Establishment of Forest Monitoring Plots
in Kirk's Bush, Papakura
with special reference to taraire (*Beilschmiedia tarairi*)

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SUMMARY

Two permanent circular sample plots each of 400 m² area were established in Kirk's Bush, Papakura, on 6 August 2001. Plot 1 samples the more or less pure taraire forest, with a light admixture of tawa and pukatea. This forest type features a dense stand of mature taraire with a canopy height of c. 24 m, with a high stocking of taraire (70% of total basal area), a light understorey 2-3 m tall of kohekohe saplings and hangehange, and a complete absence of taraire seedlings or saplings. Plot 2 samples the mixed broadleaved forest comprising a canopy of karaka, taraire, puriri, rewarewa, and pukatea, with an abundance of karaka seedlings.

The objective of the plots is to provide, through periodic re-assessment, a basis for monitoring changes over time in the forest, particularly regeneration of canopy species, in response to control of animal pests (possums, rats) and reduction in trampling by people.

INTRODUCTION

Kirk's Bush is a 6.9 ha reserve in suburban Papakura. Some 5.5 ha is owned by the Department of Conservation, and 1.4 ha by the Papakura District Council (Benson 1998). It is undoubtedly one of the Auckland region's finest examples of tall lowland broadleaved forest, featuring mature stands of taraire (*Beilschmiedia tarairi*), with associated tawa (*B. tawa*), pukatea (*Laurelia novae-zelandiae*), rewarewa (*Knightia excelsa*), puriri (*Vitex lucens*), mangeao (*Litsea calicaris*), titoki (*Alectryon excelsum*), and karaka (*Corynocarpus laevigatus*) (Millener 1979; Cranwell 1981; Auckland Botanical Society 1982; Cameron & Morton 1993; Cameron, Hayward & Murdoch 1997). In one area there are podocarps – rimu (*Dacrydium cupressinum*), kahikatea (*Dacrycarpus dacrydioides*), and miro (*Prumnopitys taxifolia*). The understorey is very sparse over much of the area, the most prominent plants being saplings of kohekohe (*Dysoxylum spectabile*) and karaka, low trees of hangehange (*Geniostoma rupestre* var. *ligustrifolium*), pigeonwood (*Hedycarya arborea*), *Coprosma areolata*, lacebark (*Hoheria populnea*), and occasional tree ferns (*Cyathea medullaris, C. dealbata, Dicksonia squarrosa*) and nikau (*Rhopalostylis sapida*). The ground is commonly covered in heavy leaf litter of taraire, and devoid of plants other than sparse patches of ferns (*Microsorum scandens, Asplenium oblongifolium, A. lamprophyllum, Blechnum filiforme*), a scattering of broad-leaved hook sedge (*Uncinia uncinata*) and bush panic grass (*Oplismenus hirtellus* subsp. *imbecillis*). Epiphytes and lianes are not prominent, the main ones being supplejack (*Ripogonum scandens*), kiekie (*Freycinetia baueriana* subsp. *banksii*), passion vine (*Passiflora tetrandra*), parsonsia (*Parsonsia heterophylla*), and tank lily (*Collospermum hastatum*).

Weeds such as wandering jew (*Tradescantia fluminensis*), climbing asparagus (*Asparagus scandens*), jasmine (*Jasminum polyanthum*), loquat (*Eriobotrya japonica*), passion fruit (*Passiflora edulis*), Japanese spindle tree (*Euonymus japonicus*), Chinese privet (*Ligustrum sinense*), lilly pilly (*Acmena smithii*), and Taiwan cherry (*Prunus campanulata*) are a persistent problem, but have been kept under control by constant weeding efforts by the Friends of Kirk's Bush. Most of these weeds arrive through dispersal by birds.

Possums, and incidentally rats, have recently been controlled with Warfarin, and people encouraged to keep to the gravelled walking tracks by blocking off exits to old informal tracks. As a result, regeneration of some trees is reported to have increased, and nikau seedlings have appeared in abundance. To provide a basis for monitoring the increase in regeneration of the forest following these management measures, the Papakura District Council agreed to the establishment of permanent sample plots as reference points that could be re-measured and observed periodically.

METHODOLOGY

Sampling placement

Kirk's Bush is mainly of two types of forest – pure or almost pure taraire, and a mixed broadleaved forest. It was therefore decided to separately sample these two forest types by placing a plot in a representative stand of each type.

Plot design and demarcation

Each plot was circular, with a radius of 11.28 m and an area of 400 m² (0.04 ha). The centre of the plot was permanently marked by an aluminium stake. In addition, an inner sub-plot of radius 3.57 m and an area of 40 m² was demarcated, with NE, SW, SW, and NW quadrants, using the same centre as the main plot.

It should be pointed out that the 0.04 ha circular plot design used here is different from the 0.04 ha 20 m x 20 m square plot employing permanently numbered trees generally advocated in New Zealand for native forest studies (Allen 1993; Bellingham *et al.* 2000; Wiser *et al.* 2001). It was chosen for ease of demarcation and assessment, and in the expectation that the single centre stake will be less obtrusive and less likely to be discovered and maliciously removed than would be the case with the four permanent stakes required in 20 m x 20 m plots.

Assessment procedure

In each main plot the diameter at breast height (dbh at

1.4 m) was measured of every tree of diameter >3.0 cm, and recorded by species. The heights of 5 canopy trees were recorded. Trees were not permanently marked or mapped. In each inner sub-plot all plants were counted and recorded by species.

Analysis

From the individual diameters and sample heights in the main plots, the plot basal area, stand density, mean diameter, mean canopy height, and proportion of each canopy species was calculated. Basal area and density were also calculated on a per hectare basis. The density of small trees and saplings was also calculated. The density from inner sub-plot counts were summarised by species.

RESULTS

Plot 1 Taraire Forest

Table 1: canopy trees in main plot (Plot 1)

Species ranked by frequency of canopy trees	Number of trees in plot	Density of canopy trees (no./ha)	Basal area of trees in plot (m^2)	Basal area (m^2/ha)	Percentage of total tree basal area	Mean breast height diameter (cm)	Canopy Height (m)
taraire	24	600	2.121	53.0	70%	33.5	22.8
pukatea	3	75	0.449	11.2	15%	43.7	
tawa	1	25	0.292	7.3	10%	61.0	
rewarewa	1	25	0.160	4.0	5%	45.2	
TOTAL	**29**	**725**	**3.022**	**75.5**		**35.6**	

Table 2: understorey small trees and saplings (dbh in main plot > 3.0 cm, ht 3-4 m*) (Plot 1)

Species ranked by frequency in understorey	Number in plot	Density (no./ha)	Mean breast height diameter (cm)	Percentage of total number
kohekohe	17	425	3.7	44%
karaka	15	375	5.5	38%
hangehange	6	150	6.1	15%
Mamaku tree fern*	1	25	13	3%
TOTAL	**39**	**975**		

*tree fern is taller - around 10 m.

Table 3: count of all plants in inner subplot (Plot 1)

Category	NE Quadrant	NW Quadrant	SW Quadrant	SE Quadrant	Total
taraire tree	1	0	0	0	1
pukatea seedlings	0	2	0	0	2
pukatea germinant seedlings	90/m^2	30/m^2	60/m^2	80/m^2	60/m^2
karaka saplings	0	1	0	0	1
karaka seedlings	0	0	1	1	2
kohekohe saplings	4	7	5	5	21
nikau seedlings	4	0	0	2	6
kiekie colonies	0	1	1	0	2
Microsorum scandens clumps	2	2	2	1	8
Pyrrosia eleagnifolia	0	1	0	0	1
taraire leaf litter cover	90%	30%	60%	80%	65%

Plot 2 Mixed Broadleaved Forest

Table 4: canopy trees in main plot (Plot 2)

Species ranked by frequency of canopy trees	Number of trees in plot	Density of canopy trees {No./ha}	Basal area of trees in plot (m^2)	Basal area (m^2/ha)	Percentage of total tree basal area	Mean breast height diameter (cm)	Canopy Height (m)
karaka	4	100	0.453	11.3	26%	38.0	20.0
rewarewa	4	100	0.338	8.4	19%	32.8	21.5
pukatea	2	50	0.246	6.2	14%	39.6	23.1
puriri	1	25	0.166	4.1	10%	46.0	21.2
taraire	1	25	0.139	3.5	8%	42.0	
tawa	1	25	0.236	5.9	13%	54.8	25.4
mangeao	1	25	0.166	4.1	10%	46.0	
TOTAL	**14**	**350**	**1.744**	**43.6**			

Table 5: understorey small trees and saplings (dbh in main plot > 3.0 cm, ht 3-4 m*) (Plot 2)

Species ranked by frequency in understorey	Number in plot	Density (number/ha)	Mean breast height (cm) diameter	Percentage of total number
hangehange	11	275	7.5	44%
lacebark	4	100	5.0	16%
kohekohe	3	75	3.5	12%
karaka	2	50	3.9	8%
*Cyathea medullaris**	2	50	29.3	8%
mahoe	1	25	3.4	4%
*Cyathea dealbata**	1	25	17.0	4%
puriri	1	25	7.0	4%
TOTAL	**25**	**625**		

*tree ferns are taller – around 10 m.

Table 6: count of all plants in inner subplot (Plot 2)

Category	NE Quadrant	NW Quadrant	SW Quadrant	SE Quadrant	Total
puriri trees	1	0	0	0	1
puriri seedlings	1	0	0	0	1
pigeonwood saplings	1	0	1	1	3
pigeonwood seedlings	4	2	0	0	6
kohekohe saplings	0	4	2	3	9
kohekohe seedlings	0	3	0	1	4
mahoe saplings	1	0	1	1	3
lacebark saplings	1	0	0	0	1
karaka saplings	2	0	1	4	7
karaka seedlings	100	80	100	120	400
hangehange saplings	2	0	0	0	2
mangeao saplings	1	0	0	0	1
mangeao seedlings	1	0	0	0	1
nikau saplings	1	0	0	0	1
titoki seedlings	2	0	0	0	2
pukatea saplings	0	7	3	0	10
pukatea seedlings	1	0	0	0	1
tawa seedlings	0	0	0	1	1
Asplenium oblongifolium clumps	1	0	0	0	1
Microsorum scandens clumps	1	1	0	0	0
leaf litter cover	60%			50%	

Discussion of findings

Several ecologically significant features of Kirk's Bush have been revealed in this study.

- A very high stand density and basal area has been recorded in the pure taraire forest, which is considered to be around 200 years old. The taraire trees are clean boled, but several have multiple stems, and the canopy height is very uniform at around 23 m. The taraire basal area and stand density are much higher than those reported by Myers (1984), but comparable with values recorded in other dense indigenous forests (Ogden 1983).

- There is a remarkable total absence of taraire regeneration, either as seedlings or saplings. Furthermore, only very few taraire seeds (mucilaginous stage) were found on the ground, and these appeared to be malformed and unlikely to germinate. It is likely that rats or possums are eating the seeds. In any event, the lack of disturbance in much of the taraire forest in Kirk's Bush would not be conducive to effective regeneration.
- Very high numbers of new germinant seedlings (mostly cotyledonary stage) of pukatea were observed in Plot 1, growing in the taraire leaf litter, but with only very sparse numbers of established seedlings (serrate-leaved stage).
- There is a scattering of large tawa and pukatea throughout the forest, which tend to emerge somewhat above the taraire canopy. The tawa are impressively large trees with spreading crowns.
- Kohekohe saplings prevail in the understorey, yet no large kohekohe trees were observed in the plots.
- Exceedingly high numbers of karaka seedlings are regenerating in the mixed forest type. This species produces abundant seeds, which germinate well, and the seedlings and saplings are able to thrive in the dense shade.
- The small tree or shrub hangehange is widespread in the understorey.
- There is a continued presence of certain weeds, despite persistent efforts at eradicating them (several plants of *Euonymus japonicus*, *Ligustrum sinense*, *Eriobotrya japonica* were observed during this study).

Shona Myers (1984) has studied the regeneration ecology of taraire in some detail (though not in Kirk's Bush), and it is pertinent to point out her main findings:

- The failure of taraire to regenerate successfully beneath its parent canopy has been widely observed ("regeneration gap").
- Regeneration is affected by introduced animals. Possums destroy taraire fruit.
- Pigeons eat taraire fruit, and aid its dispersal and germination. Kiore also eat the seed and may assist germination.
- On Little Barrier Island and at Trounson Park (Northland), there is plenty of taraire regeneration of seedlings and saplings – and there are no animal pests.
- In taraire forest there are commonly up to 140-200 trees/ha of taraire, with 110-500 saplings and 15000 seedlings/ha.
- Basal areas in mature taraire forest are typically c. 23 m^2/ha (but 53 m^2/ha recorded in Kirk's Bush – see Table 1).
- Taraire is thought to live to c. 400 years of age.
- Taraire may seed prolifically, and many seedlings commonly come up, but most die out (as observed on Tiritiri Matangi Island).
- Taraire flowers in November. Seed falls mainly in May & June, but also July and August. Germination occurs in October, 17 weeks from seedfall. Heavy seedling mortality occurs in late summer, through drought. Mortality is highest in open areas with taraire litter, which dries out in summer. Survival is better where there is an understorey of shrubs to give protection.
- The seeds germinate well in shade or light, but do not germinate in darkness (i.e., deeply buried). Shallow litter is best for germination.
- Taraire litter breaks down only slowly.
- The light intensity is very low under a taraire forest – 3.9% of full light.
- The fruit of taraire has a fleshy mesocarp (digested by pigeons). The endocarp, with seed inside (2 big
- cotyledons) passes unharmed through the gut of pigeons.
- Abundant mucilage is produced from taraire seeds during germination under very moist conditions (Godley 1985).
- Caterpillars of a moth *Cryptaspasma querula* (Ogden 1985) eat the cotyledons (also of tawa).
- Growth and survival of seedlings is not very good in the full opening of a canopy gap, but better on the margins of gaps.

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