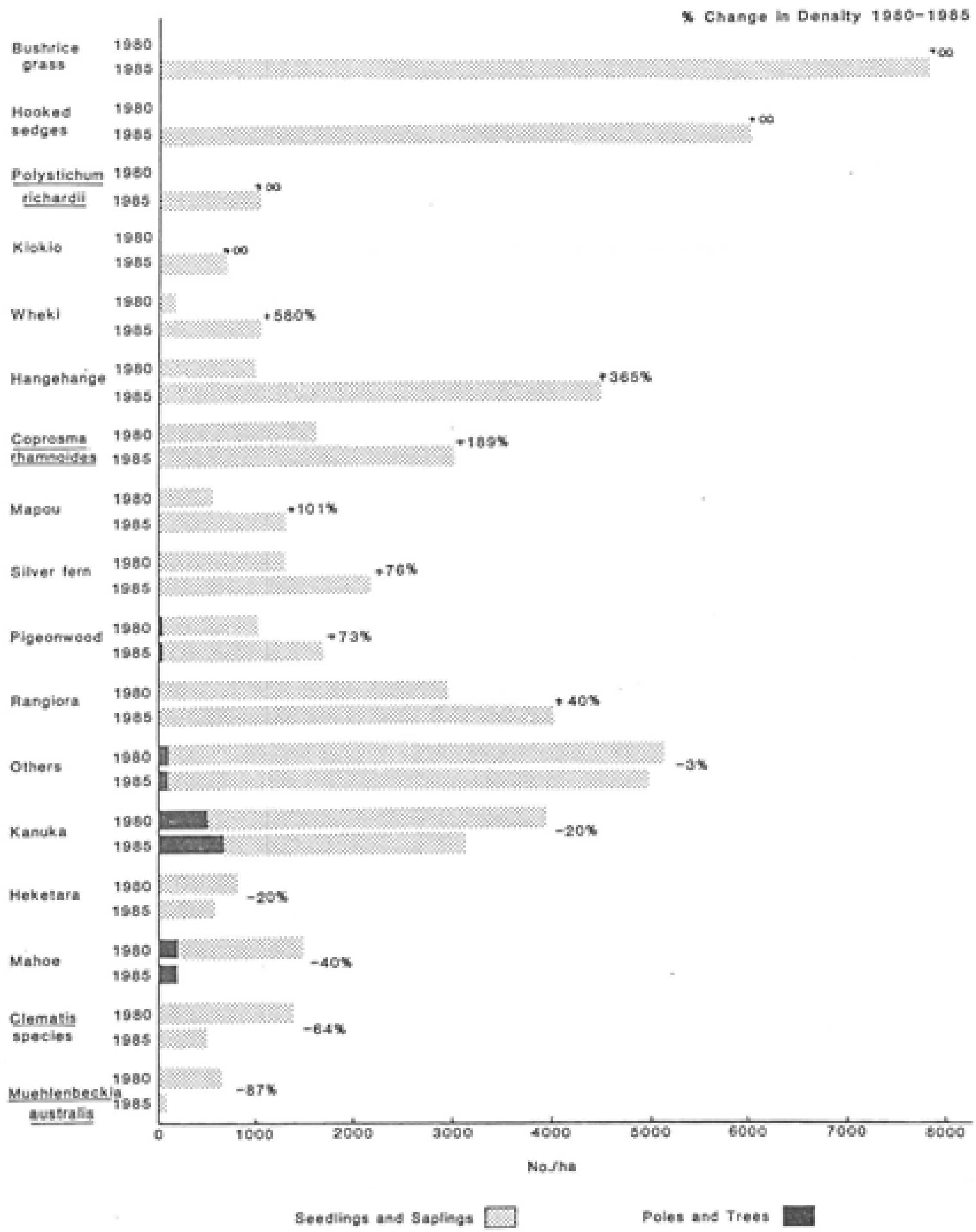


Figure 4.2.8.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Kanuka/Mahoe Forest.



9. Mahoe forest

No. of Plots	:	5
Altitude	:	300-500m a.s.l
Aspect	:	0-360^{o}
Slope	:	10-30^{o}

Basal area in this vegetation type increased slightly (Appendix 2).

The density of seedlings increased in both deer-preferred and deer non-preferred species, however the density of mahoe and rangiora decreased. Deer-preferred saplings (mahoe) decreased, whilst deer non-preferred saplings (rangiora) increased (Figures 4.1.9.2 and 4.1.9.4).

Figure 4.2.9.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 Mahoe Forest.

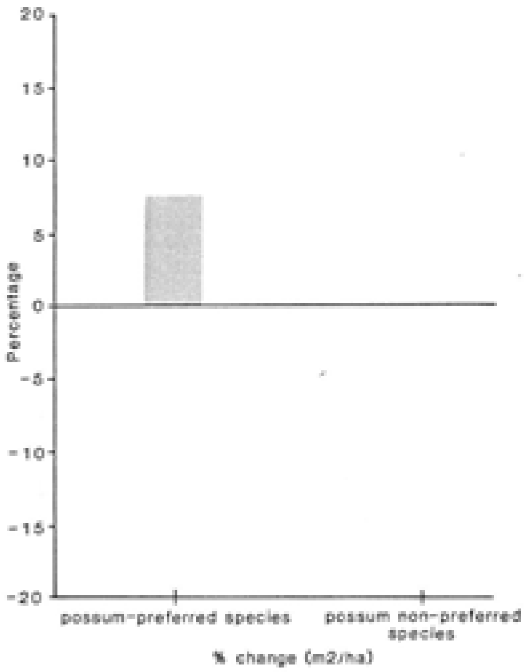


Figure 4.2.9.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 Mahoe Forest.

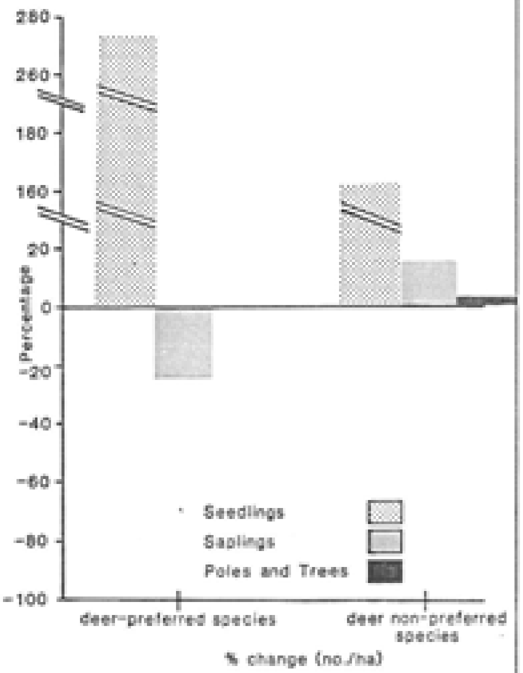


Figure 4.2.9.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 Mahoe Forest.

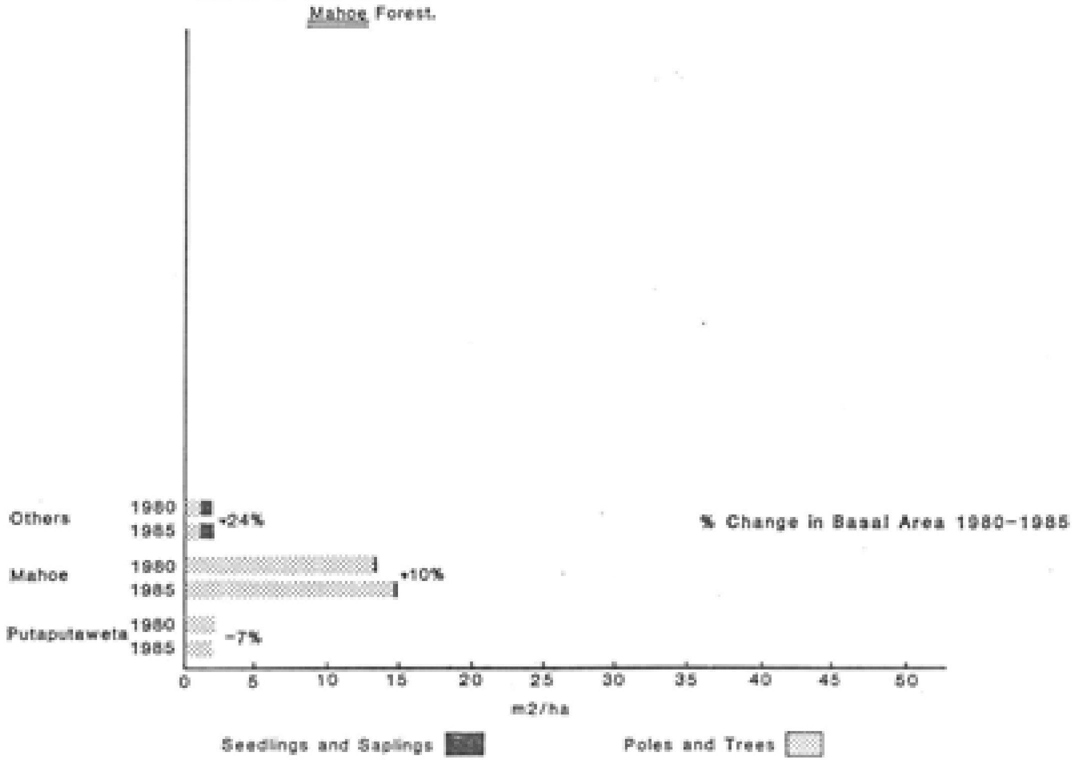
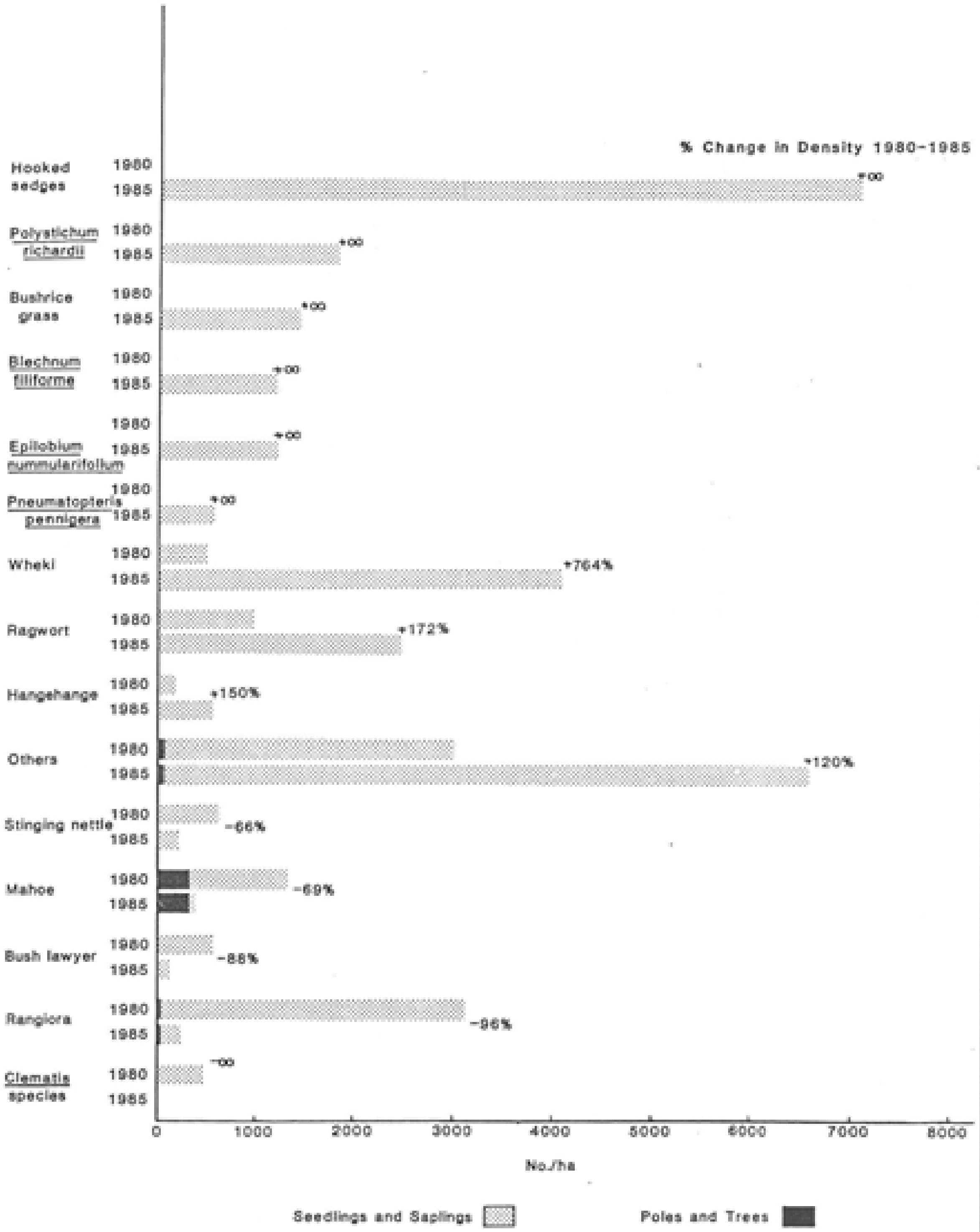


Figure 4.2.9.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 Mahoe Forest.



All Plots

No. of Plots	:	65
Altitude	:	200-900m a.s.l
Aspect	:	0-360^{o}
Slope	:	0-60^{o}

Total basal area increased during the survey period; possum non-preferred species (including kanuka, red beech, rewarewa, matai) increased in basal area while possum-preferred species decreased slightly. Overall, kamahi and mahoe showed a decrease in basal area (see Figure 4.1.10.2).

Total density of seedlings increased with a slightly higher rate of increase in deer non-preferred species than in deer-preferred species. The density of mahoe seedlings decreased.

Deer-preferred saplings (including mahoe, kanono, *Coprosman lucida,* tawari, mapou, lancewood and kamahi) decreased in density without a corresponding increase in tree poles. The density of deer non-preferred seedlings, saplings and poles did not change significantly (Figures 4.1.10.2 and 4.1.10.4).

Figure 4.2.10.1.Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 All Plots.

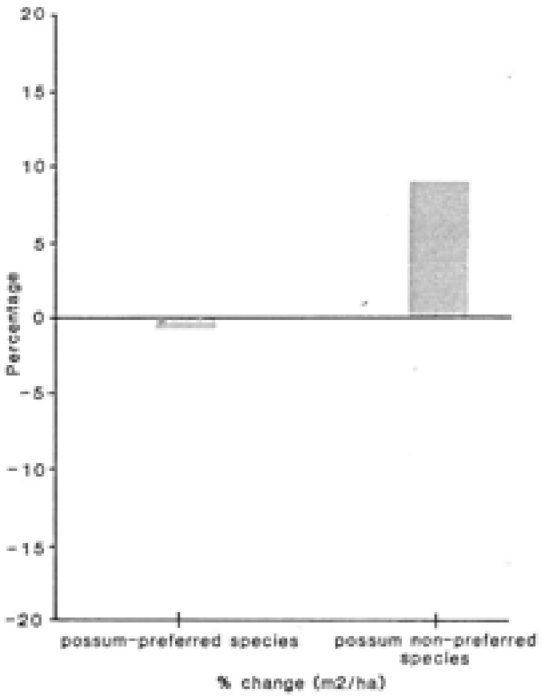


Figure 4.2.10.2.Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 All Plots.

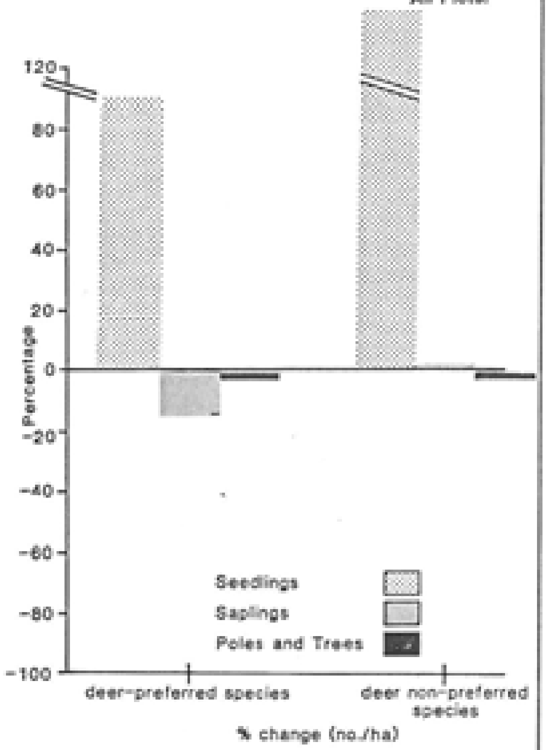


Figure 4.2.10.3.Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 All Plots.

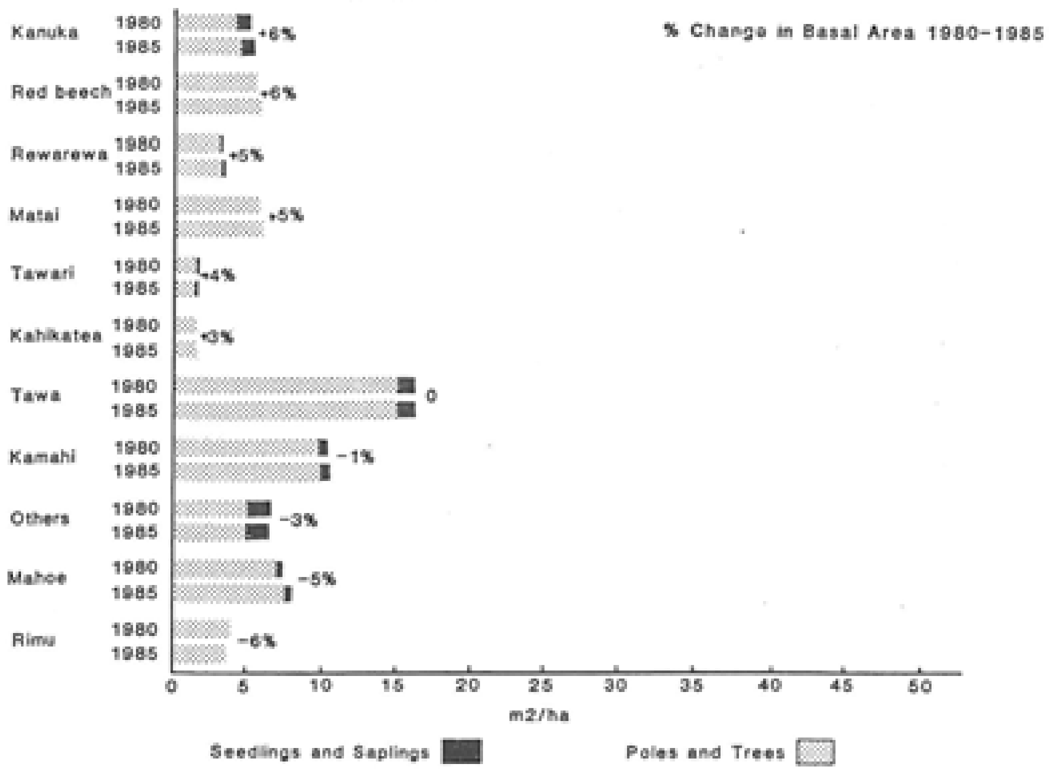
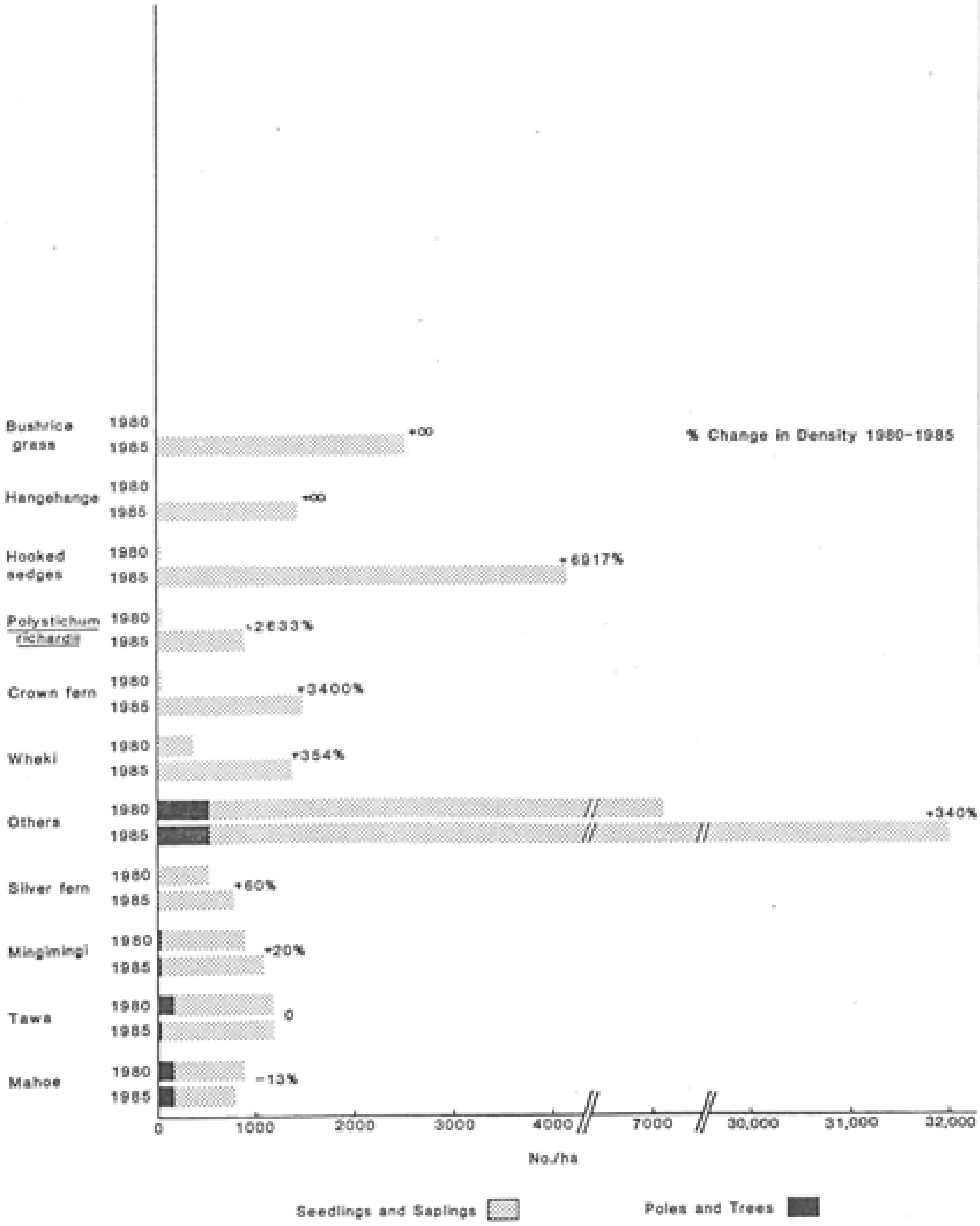


Figure 4.2.10.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 All Plots.



4.3 Group B

1. Tawa forest

No. of Plots	:	1 exclosure,1 control
Altitude	:	350m a.s.l
Aspect	:	230-260^o
Slope	:	3-5^o

Basal area increased slightly in both exclosure and control plots (Fiture 4.3.1.1).

In the exclosure plot, the major species (tawa) recorded an increase in basal area twice as high as was recorded in the control plot (Figure 4.3.1.3).

Whilst the density of seedlings increased slightly more in the control plot than in the exclosure plot, this may have been caused by the decrease in density of trees of the control; tree density remained stable in the exclosure plot. The density of saplings remained stable in both the exclosure and control (Figures 4.3.1.2 and4.3.1.4).

Figure 4.3.1.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 in Exclosure and Control Plots Tawa Forest.

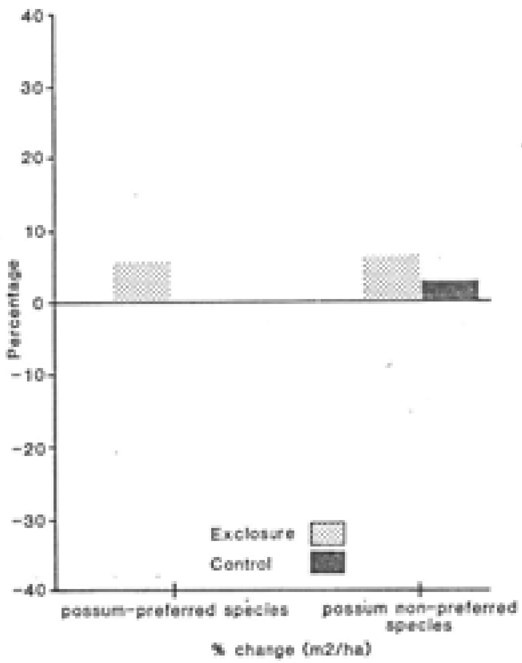


Figure 4.3.1.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 in Exclosure and Control Plots Tawa Forest.

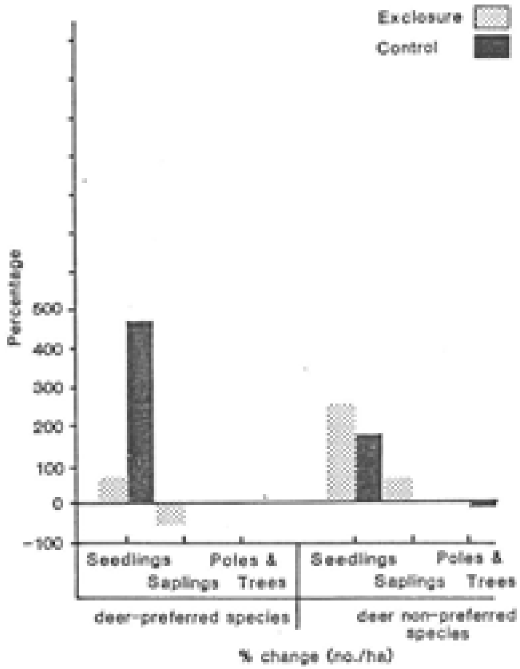


Figure 4.3.1.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 in Exclosure and Control Plots Tawa Forest.

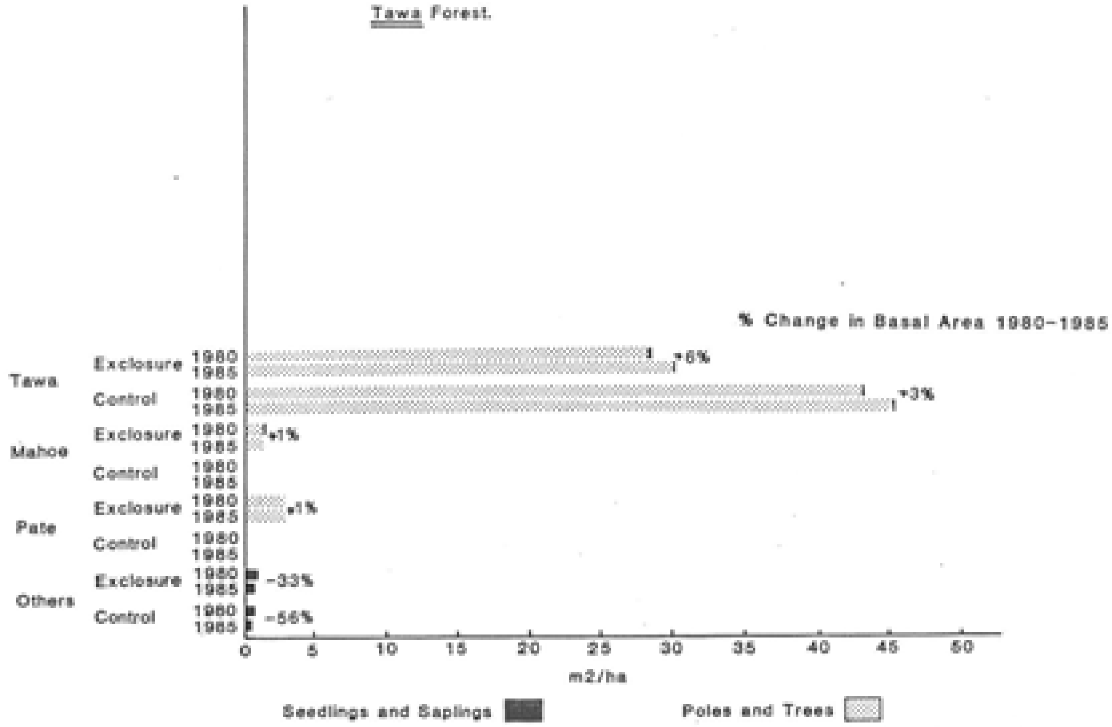
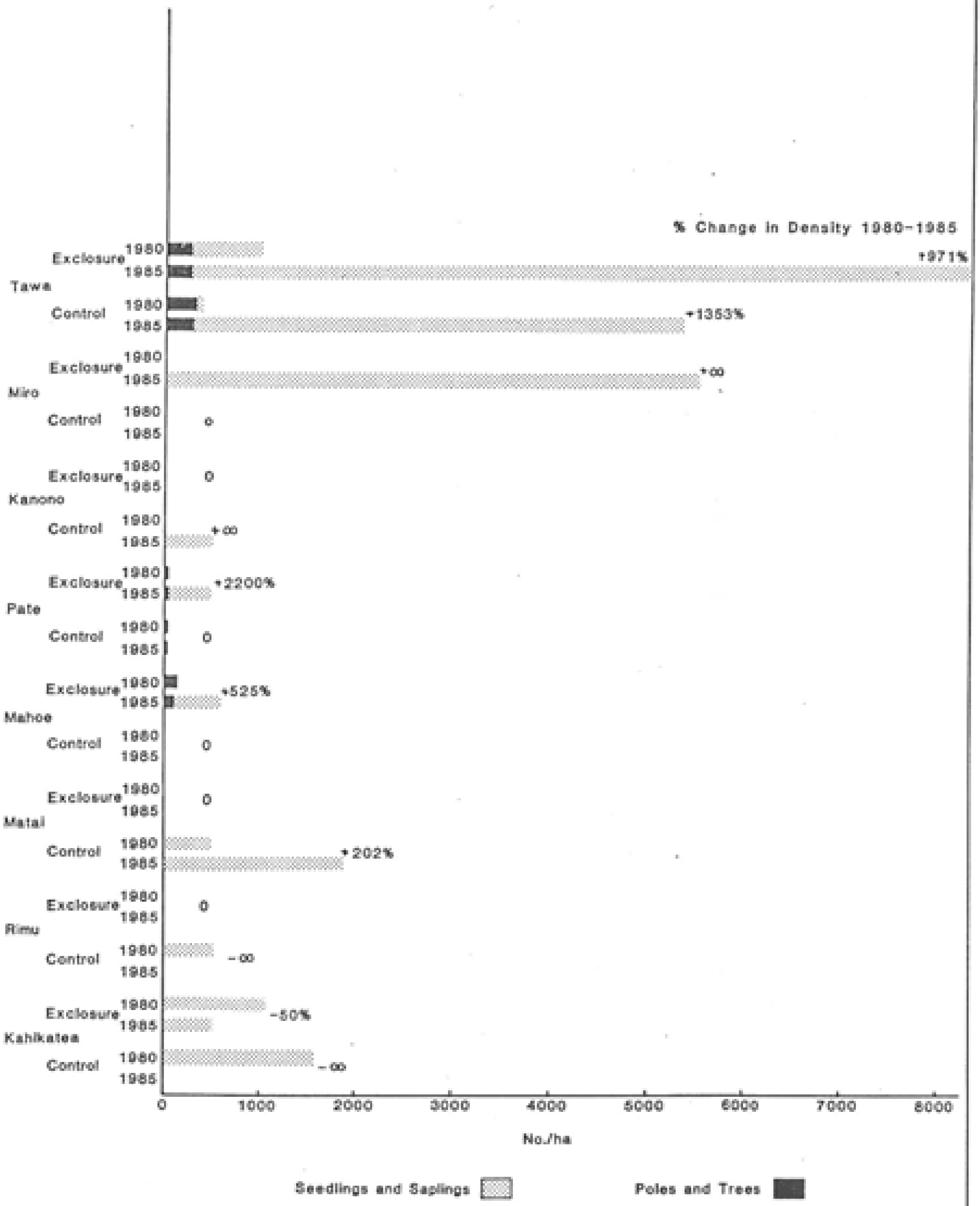


Figure 4.3.1.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 in Exclosure and Control Plots Tawa Forest.



2. Kamahi forest

No. of Plots	:	1 exclosure, 1 control
Altitude	:	450m a.s.l
Aspect	:	150-200^{o}
Slope	:	0-20^{o}

Although basal area increased in both the control and exclosure plots, the increase was greater in the exclosure plot than the control plot (Appendix 2). Increases occurred in most species, including kamahi, rewarewa, mahoe and kanuka (Figures 4.3.2.1 and 4.3.2.3).

Density of seedlings have increased in both the exclosure and control. Deer-preferred species (including hangehange, mahoe, kanono and *Coprosma lucida*) increased more in the exclosure than the control, whilst non-deer preferred species (including makomako, mingimingi and rimu) increased more in the control than the exclosure. The density of saplings decreased in both the exclosure and control plots, the decrease being greater in the control than the exclosure. The number of trees and poles remained stable in the exclosure, while there was a slight decrease in the control plot (Figures 4.3.2.2 and 4.3.2.4).

Figure 4.3.2.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 in Exclosure and Control Plots. Kamahi Forest.

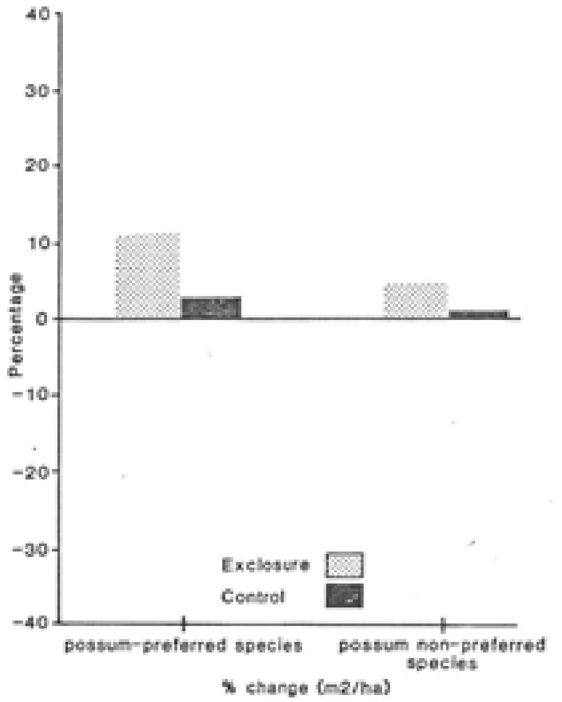


Figure 4.3.2.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 in Exclosure and Control Plots. Kamahi Forest.

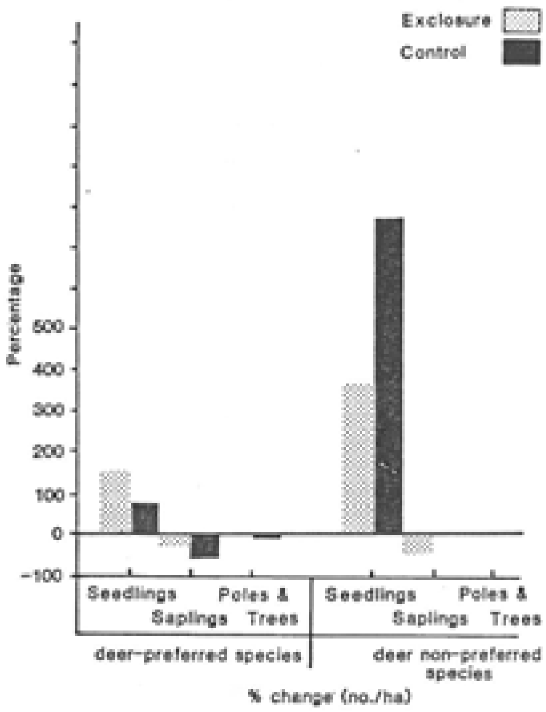


Figure 4.3.2.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 in Exclosure and Control Plots. Kamahi Forest.

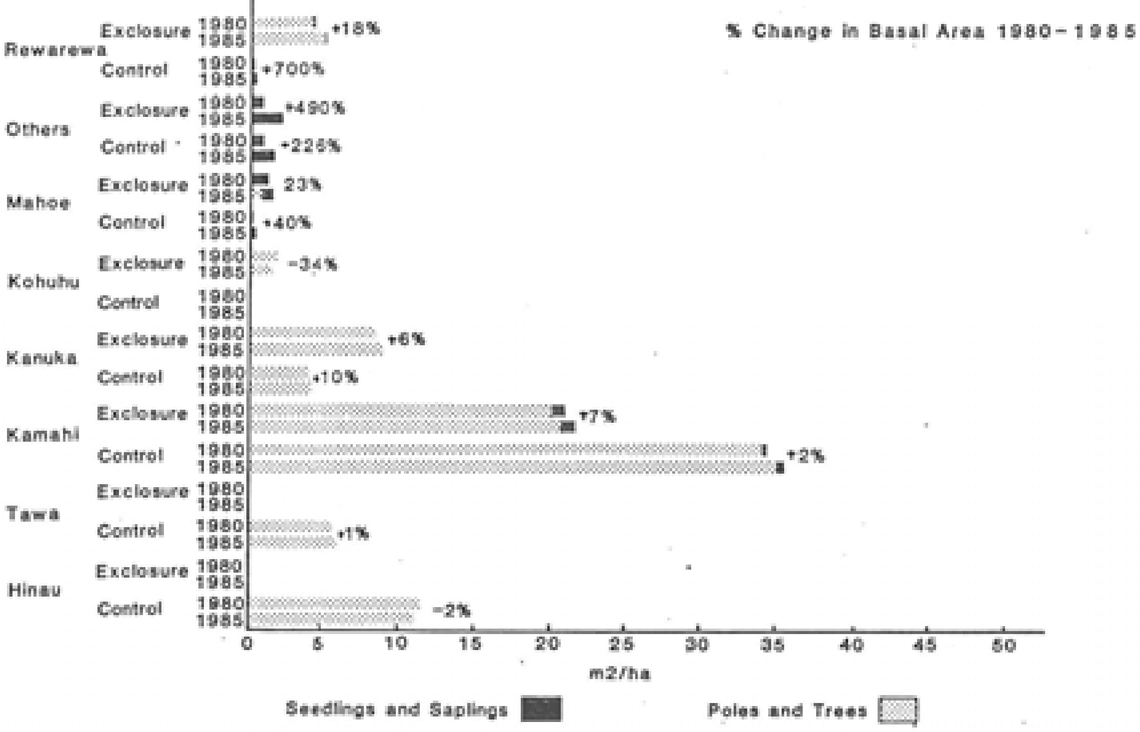


Figure 4.3.2.4. Density (no./ha) of major species
(>500/ha) in 1980 and 1985
in Exclosure and Control Plots.
Kamahi Forest.
Sheet 1.

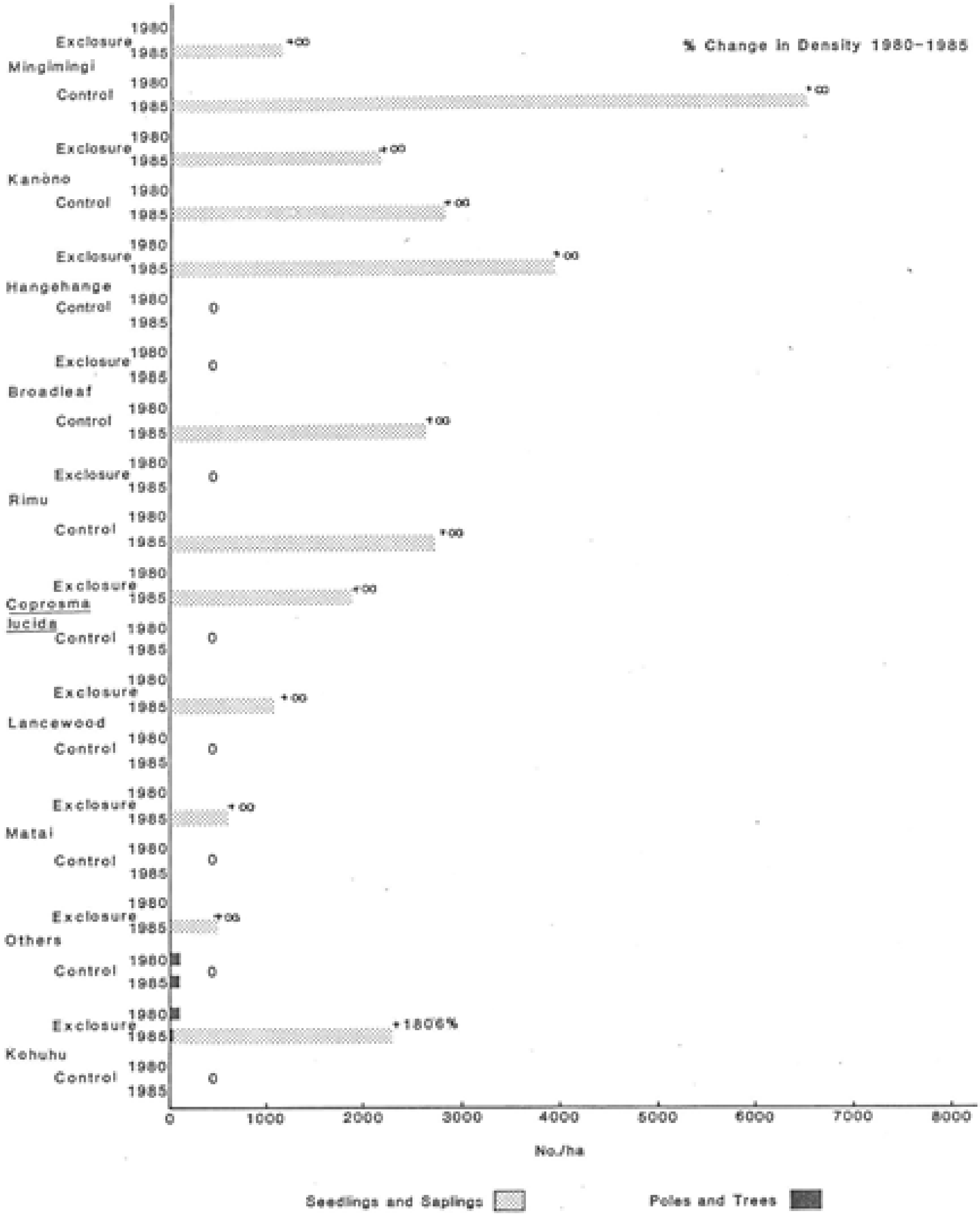
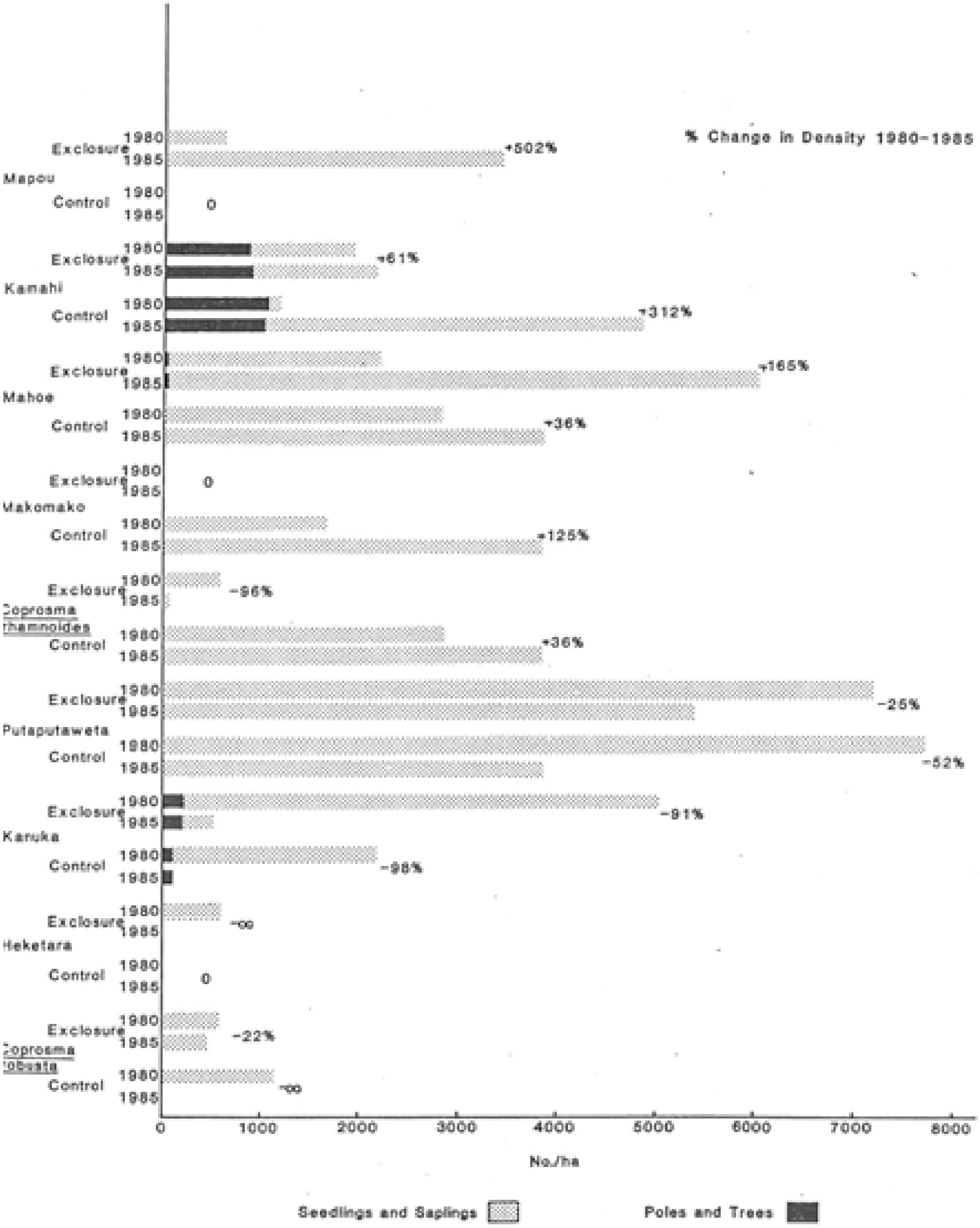


Figure 4.3.2.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 in Exclosure and Control Plots. Kamahi Forest. Sheet 2.



3. Mahoe forest

No. of Plots	:	2 exclosures, 2 control plots
Altitude	:	350-460m a.s.l
Aspect	:	230-320^{o}
Slope	:	0-15^{o}

Mahoe is the dominant canopy species in the plots. There was an increase in basal area in both exclosure and control plots, although the increase was greater in the exclosure plots (Figures 4.3.3.1 and 4.3.3.3).

The incidence of seedlings increase in both exclosure and control plots.

Deer-preferred species increased more in the control plots than they did in the exclosure plots, and deer non-preferred species increased more in the exclosure plots than they did in the control plots.

Deer-preferred saplings (mahoe) increased in both exclosure and control plots. However whilst deer non-preferred saplings (tawa) decreased in the exclosure plots, this was caused by growth into the pole category, which resulted in an increased density of poles (Figures 4.3.3.2 and 4.3.3.4).

Figure 4.3.3.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 in Exclosure and Control Plots. Mahoe Forest.

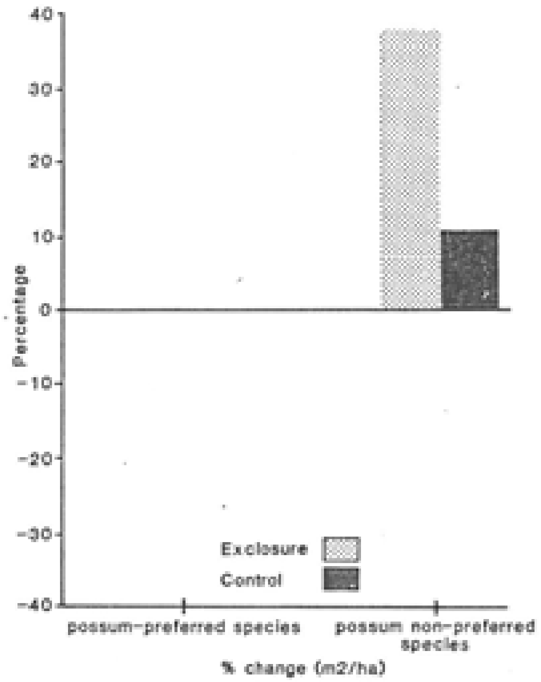


Figure 4.3.3.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 in Exclosure and Control Plots. Mahoe Forest.

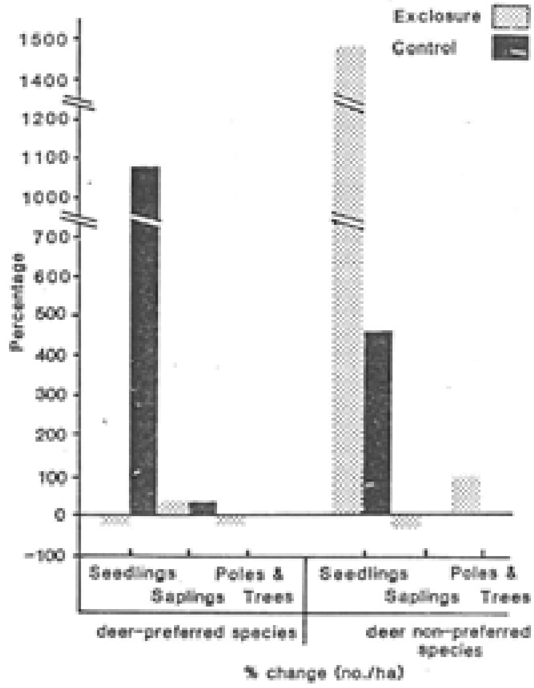


Figure 4.3.3.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 in Exclosure and Control Plots. Mahoe Forest.

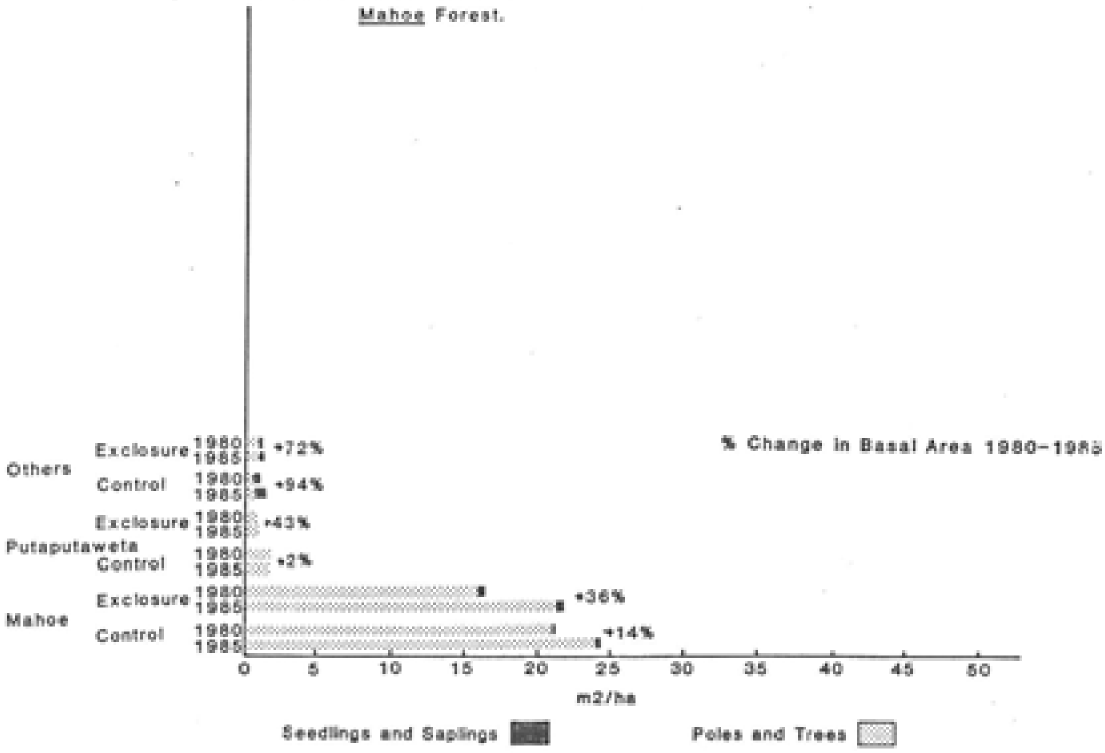
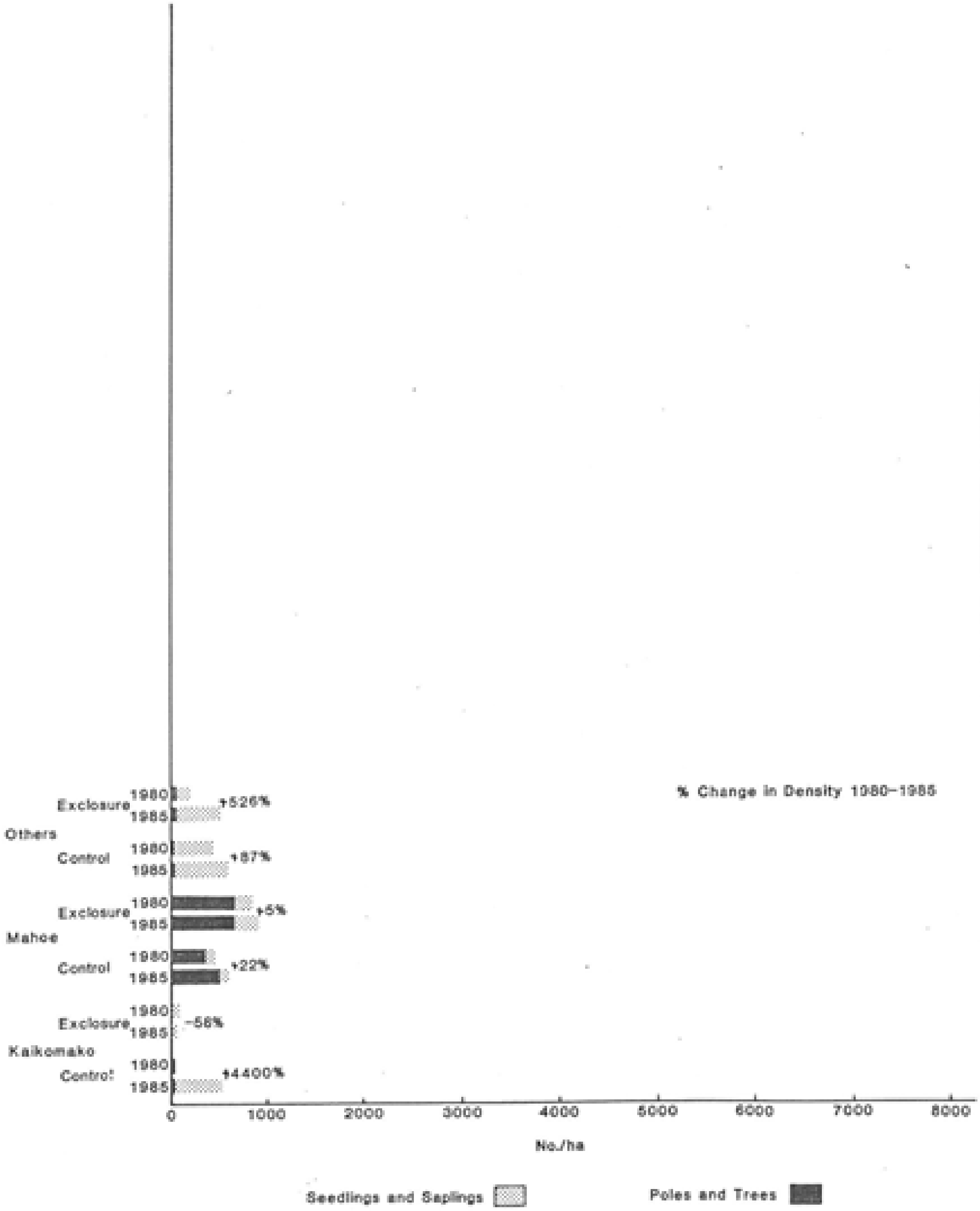


Figure 4.3.3.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 in Exclosure and Control Plots. Mahoe Forest.



4. Mahoe-wheki forest

No. of Plots	:	2 exclosures, 2 control plots
Altitude	:	350 – 350n a.s.l
Aspect	:	20-325^{o}
Slope	:	5 – 40^{o}

The basal area in both the control and exclosure plots increased between survey areas (Figures 4.3.4.1and 4.3.4.3).

The density of deer-preferred seedlings in the exclosure plots increased dramatically, (including hangehange, putaputaweta, mapou and mahoe) compared with the control plots (Figures 4.3.4.2 and 4.3.4.4).

Figure 4.3.4.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 in Exclosure and Control Plots. Mahoe-Wheki Treeland

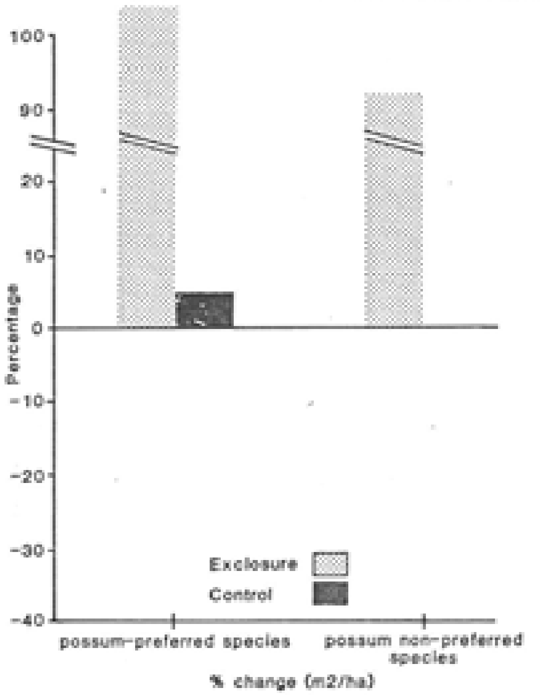


Figure 4.3.4.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 in Exclosure and Control Plots. Mahoe-Wheki Treeland

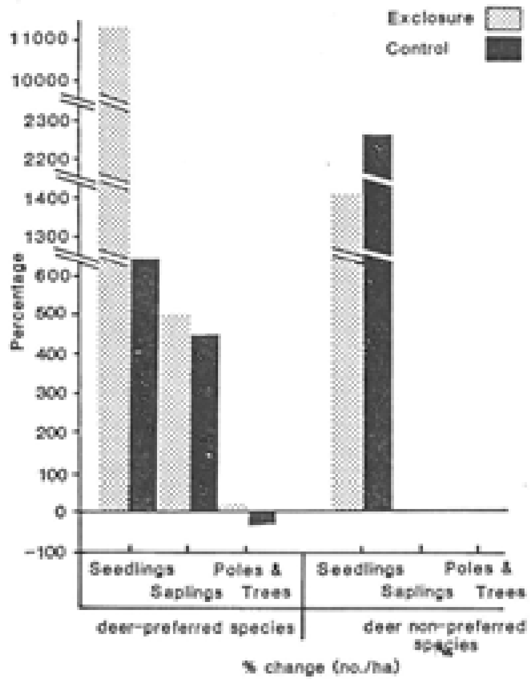


Figure 4.3.4.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 in Exclosure and Control Plots. Mahoe-Wheki Treeland

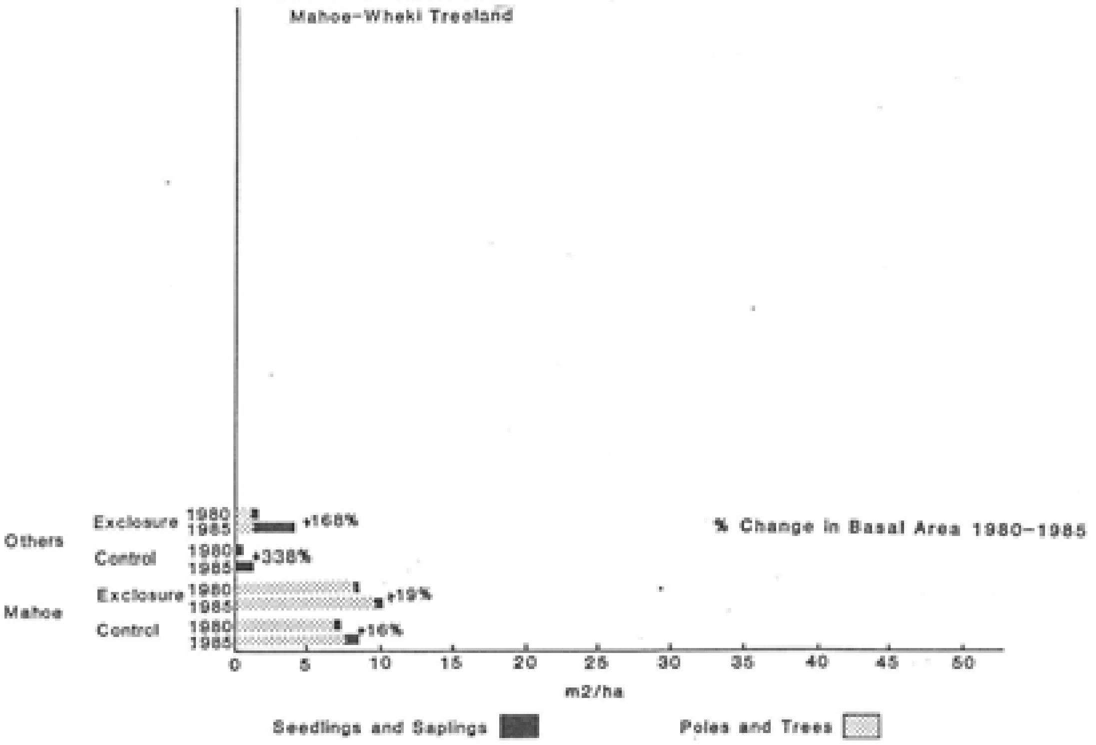
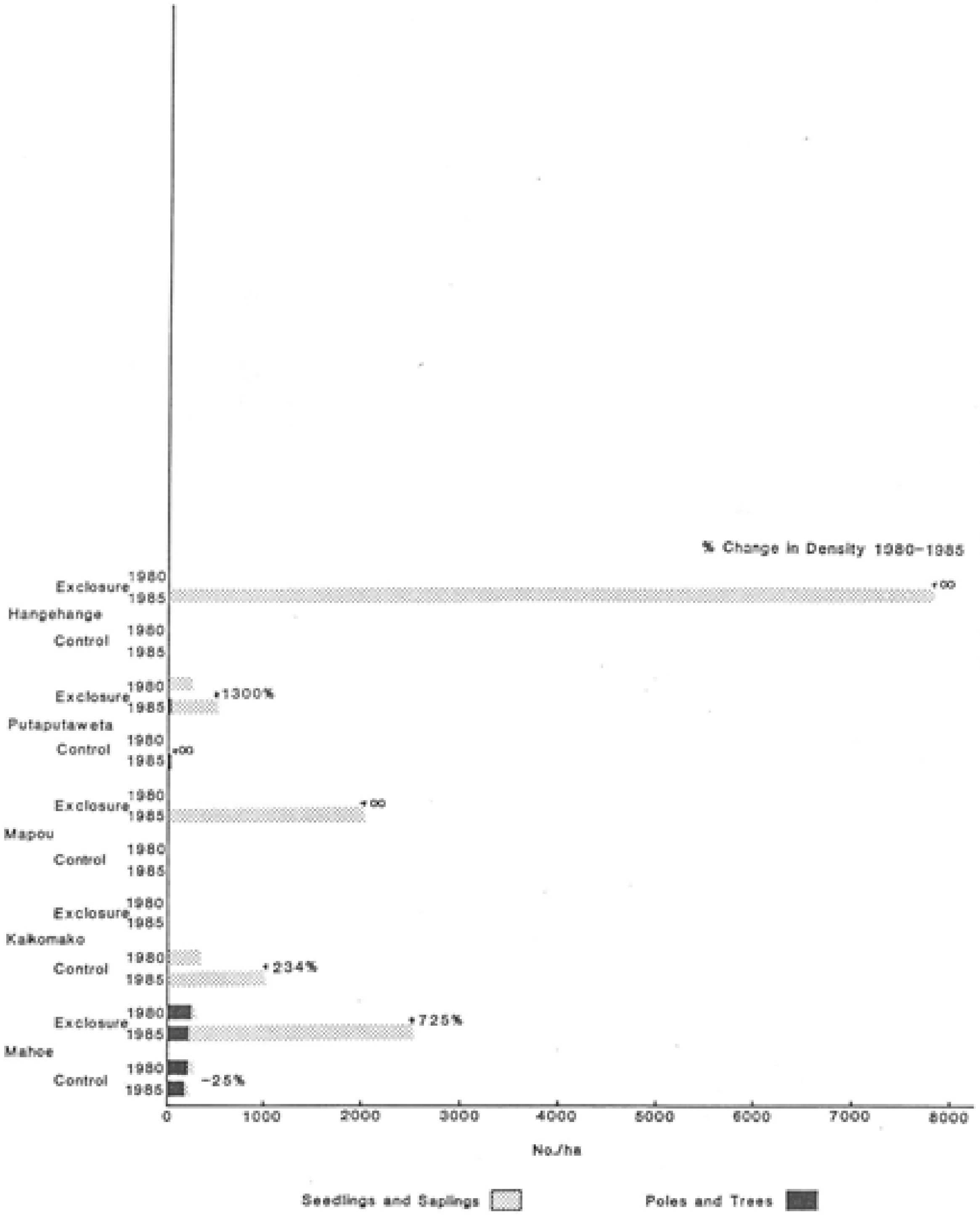


Figure 4.3.4.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 in Exclosure and Control Plots. Mahoe-Wheki



All Plots

No. of Plots	:	4 exclosures, 4 control plots
Altitude	:	350 – 460m a.s.l
Aspect	:	20 -325^{o}
Slope	:	0 – 40^{o}

Basal area for all plots combined increased in both the exclosure and the control plots. The increase was larger in the exclosure plots than in the control plots.

The incidence of seedlings increased in both the exclosure and control plots (including hangehange, pate, tawa, and mapou). The incidence of deer-preferred saplings increased in both the exclosure and control plots, however deer non-preferred species decreased in the exclosure plots (kanuka and tawa). The density of trees remained relatively stable.

Figure 4.3.5.1. Percentage Change in Basal Area(m2/ha) of possum-preferred and possum non-preferred poles and trees between 1980 and 1985 in Exclosure and Control Plots. All Plots.

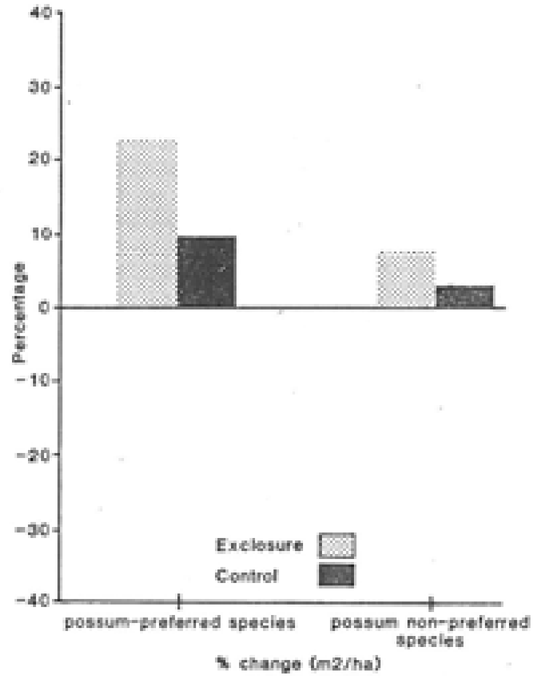


Figure 4.3.5.2. Percentage Change in Density (no./ha) of deer-preferred and deer non-preferred species between 1980 and 1985 in Exclosure and Control Plots. All Plots.

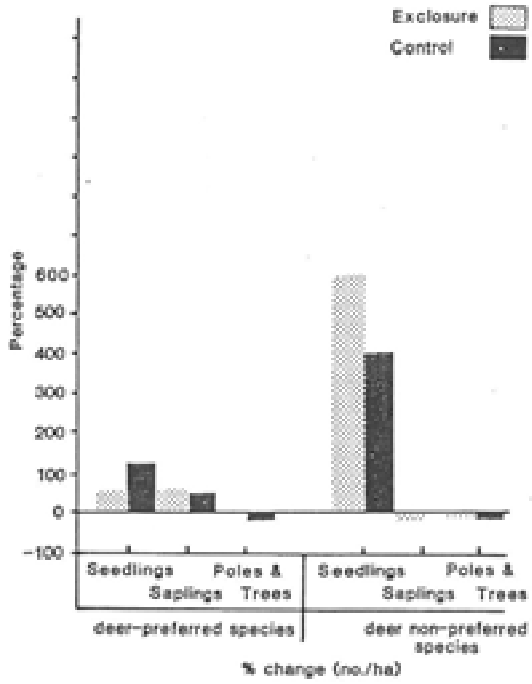


Figure 4.3.5.3. Basal Area (m2/ha) of major species (>1m2/ha) in 1980 and 1985 in Exclosure and Control Plots. All Plots.

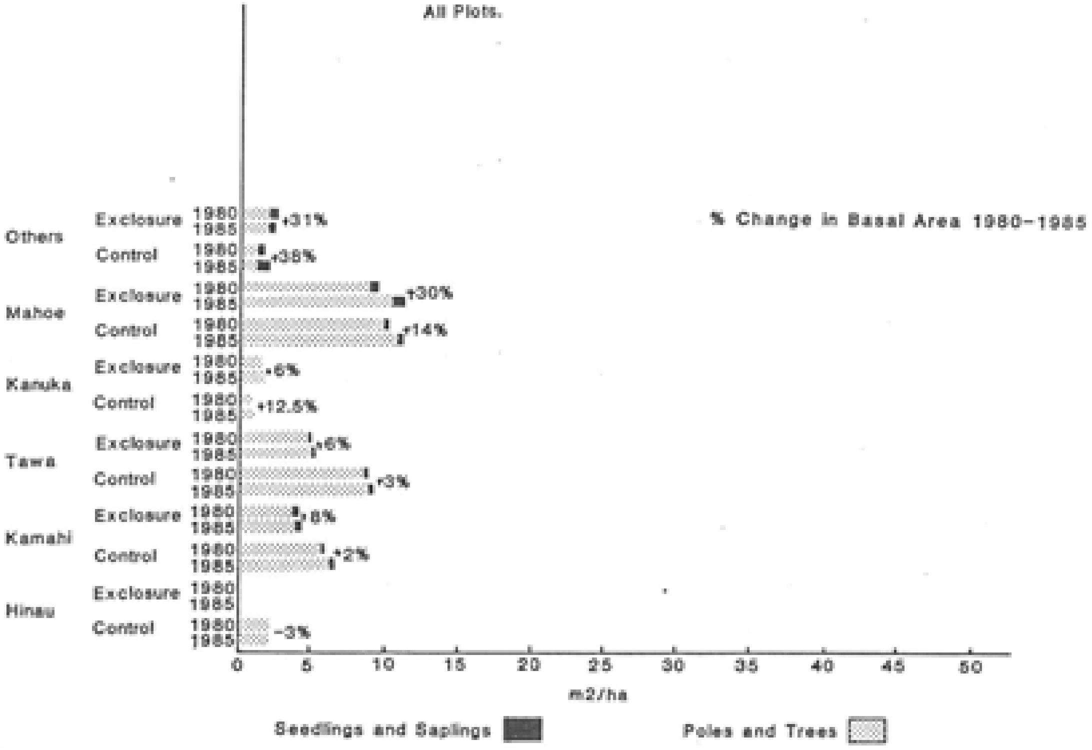
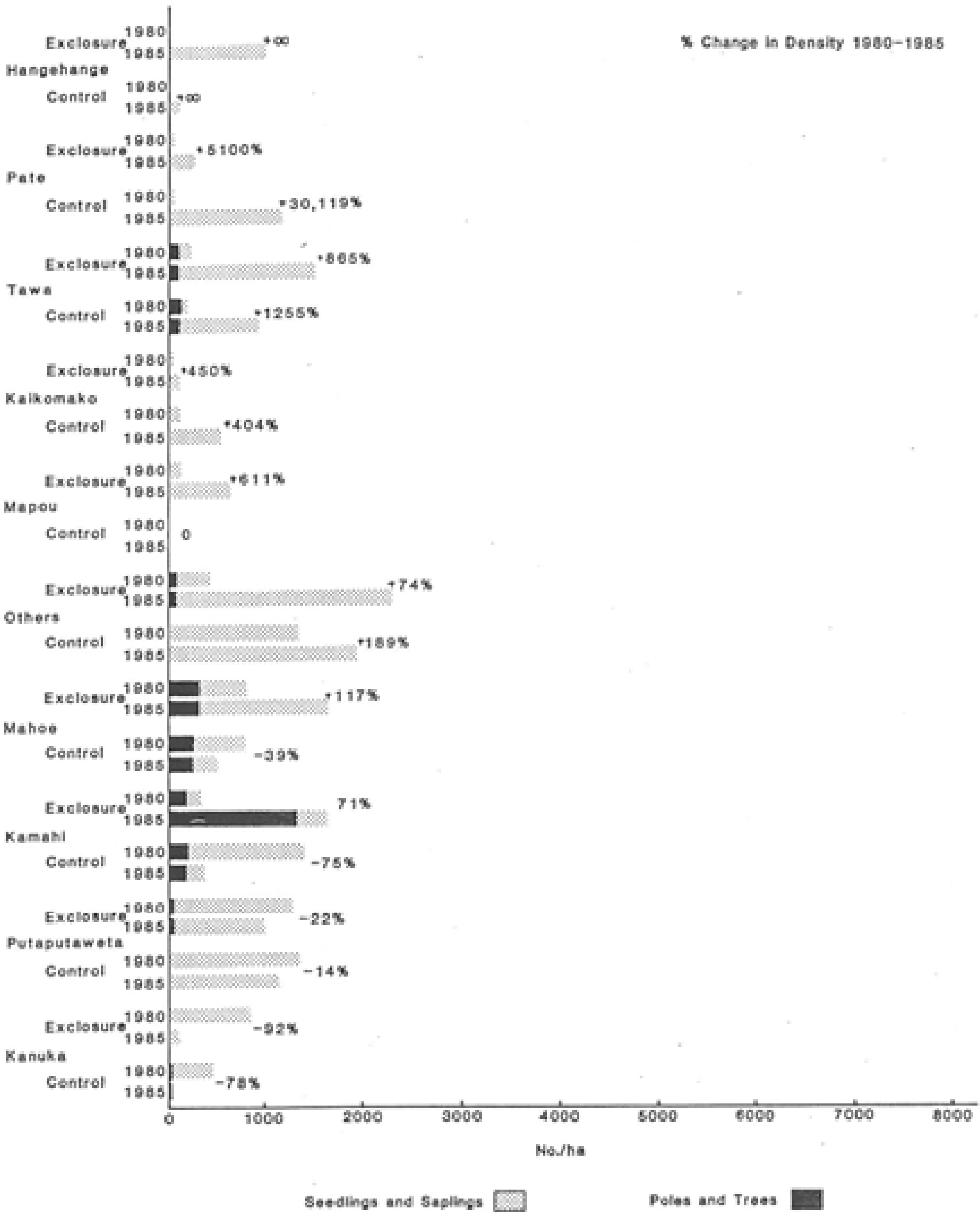


Figure 4.3.5.4. Density (no./ha) of major species (>500/ha) in 1980 and 1985 in Exclosure and Control Plots. All Plots.



5. SUMMARY AND DISCUSSION OF RESULTS

Group A (63 permanent plots)

Basal Area

The basal area of trees and poles (> 2.5 dbh) of possum-preferred species increased slightly over the survey period in five vegetation types (Table 3):

tawa/mahoe forest
(rimu)/tawa-kamahi-rewarewa-(hinau)/pigeonwood-mahoe forest
kamahi-rewarewa-tawa forest
rewarewa/kanuka/kamahi forest
mahoe forest

Basal area of possum-preferred species decreased slightly over the survey period in three vegetation types:

rimu-(matai)/tawa-mahoe forest
kanuka/mahoe forest
red beech/tawari-kamahi forest

No possum-preferred species were present in forest.

The basal area of possum non-preferred species increased slightly over the survey period in six vegetation types;

black beech forest
tawa/mahoe forest
kamahi-rewarewa-tawa forest
rewarewa/kanuka/kamahi forest
kanuka/mahoe forest
red beech/tawari-kamahi forest

Basal area of possum non-preferred species decreased slightly in three vegetation types:
rimu-(matai)/tawa/mahoe forest
(rimu)/tawa-kamahi-rewarewa-(hinau)/pigeonwood-mahoe forest
mahoe forest

Table 3 : Changes in Basal Area (larger stems) and density (smaller stems) within forest types 1980 - 1985

	Basal Area Poles and Trees			Density Seedlings		
	Possum-Preferred	Possum non-Preferred	Total	Deer-Preferred	Deer non-Preferred	Total
rimu-(matai)/tawa/mahoe forest	↑↑	↓	↓	↑	↑↑	↑
(rimu)/tawa-kamahi-rewarewa-(hinau)/ pigeonwood-mahoe forest	↓↓	↓	↓	↓	↑↑	↑
(tawa)/mahoe forest	↑	↑↑	↑	↑↑	↑	↑
black beech forest	n/a	↑	↑	↓↓	↓	↓
red beech/kamahi-tawari forest	↓	↑↑	↑	↑	↑↑	↑
kamahi-rewarewa-tawa forest	↑↑	↑	↑	↑	↑↑	↑
rewarewa/kanuka-kamahi	↑↑	↑	↑	↑	↑↑	↑
kanuka/mahoe	↓	↑↑	↑	↑	↑↑	↑
mahoe forest	n/a	n/a	↑	↑↑	↑	↑
All Plots	↓	↑↑	↑	↑	↑↑	↑

Key : ↑ increase

↓ decrease

↑↑ or ↓↓ indicates greatest positive or negative change respectively

For all species combined, seven vegetation types recorded a slight increase in basal area, whilst two types rimu-(matai)/tawa/mahoe forest and kanuka/mahoe forest recorded a slight decrease.

These changes were relatively slight (all less than 10%) and at this stage no major trends can be identified.

The basal area of possum-preferred species for all plots combined increased by approximately 2 percent. Possum non-preferred species increased by a similar amount. However whilst all possum-preferred species recorded increased basal area, several possum non-preferred species decreased, including some deer-preferred species. The species which decreased were kanono, putaputaweta, *Coprosma tenuifolia,* rimu, hangehange, tawari, mingimingi, mapou, kohuhu, horopito and tawheowheo.

Density

In seven vegetation types the percentage change in the density of seedlings was either a greater positive change or a smaller negative change for deer non-preferred species than for deer-preferred species (Table 3). These seven vegetation types were:

black beech forest
rimu-(matai)/tawa/mahoe forest
(rimu)/tawa-kamahi-rewarewa-(hinau)/pigeonwood-mahoe forest
kamahi-rewarewa-tawa forest
rewarewa/kanuka/kamahi forest
kanuka/mahoe forest
red beech/tawari-kamahi forest

This indicates that the proportion of deer-preferred species is decreasing overall relative to deer non-preferred species.

Of particular interest is the future canopy composition of several of the secondary forest types, e.g. kanuka/mahoe forest. The probable successional pathway in this vegetation type before the introduction of wild animals would have been to kamahi forest, and then to tall forest ((rimu)-(rata)/tawa-kamahi). Since the introduction of wild animals in the Ureweras kamahi is largely failing to establish (Allen *et al.* 1984).

Mahoe is a major canopy component in two vegetation types in this study ((tawa)/mahoe and mahoe forest). In both these types basal area increased for possum-preferred species and overall basal area also increased. However these types are likely to be sensitive to wild animal impact for two reasons:

(a) existing forests – Mahoe is a possum-preferred species and existing canopies may be adversely affected by possums;

(b) future forests – Mahoe forest currently commonly occurs in gullies and on old landslide scars. However, it is now less likely to establish given the current levels of deer. Mahoe seedlings/saplings were significantly less common outside exclosures than inside exclosures in the study of Allen *et al.* (1984).

These results show that there has not been any major degradation of the existing canopy species between 1980/81 and 1985/86. However a trend towards an increasing proportion of deer non-preferred species in the seedling and sapling tiers is apparent.

Several common canopy and sub-canopy species are deer-preferred species, kamahi, mapou, and putaputaweta, so it is likely that in the future these species will be less common or will become rare in the canopy/sub-canopy. Kamahi commonly establishes epiphytically on tree ferns (refer to next page), so it may not be affected to the same extent as other species e.g mahoe.

Although total basal area increased in three forest types with possum-preferred species as their main canopy dominant, larger increases in basal area are to be expected in secondary forest types and may have been even higher in the absence of introduced browsing animals.

Group B (Six and Six Control Plots)

Basal Area

Basal area increased in all vegetation types for possum-preferred species and possum non-preferred species in both exclosure and control plots. In all cases except one (possum-preferred species in tawa forest) the increases were greater in the exclosure plots than in the control plots. This probably reflects the exclusion of browsing animals.

Density

Seedling density of deer-preferred and deer non-preferred species increased in all vegetation types.

Table 4 indicates in which plots, exclosure or control, the greatest changes occurred. It is interesting to note that for three vegetation types, kamahi forest, mahoe forest, and mahoe-wheki forest the density of deer-preferred seedlings and saplings increased more in the exclosure plots than they did in the control plots. This is also true for all species combined.

These results indicate that the structure and composition of exclosure plots compared with control plots differ very slightly after an interval of five years. However it is well established that browsing animals inhibit the ability of certain species to regenerate. Allen *et al.* (1984) conducted a study of forest structure and species composition using 17 exclosure and control plots in the Urewera forests, established between 1961 and 1988. They concluded that introduced browsing animals, particularly deer, affect the structure and composition of most forest types. In particular the abundance of some forest types with palatable species as their main canopy tree, is likely to decrease, e.g. mahoe forest and kamahi forest (c.f. Payton *et al.* 1984). Kamahi may continue to establish over reduced areas using tree ferns as a host for epiphytic establishment. However mahoe is unlikely to be successful using this method, due to its greater susceptibility to both possum and deer browse.

Since they are located in secondary forest with palatable species as their main canopy tree, exclosure and control plots may show sizeable differences in structure and composition after a lengthy remeasurement period.

TABLE 4
HIGHEST PERCENTAGE CHANGE FOR DEER-PREFERRED AND DEER NON-PREFERRED SPECIES IN PAIRED EXCLOSURE/CONTROL PLOTS

Vegetation type	Category	Highest Percentage Change	
		Seedlings	Saplings
tawa forest	deer-preferred species	control	control
	deer non-preferred species	exclosure	exclosure
kamahi forest	deer-preferred species	exclosure	exclosure
	deer non-preferred species	control	control
mahoe forest	deer-preferred species	control	exclosure
	deer non-preferred species	exclosure	control
mahoe-wheki forest	deer-preferred species	exclosure	exclosure
	deer non-preferred species	control	control

DEER POPULATIONS

Deer pellet density surveys were carried out in the Urewera forests in 1980 and 1985. The catchment is part of the Southern deer pellet survey region which showed an increase in deer pellet density between 1980 and 1985 (Beadel 1988). However no vegetation data was collected during the pellet survey therefore although overall trends can be assessed, deer pellet data cannot be related to specific vegetation types. In future animal density surveys should be made in direct association with vegetation plot remeasurements to assess the changes of deer populations in different vegetation types and to consider them in relation to changes occurring in the vegetation plots (see Recommendations).

6. CONCLUSIONS

Brief conclusions are presented in two sections, reflecting the sampling carried out during the survey.

Group A (for the permanent plots, excluding which are discussed below)

Changes in basal area in all vegetation types were relatively slight (all less than 10%) and at this stage no major trends can be identified. However these results do indicate that there has not been any major degradation of existing canopy species between 1980/81 and 1985/86. In the understorey the proportion of deer-preferred species is decreasing overall relative to deer non-preferred species. The Waikare catchment is part of the Southern Whakatane deer pellet survey region in which there was an increase in deer pellet density between 1980 and 1985 (Beadel 1988). The changes in understorey composition probably reflects the increase in deer numbers in the area over the survey period.

Group B (exclosure plots)

Basal area increased in all vegetation types in both exclosure and control plots. In all cases except one the increases were greater in the exclosure plots than in the control plots. This probably reflects the exclusion of deer. Seedling density of deer-preferred and deer non-preferred species increased in all vegetation types. For three of the four vegetation types the density of deer-preferred seedlings and saplings increased more in the exclosure plots than they did in the control plots. Again this probably reflects the exclusion of deer, and their impacts.

7. RECOMMENDATIONS FOR FURTHER MONITORING

- The main objective of this study was to monitor vegetation structure in relation to animal impact. It is important to consider the long term goals for management of vegetation in Te Urewera National Park. The most basic objective should be to maintain existing broad vegetation classes (c.f. Nicholls, 1974). Another basic objective could be to maintain or enhance the current level of biodiversity within the National Park. This is covered in the general objectives contained in the National Park Act 1980 and the current management plan (Anon, 1989). To assess whether existing classes are being maintained, vegetation on 'sensitive' sites should be included in any vegetation monitoring program (e.g. landslide scars, windfall sites) (c.f. Beadel 1988). This would help to determine whether forest cover is re-establishing on disturbed sites.

- All exclosure and control plots are located in secondary or disturbed forest associations. Continued monitoring of these plots will help to establish the long-term effects of browsing animals on forest and regeneration processes in the Urewera.

- Remeasurement of the 63 permanent plots (Group A) after a suitable interval, say 10 years, will provide information on vegetation condition in a range of primary and secondary forest types.

- Scientists at the Forest Research Institute, Christchurch, are carrying out a major research project to investigate browsing animal/vegetation relationships in the central North Island. Results from this study are likely to give direction for future survey, monitoring and management of areas with wild animal populations. These results should be considered before a remeasurement of the Waikare vegetation plots is made.

Remeasurements

- The objectives of any remeasurements and subsequent data analysis should be clearly identified before any remeasurement is undertaken. This is a fundamental and very significant point.

- Wild animal density surveys designed to complement vegetation condition studies should be undertaken at the same time as remeasurement of the vegetation plots (e.g. collecting deer pellet density data in the same vegetation types as the vegetation plots are located in). Existing pellet survey lines should be used where possible. However, to provide enough data more pellet survey lines may need to be established in association with the vegetation plots.

Group A (58 permanent plots)

- These plots should not be remeasured at less than 10 yearly intervals.

Group B (six exclosure plots and six control plots)

- The six exclosures and six control plots should be remeasured using staff with a good level of botanical expertise. Remeasurement in the summer of 1995/1996 would give a 15-year experimental period, which should provide statistically significant results given the location of the plots (in secondary forest). A preliminary field inspection should be made before remeasurements are carried out.

- Remeasurement and subsequent analyses of data should provide confirmation or otherwise of trends indicated in this analysis.

- It is highly preferable that the field work and data analysis of any subsequent measurements be carried out by the same person. This was not the case with this study.

Maintenance

- All permanent plots should be maintained, i.e. relocated and remarked at least every 10 years (i.e. this should be carried out in 1995). If this is not done, plot locations will be lost.

- Exclosure plots should be inspected regularly and maintained to exclude browsing animals. Inspections should be made at least every 2 -3 years.

General

- The maintenance and further measurement of the plots and exclosures should be considered within a larger estate monitoring package including the entire Urewera tract. Vegetation and animal monitoring should be considered together.

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APPENDIX 1
LIST OF PLOTS WITHIN EACH VEGETATION TYPE[1]

Group A

1. Rimu-(matai)-(miro)/tawa/mahoe forest	1, 3, 10, 15, 16, 23, 26, 29, 43
2. (Rimu)/tawa-kamahi-rewarewa-(hinau)/pigeonwood-mahoe forest	17, 22, 28, 31, 37, 38, 41, 46, 7, 50, 53, 54, 56, 58.
3. Tawa/mahoe	6C, 2, 4, 27, 39, 49, 51, 55, 59.
4. Black beech	forest 18.
5. Red beech/tawari-kamahi	6, 7, 8, 32, 33, 34, 48.
6. Kamahi-rewarewa-tawa forest	4C, 21, 30, 42, 57
7. Rewarewa/kanuka/kamahi forest	19, 20, 24, 25, 36.
8. Kanuka/mahoe forest	5, 11, 12, 14, 35, 45, 52.
9. Mahoe forest	2C, 3C[2], 5C, 13, 40

Group B

1. Tawa forest	IX, IC
2. Kamahi forest	4X, 4C
3. Mahoe forest	2X, 2C, 6X, 6C
4. Mahoe-wheki treeland	3X, 3C, 5X, 5C

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1 Plots 9 and 44 were no longer in existence in 1985.
2 This plot is dominated by sedges with only a limited area of mahoe canopy.

BASAL AREA (M2/HA) OF ALL MEASURED TREES AND POLES GREATER THAN 2.5 CM DBH

GROUP A

SPECIES	Year	Vegetation Type 1	2	3	4	5	6	7	8	9	All Plots Combined
POSSUM-PREFERRED											
Alectryon excelsus	1980	0.04	0.01	0.37						0.06	
(titoki)	1985	0.05	0.01	0.38						0.06	
Melicytus ramiflorus	1980	3.97	1.12	30.17			0.03	0.18	4.33	13.25	6.61
(mahoe)	1985	3.91	1.02	32.10			0.03	0.19	4.18	14.57	6.95
Metrosideros robusta	1980		0.69				0.61				0.20
(northern rata)	1985		0.76				0.58				0.21
Myrsine salicina	1980					0.75					0.06
(toro)	1985					0.82					0.05
Nestegis sp.	1980		0.01								0.04
(maire)	1985		0.01								0.04
Schefflera digitata	1980	0.01		0.05							0.01
(pate)	1985	0.01		0.05							0.01
Weinmannia racemosa	1980	0.65	11.22			14.77	51.48	21.74			9.89
(kamahi)	1985	0.64	11.26			13.71	53.23	22.12			9.97
SUBTOTAL	1980	4.67	13.05	30.59		15.52	52.12	21.92	4.33	13.25	16.86
	1985	4.58	13.06	32.53		14.53	53.84	22.31	4.18	14.57	17.23
POSSUM NON-PREFERRED											
Beilschmiedia tawa	1980	38.61	36.31	4.46	1.25	0.92	3.35		0.05		15.66
(tawa)	1985	39.76	35.20	4.76	1.38	0.98	3.44		0.07		15.67
Brachyglottis repanda	1980	0.02	0.02	0.47					0.35	0.41	0.14
(rangiora)	1985	0.01		0.57					0.21	0.38	0.14
Carpodetus serratus	1980	0.02						0.04	1.07	2.19	0.30
(putaputaweta)	1985	0.02						0.04	1.06	2.02	0.28
Coprosma grandifolia	1980	0.02		0.04	0.01		0.17		0.07		0.03
(kanono)	1985			0.04	0.01		0.18		0.08		0.02
Coprosma lucida	1980					0.05		0.07			0.01
(karamu)	1985					0.05		0.01			0.01
Coprosma (rhamnoides?)	1980					0.02				0.02	+0.00
	1985					0.02				0.02	+0.00
Coprosma tenuifolia	1980								0.17		0.02
	1985								0.08		0.01
Dacrydium cupressinum	1980	12.90	7.27								3.66
(rimu)	1985	10.90	7.68								3.44
Dacrycarpus dacrydioides	1980	3.88		6.03							1.48
(kahikatea)	1985	3.88		6.33							1.52
Dracophyllum latifolium	1980					0.14					0.02
	1985					0.14					0.02
Elaeocarpus dentatus	1980		0.73			0.09	2.33				0.36
(hinau)	1985		0.76			1.10	2.28				0.36
Elaeocarpus hookerianus	1980					1.23					0.08
(pokaka)	1985					1.24					0.08
Geniostoma rupestre var.	1980	0.01	0.04	0.04							0.02
ligustrifolium (hangehange)	1985	0.01	0.03	0.04							0.01
Griselinia littoralis	1980		0.01								+0.00
(broadleaf)	1985										
Hedycarya arborea	1980	0.04	0.68	0.08					0.27		0.18
(pigeonwood)	1985	0.05	0.69	0.09					0.29		0.19
Ixerba brexioides	1980		0.22								1.40
(tawari)	1985		0.26			13.13					1.35

Continued ...

BASAL AREA (M2/HA) OF ALL MEASURED TREES AND POLES GREATER THAN 2.5 CM DBH

GROUP A

SPECIES	Year	Vegetation Type 1	2	3	4	5	6	7	8	9	All Plots Combined
Knightia excelsa	1980	0.01	7.27	1.75		0.12	1.76	7.79	0.47		2.42
(rewarewa)	1985	0.01	3.35	1.93		0.12	1.88	8.45	0.55		2.54
Kunzea ericoides var.	1980		1.44				0.67	21.79	21.84		4.21
ericoides (kanuka)	1985		1.59				0.75	21.80	23.99		4.45
Leucopogon fasciculatus	1980				0.36	0.25					0.04
(mingimingi)	1985				0.38	0.20					0.03
Melicope simplex	1980			0.01							+0.00
	1985										
Mida salicifolia	1980		+0.00								+0.00
	1985		+0.00								+0.00
Myrsine australis	1980	0.24	0.23		0.78	0.06	0.17	0.07	0.05		0.14
(mapou)	1985	0.25	0.19		0.70	0.06	0.18	0.07	0.05		0.13
Neomyrtus pedunculatus	1980					0.04					+0.00
	1985					0.05					+0.00
Nothofagus fusca	1980					47.94					6.09
(red beech)	1985					50.74					6.44
Nothofagus menziesii	1980					0.19					0.02
(silver beech)	1985					0.31					0.02
Nothofagus solandri var.	1980				48.25						0.77
solandri (black beech)	1985				50.66						0.80
Nothofagus truncata	1980					2.11					0.28
(hard beech)	1985					2.22					0.28
Olearia rani	1980	0.10	0.57			0.24	0.63	0.29	0.45		0.32
(hekatara)	1985	0.10	0.51			0.27	0.64	0.26	0.48		0.32
Pennantia corymbosa	1980			0.03							+0.00
(kaikomako)	1985			0.05						0.04	0.01
Pittosporum eugenioides	1980							0.10	1.48	0.26	0.19
(tarata)	1985								1.64	0.28	0.20
Pittosporum tenuifolium	1980	0.01	0.26	0.08	0.11			0.02	0.86		0.11
subsp. *tenuifolium* (kohuhu)	1985	0.01		0.09	0.11			0.03	0.21		0.04
Podocarpus hallii	1980	5.74				0.02					0.91
(Hall's totara)	1985	5.71				0.02					0.91
Podocarpus totara	1980	1.21									0.19
(totara)	1985	1.22									0.19
Prumnopitys ferruginea	1980	3.67	0.30			0.78					0.75
(miro)	1985	3.66	0.33			0.78					0.75
Prumnopitys taxifolia	1980	12.24		4.98							2.65
(matai)	1985	12.64		5.40							2.78
Pseudowintera axillaris	1980		0.12			0.02	+0.00				0.03
(horopito)	1985		0.10			0.02	0.01				0.02
Pseudowintera colorata	1980					0.26					0.02
(horopito)	1985					0.35					0.02
Pseudopanax crassifolius	1980		0.01		0.47	0.24			0.23		0.07
(lancewood)	1985		+0.00		0.52	0.25			0.27		0.07
Quintinia serrata	1980					2.24	+0.00				0.19
(tawheowheo)	1985					1.93					0.17
SUBTOTAL	1980	78.71	51.60	30.59	51.22	70.47	9.09	30.18	27.38	2.86	42.75
	1985	78.00	50.76	32.53	53.74	72.80	9.34	30.67	28.98	2.72	43.38
TOTAL	1980	83.38	64.65	48.51	51.22	85.99	61.21	52.10	31.71	16.11	59.61
	1985	82.82	63.82	51.80	53.74	87.33	63.18	52.98	33.16	17.29	60.61

EXCLOSURE AND CONTROL PLOTS

GROUP B

Basal Area (m^2/ha)

SPECIES		Year	Vegetation Type 1	2	3	4	All Plots Combined
POSSUM-PREFERRED							
Melicytus ramiflours subsp. *ramiflorus* (mahoe)	Exclosure	1980	0.99	8.03	0.70	19.52	9.46
		1985	0.99	9.46	0.72	22.47	10.93
	Control	1980		7.16		21.36	9.51
		1985		8.38		24.30	10.86
Schefflera digitata (pate)	Exclosure	1980	2.26				0.38
		1985	2.28			0.01	0.38
	Control	1980	0.07				0.01
		1985	0.08	0.01			0.01
Weinmannia racemosa (kamahi)	Exclosure	1980			20.68		3.45
		1985			22.27		3.71
	Control	1980			34.29		5.72
		1985			35.08		5.85
SUBTOTAL	Exclosure	1980	3.25	8.03	21.38	19.52	13.29
		1985	3.27	9.46	22.99	22.48	15.02
	Control	1980	0.07	7.16	34.29	21.36	15.24
		1985	0.08	8.28	35.08	24.30	16.72
NON-PREFERRED							
Beilschmiedia tawa (tawa)	Exclosure	1980	27.91			0.27	4.74
		1985	29.27			0.37	5.00
	Control	1980	42.76		6.20	0.02	8.17
		1985	44.00		6.29	0.03	8.39
Carpodetus serratus (putaputaweta)	Exclosure	1980		0.37		0.51	0.29
		1985		0.72		0.72	0.48
	Control	1980				1.95	0.65
		1985				1.99	0.66
Dacrycarpus dacrydioides (kahikatea)	Exclosure	1980				+0.00	+0.00
		1985				+0.00	+0.00
	Control	1980					
		1985					
Elaeocarpus dentatus (hinau)	Exclosure	1980					
		1985					
	Control	1980			11.57		1.95
		1985			11.40		1.90
Knightia excelsa (rewarewa)	Exclosure	1980			4.55		0.76
		1985			5.32		0.89
	Control	1980					
		1985					
Kunzea ericoides var. *ericoides*	Exclosure	1980			7.22		1.20
		1985			7.69		1.28
	Control	1980			3.34		0.56
		1985			3.73		0.62
Pennantia corymbosa (kaikomako)	Exclosure	1980					
		1985				0.02	0.01
	Control	1980				0.13	0.04
		1985		0.11		0.21	0.11
Pittosporum tenuifolium subsp. *tenuifolium*	Exclosure	1980			1.55		0.26
		1985			0.99		0.17
	Control	1980					
		1985					
SUBTOTAL	Exclosure	1980	27.91	0.37	13.32	0.78	8.45
		1985	29.27	0.72	14.00	1.11	8.87
	Control	1980	42.76	0.00	21.21	2.10	11.37
		1985	44.00	0.11	21.42	2.23	11.68
TOTAL	Exclosure	1980	31.16	8.40	34.70	20.30	21.74
		1985	32.54	10.17	36.99	23.60	23.89
	Control	1980	42.83	7.16	55.50	23.46	26.60
		1985	44.09	8.39	56.50	26.53	28.40

APPENDIX 3

LIST OF PREFERRED PLANT SPECIES

3.1 Deer Preferred Plant Species

The following list was compiled from the following sources:

Wallis and James (1972); Burrows (1980); Rose and Burrows (1985); Burrows (1980); Jane (1983); Wardle (1974); Holloway (1950); the 1981 reconnaissance descriptions and field observations.

Scientific Name	Common Name
Trees	
Carpodetus serratus	putaputaweta
Fuschia excorticata	fuchsia
Griselinia littoralis	broadleaf
Hedycarya arborea	pigeonwood
Ixerba brexioides	tawari
Melicytus ramiflorus subsp. *ramiflorus*	mahoe
Metrosideros robusta	northern rata
Myrsine australis	rnapou
M. salicina	toro
Pennantia corymbosa	kaikomako
Pseudopanax arboreus	fivefinger
P. crassifolius	lancewood
Schefflera digitata	pate
Weinmannia racemosa	kamahi
Shrubs	
Alseuosmia macrophylla	toropapa
Brachyglottis kirkii var. *kirkii*	kohurangi
Coprosma foetidissima	hupiro
C. grandifolia	kanono
C. lucida	
C. rhamnoides	
C. robusta	karamu
C. tenuifolia	
Geniostoma rupestre var. *ligustrifolium*	hangehange
Griselinia lucida	puka
Macropiper excelsum	kawakawa
Pseudopanax edgerleyi	raukawa
Lianes	
Freycinetia baueriana subsp. *banksii*	kiekie
Ripogonum scandens	supplejack

Ferns

Asplenium bulbiferum s.s	hen and chicken
Blechnum "black spot"	kiokio
B. chambersii	
Dicksonia squarrosa	wheki
Penumatopteris pennigera	
Polystichum richardii	shield fern
P. vestitum	prickly shield fern

Monocot. Herbs

Astelia solandri	perching Lily
Collospermum hastatum	perching Lily

3.2 Possum-Preferred Plant Species

The list below was compiled from the following sources:

Fitzgerald (1976); Mason (1958) and Coleman *et al.* (1980)

<u>Scientific Name</u>	<u>Common Name</u>
Trees	
Alectryon excelsus	titoki
Aristotelia serrata	makomako
Fuchsia excorticata	fuschia
Hoheria populnea var. *lanceolata*	lacebark
Melicytus ramiforus subsp. *ramiflorus*	mahoe
Metrosideros robusta	Northern rata
Myrsine salicina	toro
Nestegis cunninghamii	black maire
N. lanceolata	white maire
Pseudopanax arboreus	fivefinger
Schleffera digitata	pate

Shrubs

Pseudopanax edgerleyi	raukawa

Lianes

Rubus cissoids	bush lawyer
R. schmidelioides	bush lawyer

3.3 Pig-Preferred Species

The following list was compiled from Llewellyn (unpublished data) and is based on the analysis of the contents of 100 pig stomachs from the Upper Tauranga Valley, Urewera National Park. (Leaves or stems of the plants listed below comprised 1% dry weight of the samples for one or more seasons.)

Scientific Name	Common Name
Trees	
Melicytus ramiflorus subsp. *ramiflorus*	mahoe
Ixerba bresioides	tawari
Lianes	
Ripogonum scandens	supplejack
Ferns	
Cyathea smithii	soft tree fern
Pteridium esclentum	bracken
Sedges	
Uncinia species	hooked sedge
Grasses	
Microlaena avenacea	bush rice grass
Monocot. Herbs (other than sedges and grasses)	
Orchids (C. E. Ecroyd pers. comm.)	
Dicot. Herbs	
Cirsium arvense	Californian thistle

4.1 Vascular Plant Taxa Recorded from Seedling Subplots – 1980/81 and 1985/86

	1980/81	1985/86
4.1.1 Indigenous Vascular Plants		
1. Gymnosperm. Trees and Shrubs		
Dacrycarpus dacrydioides	*x*	
Dacrydium cupressinum	*x*	*x*
Podocarpus hallii	*x*	*x*
P. totara		*x*
Prumnopitys ferruginea	*x*	*x*
P. taxifolia	*x*	*x*
	5	*5*
2. Monocot. Trees and Shrubs		
Cordyline australia		*x*
C. banksii		*x*
3. Dicot. Trees		
Alectryon excelsus	*x*	*x*
Aristotelia serrata	*x*	*x*
Beilschmiedia tawa	*x*	*x*
Carpodetus serratus	*x*	*x*
Dracophyllum latifoium (inc *D. mathewsii)*	*x*	*x*
Elaeocarpus dentatus	*x*	*x*
E. hookerianus	*x*	*x*
Fuchsia excorticata	*x*	
Griselinia littoralis	*x*	
Hedycarya arborea	*x*	*x*
Hoheria populnea var. *lanceolata*	*x*	*x*
Ixerba brexiodes	*x*	*x*
Knightia excelsa	*x*	*x*
Kunzea ericoides var. *eroicoides*	*x*	*x*
Laurelia novae-zelandiae	*x*	
Melicytus ramiflorus subsp. *ramiflorus*	*x*	*x*
Metrosideros robusta	*x*	*x*
Myrsine australis	*x*	*x*
Nestegis cunninghamii		*x*
N. lanceolata	*x*	*x*
Nothofagus fusca	*x*	*x*
N. menziesii	*x*	*x*
N. solandri var. *solandri*	*x*	*x*
N. truncata	*x*	*x*
Olearia rani	*x*	*x*
Pennantia corymbosa	*x*	*x*
Pittosporum eugenioides	*x*	*x*
P. tenuifolium subsp. *tenuifolium*	*x*	*x*
Pseudopanax arboreus	*x*	*x*

	1980/81	1985/86
P. simplex (incl. *P. simplex* var. *sinclairii)*	*x*	*x*
Quintinia serrata (incl. *Q. acutifolia* and *Q. elliptica)*	*x*	*x*
Schefflera digitata	*x*	*x*
Weinmannia racemosa	*x*	*x*
	32	32
4. Dicot Shrubs		
Alseuosmia macrophylla		*x*
Brachyglottis repanda	*x*	*x*
Coprosma foetidissima	*x*	*x*
C. grandifolia	*x*	*x*
C. lucida	*x*	*x*
C. rhamnoides	*x*	*x*
C. tenuifolia	*x*	*x*
Coriaria arborea	*x*	
Cyathodes juniperina	*x*	
Gaultheria antipoda	*x*	*x*
Geniostoma rupestre var. *ligustrifolium*	*x*	*x*
Hebe stricta var. *stricta*	*x*	*x*
Helichrysum aggregatum	*x*	
Leucopogon fasciculatus	*x*	
Macropiper excelsum		*x*
Melicope simplex	*x*	
Neomyrtus pedunculata	*x*	*x*
Pseudopanax edgerleyi	*x*	
Pseudowintera axillaris	*x*	*x*
P. colorata	*x*	*x*
Solanum aviculare		*x*
Urtica ferox	*x*	*x*
	20	18
5. Monocot Lianes		
Ripogonum scandens	*x*	*x*
	1	1
6. Dicot. Lianes		
Clematis foetida	*x*	*x*
C. paniculata	*x*	*x*
Metrosideros diffusa	*x*	*x*
M. fulgens		*x*
M. perforata	*x*	*x*
Muehlenbeckia australis	*x*	
Parsonsia capsularis	*x*	
P. heterophylla	*x*	*x*
Rubus cissoides	*x*	*x*
	8	7

	1980/81	1985/86
7. Psilopsids and Lycopods		
Lycopodium varium		*x*
L. volubile	*x*	*x*
Tmesipteris tannesis	*x*	*x*
	2	3

8. Ferns

	1980/81	1985/86
Adiantum cunninghamii	*x*	
Anarthropteris lanceolata	*x*	*x*
Asplenium bulbiferum	*x*	*x*
A. flaccidum subsp. *flaccidum*	*x*	*x*
A. hookerianum	*x*	*x*
A. oblongifolium	*x*	*x*
A. polyodon	*x*	*x*
Blechnum 'black spot' (unnamed common sp. reduced lower pinnae)	*x*	*x*
B. chambersii	*x*	*x*
B. discolor	*x*	*x*
B. filiforme	*x*	*x*
B. fluviatile	*x*	*x*
Botrychium biforme	*x*	*x*
Ctenopteris heterophylla	*x*	*x*
Cyathea dealbata	*x*	*x*
C. smithii	*x*	*x*
Dicksonia fibrosa		
D. lanata	*x*	*x*
D. squarrosa	*x*	*x*
Grammitis billiardierei	*x*	*x*
Histiopteris incisa	*x*	*x*
Hymenophyllum sp.	*x*	*x*
Hypolepis sp. (*H. ambigua* and/or *H. rufobarbata*)	*x*	*x*
Lastreopsis glabella	*x*	*x*
L. hispida	*x*	*x*
L. microsora subsp. *pentagularis*	*x*	
Leptolepia novae-zelandiae	*x*	
Leptopteris hymenophylloides	*x*	
Lindsaea trichomanoides		*x*
Paesia scaberula	*x*	*x*
Pellaea rotundifolia	*x*	
Phymatosorus diversifolius	*x*	*x*
P. scandens	*x*	*x*
Pneumatopteris pennigera	*x*	*x*
Polystichum richardii	*x*	*x*
Pteris sp.	*x*	*x*
Pyrrosia elaeagnifolia	*x*	*x*
	35	32

	1980/81	1985/86
9. Orchids		
Caladenia carnea	x	x
Chiloglottis cornuta	x	x
Corybas trilobus	x	x
Earina autumnalis	x	x
Pterostylis sp.	x	x
Thelymitra sp.		x
	5	6
10. Grasses		
Cortaderia fulvida	x	
Deyeuxia avenoides (incl. *D. avenoides* var. *brachyantha)*	x	
Dichelachne crinita	x	
Elymus sp. (E. rectisetus agg.*)*	x	
Microlaena avenacea	x	x
Rytidosperma sp.	x	x
	6	2
11. Sedges		
Carex flagellifera	x	
C. forsteri	x	x
C. solandri	x	
C. testacea		x
Gahnia pauciflora	x	x
Uncinia ferruginea	x	
U. filiformis	x	
U. scabra	x	x
U. uncinata	x	x
	8	5
12. Rushes		
Juncus sp. *(gregiflorus?)*	x	x
		1
13. Monocot Herbs (other than Orchids, Grasses, Sedges and Rushes)		
Arthropodium candidum	x	
Astelia fragrans	x	x
A. solandri		x
Collospermum hastatum	x	x
Libertia grandiflora	x	x
Luzuriaga parviflora	x	x
	5	5

	1980/81	1985/86
Composite Herbs		
Gnaphalium gymnocephalum		x
G. keriense	x	
G. sphaericum		x
Lagenifera pumila	x	
Pseudognaphalium sp. *(P. luteoalbum* agg.)	x	
	3	3
14. Dicot. Herbs		
Australina pusilla	x	x
Cardamine sp. *(C. debilis agg.)*	x	x
Epilobium nummulariifolium		x
E. pedunculare	x	
E. rotundifolium		x
E. sp.	x	
Galium sp.	x	
Haloragis erecta subsp. *erecta*	x	
Hydrocotyle elongata		x
H. microphylla	x	
H. moschata	x	x
H. sp. *(H. novae-zelandiae agg.)*	x	
Nertera depressa	x	x
N. sp. (unnamed, aff. *N. dichondrifolia)*	x	x
Oxalis sp.	x	x
Pariereria debilis		
Pratia angulata	x	x
Ranunculus reflexus	x	
Stellaria decipiens (incl. *S. minuta* and *S. parvifolia*	x	x
Urtica incisa	x	x
Wahlenbergia sp. *(W. gracilis agg.)*	x	x
	18	14
TOTAL SPECIES	**148**	**136**

4.1.2 Adventive Vascular Plants

	1980/81	1985/86
Anagallis arvensis		*x*
Bromus sp.	*x*	
Carduus sp.	*x*	
Centaurium erythraea	*x*	
Cerastium fontanum	*x*	
Cirsium vulgare	*x*	*x*
Conyza albida		*x*
Digitaria purpurea	*x*	
Festuca arundinacea	*x*	*x*
Galium aparine		*x*
Gnaphalium coarctatum		*x*
(Hieracium pilosa/Hypochaeris radicata?)	*x*	
Holcus lanatus		*x*
(Leontodon taraxacoides/Crepis capillaris?)		*x*
Lotus pedunculatus	*x*	
Juncus tenuis		*x*
Mycelis muralis	*x*	*x*
Phleum pratense	*x*	
Plantago lanceolata	*x*	
Prunella vulgaris	*x*	
Ranunculus repens		*x*
Sagina procumbens		*x*
Senecio jacobaea	*x*	*x*
S. sp.	*x*	
Sonchus asper	*x*	
Taraxacum officinale		*x*
Trifolium repens	*x*	*x*
Veronia arvensis		*x*
	17	16

4.2 Vascular Plants of Waikare Exclosure and Control Plots

Key: * Adventive Species

	Control		Exclosure	
	1980	1985	1980	1985
Gymnosperm Trees				
Dacrycarpus dacrydioides	x		x	x
Dacrydium cupressinum	x	x	x	x
Podocarpus totara				x
Prumnopitys ferruginea		x	x	x
P. taxifolia	x	x		x
	3	3	3	4
Monocot. Trees and Shrubs				
Cordyline sp.				x
Dicot. Trees and Shrubs				
Alseuosmia macrophylla				x
Aristotelia serrata	x	x		x
Beilschmiedia tawa	x	x	x	x
Brachyglottis repanda	x			x
Carpodetus serratus	x	x	x	x
Coprosma grandifolia	x	x	x	x
C. lucida	x	x	x	x
C. rhamnoides	x	x	x	x
C. robusta	x		x	
C. tenuifolia	x			x
Coriaria arborea	x			
Elaeocarpus dentatus				x
Geniostoma rupestre var. *ligustrifolium*	x	x	x	x
Griselinia littoralis				x
Hebe stricta var. *stricta*	x			
Hedycarya arborea	x		x	
Hoheria populnea var. *lanceolata*	x			
Knightia excelsa	x	x	x	x
Kunzea ericoides var. *ericoides*	x		x	x
Leucopogon fasciculatus		x		x
Macropiper excelsum				x
Melicytus ramiflorus subsp. *ramiflorus*	x	x	x	x
Myrsine australis	x	x	x	
Olearia rani	x		x	
Pennantia corymbosa	x	x	x	
Pittosporum tenuifolium subsp. *tenuifolium*	x		x	x
Pseudopanax arboreus	x			x
P. crassifolius	x		x	
Schefflera digitata	x	x	x	x
Solanum aviculare				x
Urtica ferox		x	x	x
Weinmannia racemosa	x	x	x	x
	24	16	18	23

	Control		Exclosure	
	1980	1985	1980	1985
Monocot. Lianes				
Luzuriaga parviflora	*x*			
Ripogonum scandens	*x*	*x*	*x*	*x*
	2	1	1	1
Dicot. Lianes				
Clematis foetida	*x*	*x*	*x*	*x*
C. paniculata	*x*	*x*	*x*	
Metrosideros diffusa	*x*	*x*	*x*	
M. fulgens		*x*		
M. perforata	*x*	*x*		
Muehlenbeckia australis	*x*	*x*	*x*	
M. complexa	*x*		*x*	
Parsonsia heterophylla		*x*	*x*	*x*
Rubus cissoides	*x*	*x*	*x*	
	7	8	7	2
Ferns				
Asplenium bulbiferum subsp. *bulbiferum*	*x*		*x*	*x*
A. flaccidum subsp. *flaccidum*	*x*		*x*	*x*
A. hookerianum	*x*		*x*	
Blechnum 'blackspot'	*x*	*x*		*x*
B. chambersii	*x*	*x*	*x*	
B. discolor	*x*	*x*		*x*
B. fluviatile	*x*	*x*	*x*	*x*
Ctenopteris heterophylla			*x*	*x*
Cyathea dealbata	*x*	*x*	*x*	*x*
C. smithii	*x*	*x*	*x*	
Dicksonia fibrosa	*x*	*x*	*x*	
D. squarrosa	*x*	*x*	*x*	*x*
Grammitis species	*x*			
Histiopteris incisa	*x*	*x*	*x*	*x*
Hymenophyllum species	*x*	*x*	*x*	*x*
Hypolepsis sp. (*ambigua/rugosa*)	*x*	*x*	*x*	*x*
Lastreopsis glabella	*x*	*x*		
L. microsora			*x*	
Leptopteris hymenophylloides	*x*		*x*	*x*
Paesia scaberula	*x*			
Phymatosorus diversifolius	*x*	*x*	*x*	*x*
P. scandens		*x*		
Pneumatopteris pennigera	*x*	*x*	*x*	*x*
Polystichum richardii	*x*	*x*	*x*	*x*
Pyrrosia elaegnifolia	*x*	*x*	*x*	*x*
	23	16	19	16

	Control		Exclosure	
	1980	**1985**	**1980**	**1985**
Orchids				
Chiloglottis cornuta			*x*	*x*
Corybas trilobus	*x*		*x*	
C. sp.		*x*		*x*
Dendrobium cunninghammii				*x*
Earina autumnalis		*x*		
'orchid'				*x*
	1	2	3	3
Grasses				
Bromus sp.*	*x*		*x*	
Cortaderia fulvida	*x*		*x*	*x*
Deyeuxia avenoides	*x*		*x*	
Dichelachne crinita			*x*	
Elymus sp.	*x*			
*Festuca arundinacea**	*x*	*x*	*x*	
*Holcus lanatus**		*x*		*x*
Microlaena avenacea	*x*	*x*	*x*	*x*
*Phleumpratense**	*x*		*x*	
Rytidosperma spp.	*x*	*x*	*x*	*x*
	5(3)	*2(3)*	*5(3)*	*3(1)*
Sedges				
Carex (flagellifera?)	*x*	*x*		
C. (forsteri?)	*x*			
Uncinia ferrugina	*x*		*x*	
U. rupestris	*x*		*x*	
U. uncinata	*x*		*x*	*x*
U. spp.	*x*	*x*		
	6	2	3	1
Rushes				
*Juncus tenuis**		*x*		
Juncus spp.			*x*	
			(1)	1
Monocot Herbs other than Orchids, Grasses, Sedges and Rushes				
Collospermum hastatum	*x*			
		1		

	Control		Exclosure	
	1980	**1985**	**1980**	**1985**
Composite Herbs				
*Cerastium fontanum**	*x*		*x*	
*Cirsium vulgare**	*x*	*x*	*x*	*x*
*Conyza albida**	*x*	*x*		
*Crepis capillaris**		*x*		
Gnaphalium gymnocephalum				*x*
Gnaphalium sphaericum		*x*	*x*	
*G. coarctatum**			*x*	
Lagenifera (pumila?)			*x*	
*Mycelis muralis**	*x*	*x*	*x*	
*Senecio jacobaea**	*x*	*x*	*x*	*x*
*S. species**	*x*			
*Sonchus asper**	*x*			
*Taraxacum officinale**		*x*		
	(7)	1(6)	2(5)	1(2)
Dicot. Herbs other than Composites				
*Anagallis arvensis**		*x*		*x*
*Australina pusilla**	*x*	*x*	*x*	*x*
Cardamine sp. (C. debilis agg.*)*	*x*	*x*	*x*	
*Centaurium erythraea**	*x*			
*Digitalis purpurea**			*x*	*x*
Epilobium nummularifolium		*x*		*x*
E. pedunculare	*x*		*x*	
*Galium aparine**				*x*
G. propinquum	*x*		*x*	
Haloragis erecta subsp. *erecta*			*x*	
Hydrocotyle elongata		*x*		
H. moschata	*x*	*x*	*x*	*x*
H. novae-zelandiae	*x*		*x*	
Linum sp.		*x*		
Nertera depressa	*x*	*x*		*x*
Nertera sp. (c.f. *N. dichondrifolia)*	*x*	*x*	*x*	*x*
Oxalis sp.			*x*	*x*
*Prunella vulgaris**	*x*	*x*	*x*	*x*
Ranunculus reflexus	*x*	*x*	*x*	*x*
*Sagina procumbens**		*x*		
*Stellaria parviflora (*incl. *S. decipiens* and *S. minuta)*	*x*		*x*	
*S. media**	*x*		*x*	
Trifolium repens	*x*	*x*	*x*	
Urtica incisa	*x*	*x*	*x*	*x*
*Veronica arvensis**		*x*		
Unknown herb *('Anisotome* sp'*)*			*x*	
	11(4)	8(7)	11(6)	6(4)
TOTAL	83	78	73	64

4.3 Doubtful or Erroneous Plant Records Not Included in Above List

Record	Probably Identity of Plant of Which Record is Based
Anisotome sp.	*(Oreomyrrhis ramose/Achillea millefolium?)*
Aporostylis bifolia	*Caladenia catenata*
Astelia trinervia	*Astelia fragrans* or *A. solandri*
Botrychium australe	*Botrychium biforme*
Cardamine depressa	*Cardamine deblis* agg.
Carex coriacea	*Carex forsteri*
Clematis australis	*Clematis paniculata*
Cortaderia richardii	*Cortaderia fulvida*
Deyeuxia sp.	*Deyeuxia avenoides* (incl. *D. a.* var. *brachyantha)*
Epilobium linnaeoides	*Epilobium (pedunculare?)*
Gentiana corymbifera	*Centaurium eryrhraea*
Gnaphalium colinum	*Gnaphalium (coarctatum?)*
G. trinerve	*G. keriense*
Gymnelaea montana	*Nestegis cunninghamii/lanceolata)*
Hieracium sp.	*(Hypochaeris radicata?)*
Hypolepis distans	*Hypolepis rufobarbata*
H. millefolium	*H.* sp.
H. rugosula	*H. rufobarbata*
H. tenuifolia	*H. ambigua*
Lagenifera petiolata	*Lagenifera (pumila?)*
Libertia ixioides	*Libertia grandiflora*
Microseris scapigera	*(Leontodon taraxacoides/Crepis capillaris?)*
Muehlenbeckia complexa	*Muehlenbeckia australis*
Nertera dichondrifolia	*Nertera* sp. (unnamed, aff. *N. dichondrifolia)*
Parahebe catarractae	*Veronica arvensis*
Stellaria gracilenta	*Stellaria decipiens* (incl. *S. minuta* and *S. parviflora)*

APPENDIX 5

LOCATION MAP OF WAIMANA ECOLOGICAL DISTRICT.

APPENDIX 6

GLOSSARY OF PLANT NAMES USED IN THE TEXT

black beech	*Nothofagus solandri var. solandri*
broadleaf	*Griselinia littoralis*
bush lawyer	*Rubus cissoids*
bush rice grass	*Microlaena avenacea*
cabbage tree	*Cordyline australis*
crown fern	*Blechnum discolor*
cudweeds	*Gnaphalium* species
filmy ferns	*Hymenophyllum* species
five finger	*Pseudopanax arboreus*
Hall's totara	*Podocarpus hallii*
hangehange	*Geniostoma rupestre* var. *ligustrifolium*
heretara	*Olearia rani*
hen and chicken fern	*Asplenium bulbiferum* subsp. *bulbiferum*
hinau	*Elaeocarpus dentatus*
hooked sedges	*Uncinia* species
horopito	*Pseudowintera colorata*
kaikomako	*Pennantia corymbosa*
kamahi	*Weinmannia racemosa* var. *racemosa*
kanono	*Coprosma grandifolia*
kanuka	*Kunzea ericoides* var. *ericoides*
kiokio	*Blechnum* 'black spot' (unnamed common sp., reduced lower pinnae)
lancewood	*Pseudopanax crassifolium*
mahoe	*Melicytus ramiflorus* subsp. *ramiflorus*
makomako	*Aristotelia serrata*
mamaku	*Cyathea medullaris*
mapou	*Myrsine australis*
matai	*Prumnopitys taxifolia*
mingimingi	*Leucopogon fasciculatus*
miro	*Prumnopitys ferrugineus*
neinei	*Dracophyllum latifolium*
piegonwood	*Hedycarya arborea*
pokaka	*Elaeocarpus hookerianus*
putaputaweta	*Carpodetus serratus*
rangiora	*Brachyglottis repanda*
rata	*Metrosideros robusta*
red beech	*Nothofagus fusca*
rimu	*Dacrydium cupressinum*
silver fern	*Cyathea dealbata*
supplejack	*Ripogonum scandens*
tarata	*Pittosporum eugenoides*
tawa	*Beilschmiedia tawa*
tawari	*Ixerba brexioides*
tawheowheo	*Quintinia serrata* (incl. *Q. acutifolia* and *Q. elliptica)*
titoki	*Alectryon excelsus*
totara	*Podocarpus totara* var. *totara*
tree nettle	*Urtica ferox*
wheki	*Dicksonia squarrosa*

APPENDIX 7

SYMBOLS USED IN VEGETATION TYPE NAMES

=============	more than 50% cover of the underlined species, within that tier or layer of plants
------------------------------------	more than 20% cover
	no underlining : 5 -20% cover
/	emergent over
-	in the same tier
e.g.	rimu/tawa-kamahi: rimu emergent over a tawa dominant canopy with common kamahi