5.2 Effect of logging Block A, Erua

Within the 10 m x 10 m plots in Block A at Erua (Map 1) 156 *Pittosporum turneri*, 44 *Melicytus* "flexuose" and 22 *Coprosma wallii* were recorded prior to the logging. As this is a 1 % sample of the area, the total number of *P. turneri* plants was estimated to be 14,000 (with a 95% confidence interval of ± 6,000), the number of *M.* "flexuose" ca. 4,400 and the number of *C. wallii* ca. 2,200.

After the logging, 16 plots were remeasured and within these plots 97 (87%) of the 112 tagged *P. turneri, M.* "flexuose" and *C. wallii* were found. Twenty-three (21%) were under felled pine trees or damaged in some way. It was especially noticeable that the *P. turneri* stems were extremely flexible and withstood being bent to the ground without breaking. The 15 plants (13%) not relocated were probably directly under the felled pines.

A visual estimation of the amount of pine slash covering plots with felled pines varied from 10% of the plot area to 80%; but was about 35% in most plots.

Fifteen plots were remeasured again in November 1993 and within these plots 19 (16.5%) of the 115 tagged *P. turneri* could not be found and were presumed smothered under the dense pine slash, 23 (20%) were found dead and 17 (15%) were damaged. By combining the percentage of plants found dead (20%) with an average of the number of plants which could not be found in 1992 (13%) and 1993 (16.5%) the mortality due mainly to the logging is estimated to be about 35%. A few of the damaged plants were also likely to die.

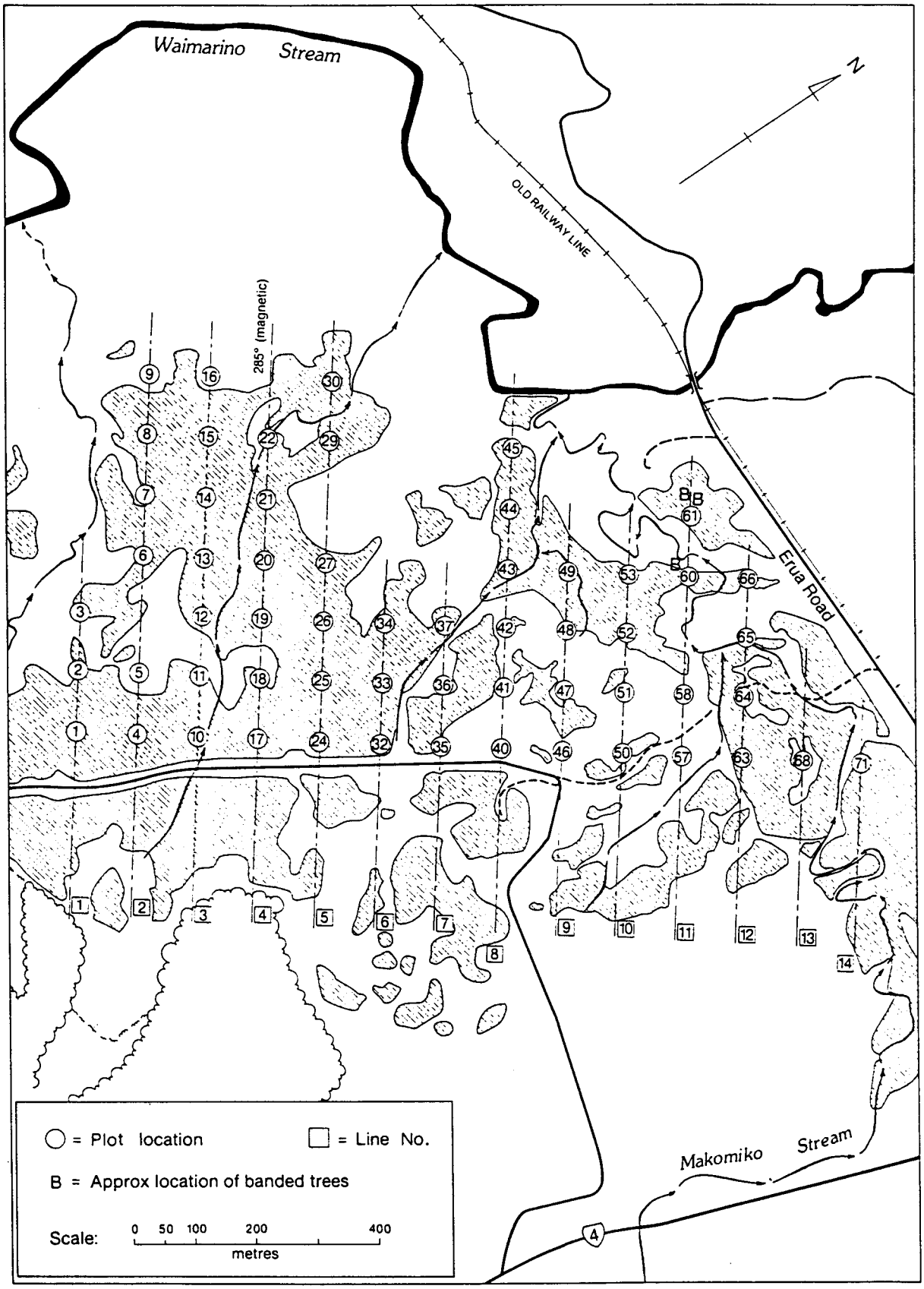
It is estimated that in 1993, a year after the logging, the total number of *P. turneri* in Block A was about 9,100 with 2,600 *Melicytus* "flexuose" and 1430 *Coprosma wallii*. There were very few *Pinus contorta* seedlings present in the logged block - only one was noted during a day's field work.

5.3 Ecology of *Pittosporum turneri*

5.3.1 Erua

The *P. turneri* measured in the plots in Block A before logging had a mean diameter of 1.6 cm, mean height of 1.9 m, minimum height of 40 cm, and maximum height of 4.1 m (see Table 1 and Appendix 4). Twenty-one (12%) of the plants found were dead, a likely underestimate since only dead plants which could be identified were counted. Fifty-four percent of the live plants were unhealthy or suppressed and only one plant had semi-adult foliage.

The largest plants found in the block were near Erua Road and along the Makomiko Stream. One of the plants near Erua Road had fully adult foliage on a partly broken, possum-damaged leader. On 26th November 1992 two very large buds were noted on this branch and on 9th December 1992 there were 11 male flowers in two umbels. A few weeks later the flowers had finished and only the bare pedicel (flower stalk) remained. New foliage was noted at Erua on 9th December 1992.



Map 1. Location of plots in Block A at Erua

On 4 November 1993 five flower buds were noted on the same branch. The first flower was just starting to open on 25 November and on 15 December 1993 there were six umbels in full flower. One of the other nearly mature *P. turneri* nearby had its main leader damaged and the top 0.5 m or more of its crown killed by a stem borer; probably the native lemon tree borer *(Oemona hirta).*

The Erua Sanctuary was carefully searched for *P. turneri* and 81 plants were found and measured (Table 1). One dead plant was found, 8 % were unhealthy, and 8 % were semi-adult. Only one had adult foliage, but this plant and most of the semi-adults had heavily browsed or dead crowns. The total population in the Sanctuary was estimated to be about 100 plants.

Mature and juvenile *M.* "flexuose" plants were found, especially under the silver pine *(Lagarostrobus colensoi)*/matai *(Prumnopitys taxifolia)*/mountain toatoa *(Phyllocladus alpinus)* forest near the western end of the sanctuary, but no *Ranunculus ternatifolius* was found.

Another 80 *P. turneri* up to 4.5 m tall were found along the west bank of the Waimarino Stream below the confluence with the Makomiko Stream and it is estimated that about 200 exist on this side of the stream. *Melicytus* "flexuose" and *Coprosma wallii* trees, some up to 43 cm dbh, were also found scattered along the banks of these streams. Five *P. turneri* plants were found north of the Erua Road bridge in a narrow strip of shrubland extending nearly 1 km along the east bank of the Waimarino Stream and there are likely to be a few more further upstream.

The total population of *P. turneri* at Erua in 1993 is estimated to be 9,400 (Table 2). The known distribution at Erua is mapped (Appendix 1) except for three plants found in 1981 bordering a swamp on the eastern bank of the Waimarino Stream, just to the south of the mapped area.

The soil pH close to *P. turneri* ranged from 4.0 to 5.7 with a mean of 4.8.

5.3.2 Kapoors Road, Tongariro Forest

A total of 270 plants have been found at this site and the entire population is estimated to be around 600-1000 plants (Table 2). The known distribution of plants is mapped (Appendix 3). Data were collected on 107 *P. turneri* plants during visits on 24 November 1992, 25 November 1993 and 20 April 1994 (Table 1). Nine dead plants were found, 19 (18%) were unhealthy, 6 (6%) were adult and 10 (9%) semi-adult. Many of the mature plants were heavily browsed. A tree protected from possums with an aluminium band on 24 November 1992 showed a slight increase in foliage by 25 November 1993.

No capsules were seen but two plants with diameters of only 4.0 and 6.3 cm, each had one umbel of flowers. They were suppressed trees growing under a canopy of mountain toatoa, which was aged at about 43 years. The soil pH near one *P. turneri* was 4.8.

TABLE 1: Summary of diameter and height data for *P. turneri*

Area	No. Measured	DIAMETER (cm)			HEIGHT (m)		
		Mean	Max.	Min.	Mean	Max.	Min.
Erua Block A	156	1.6	4.2	0.3	1.9	4.1	0.4
Sanctuary	81	2.6	7.5	0.6	2.6	5.2	0.9
Kapoors Road	101	2.3	6.8	0.5	3.0	5.5	0.5
Otamangakau	47	4.7	11.5	0.7	3.5	5.3	0.1
Kuratau	458	1.2	22.0	0.1	3.1	8.8	0.1
Whenuakura	101	5.9	13.0	1.2	3.4	5.6	1.2
Pureora	46	3.3	11.0	0.4	3.6	5.8	0.6
Ruahine	30	7.3	14.0	1.5	4.2	7.0	1.5
Ripia	102	3.4	11.7	0.4	2.8	5.6	0.6

5.3.3 Lake Otamangakau

On 23 November 1992 shrubland near Lake Otamangakau was searched for *P. turneri*. Forty-seven plants were found, tagged and measured (Table 1) and the total population is estimated at 60 plants (Table 2). Six percent were unhealthy and at least three plants were semi-adult or adult. The largest plant had a 10 cm high seedling beneath it but no capsules could be seen and the heavily browsed crown appeared to consist of only juvenile foliage. This seedling was still present on 25 November 1993 but no sign of it could be found on 22 February 1994. Two plants were protected with aluminium bands on 25 November 1993.

In 1992 at least 36% of the plants were browsed to some degree and there were possum pellets on the ground under the larger plants. The soil pH near one *P. turneri* was 5.0.

5.3.4 Kuratau

Several visits were made to this site near the Upper Kuratau Bridge where the total population of *P. turneri* was estimated to be from 600 to 1000 plants, including small seedlings (Table 2). Data were collected on 458 *P. turneri* (Table 1). Over the whole area thirty adult trees were measured. The distribution of *P. turneri* at this site is shown in Appendix 2.

In 1992 about 6% of plants over 0.5 m tall were unhealthy and four dead plants were found. A particularly notable find was a well formed tree 8.75 m tall with a 22 cm diameter trunk. However, it was unhealthy with many dead branches and only sparse foliage. A metal band was placed around the trunk to protect it from possums. This tree was found north of the highway and on the west bank of the Kuratau River on the edge of the narrow band of mountain toatoa forest between the river and the swamp. Other adult plants in this area showed heavy browsing or had dead tops. South of the highway, plants were generally not as severely browsed and beneath 10 adult female trees 303 seedlings were counted.

After the new flush of foliage in December 1993 the two *P. turneri* trees close to the road were showing considerably more foliage in their crowns than when photographed in 1992 (Fig. 2). There was no evidence of possums under any of these trees when they were inspected in February 1994.

In mid-May 1992, ten yellow-green immature capsules were found on a tree; one was opened and found to contain six seeds surrounded by a sticky white mucilage. By mid-

August the seed capsules were brown and fully matured with about 70% of the seed already dispersed. By November all the seed had gone.

Soil pH values of 4.7 and 4.6 were recorded close to *P. turneri.*

5.3.5 Whenuakura

Data were collected on 101 *P. tumeri* plants at the Whenuakura Clearing on 8 December 1992 (Table 1). Only a small part of this area was sampled and the total number of plants was estimated to be around 1000 (Table 2). Two dead plants were found, 26% were unhealthy, 12% were semi-adult and 26% were adults. Twenty-six percent of the plants had dead tops and browsing was noted on 21%, particularly on the adult plants. Some of the largest plants had little, if any, mature foliage. Of the plants measured in 1992, eight were flowering, but most had fewer than three umbels. Open capsules from previous seasons were present on three trees.

An aerial application of 1080 poison to control possums was made in this area in August 1993 and when visited in early December there was no recent evidence of possums. During this visit mature plants were targeted and 64 *P. tumeri* plants were found in flower. Of these flowering plants 31 were females and 33 were "inconstant males". These mature plants were generally found to be in better condition than those seen in 1992. At least 80 cotyledonary seedlings were present beneath two mature plants which still held abundant open capsules from the previous season's flowering. These seedlings were attempting to establish in leaf litter and moss up to 15 cm deep.

A soil pH of 4.0 was recorded close to one plant.

5.3.6 Pureora

Fifty-three plants were found and 47 measured at this site, the present northern limit for the species (Table 1). The total population in the area is thought to be about 60 plants (Table 2). Five plants (11%) were unhealthy, 14 (30%) were adult and 2 (4%) were semi-adult.

Flowering of *P. turneri* had started by 7 November in 1990. Only three plants were found flowering in 1992 and they were all "males". The first flowers were open on 18 November 1992 and each flower only lasted about five days. Flowers were often at slightly different stages within an umbel but within three weeks of the first male flower opening the whole umbel had finished flowering and dropped off. A few flowers were observed at Pureora on the 8 December 1992 and new foliage was noted.

In 1993 at least seven trees flowered, starting by 11 November and finishing soon after 10 December, but only one was female. The largest tree at this site, a female, flowered in 1989 but was heavily browsed by possums when seen in November 1992. It has now partially recovered but it has not flowered again.

Soil pH values of 5.1 and 5.3 were recorded near *P. tumeri.*

5.3.7 Ripia

The Ripia Valley has been visited in 1988, 1989, 1990, and 1993 and the population of *P. turneri* in the area is now estimated to be 200-300 plants (Table 2), spread over five

gullies. Plants could also occur in other gullies which have not been searched in the area. On 1 December 1993 104 *P. turneri* plants were measured (Table 1). The larger *P. turneri* plants were generally unhealthy and none were found flowering in 1993 although three had been observed flowering on 29 November 1989. The two mature hybrids of *P. divaricatum* and *P. turneri,* first seen in 1988 (Shaw 1989), were found and despite severe browsing damage both had a few flowers. The larger plant was very unhealthy and the smaller one nearly dead. Flowers were also present on *P. divaricatum* plants in a neighbouring gully.

Soil pH values of 4.5 and 4.0 were recorded.

5.3.8 North-West Ruahine Range

Pittosporum turneri is scattered over several sites in this area and the total population is estimated to be 300 plants (G. Rogers pers. comm.). Data on 30 *P. turneri* plants from four sites in this area are summarised in Table 1. Seventeen of these plants were noted to be heavily browsed by possums or possums and deer and all were browsed to some extent (G. Walls pers. comm.). The plants ranged from 1.5 m to 7 m tall and 1.5 cm to 14 cm in diameter.

5.3.9 Taumarunui

One *P. turneri* plant was seen by P. de Lange on 27 January 1992 from State Highway Four between Taumarunui and Mangatupoto "on ignimbrite in a small frost flat adjacent" to the highway and near Koromiko Road (Map S18 G.R.064727), and a voucher specimen was collected (NZFRI 20183). It was described as a "3 m tall juvenile easily seen from road". The location is at an altitude of 200 m. Three visits have been made to this area and no *P. turneri* plants have been found. Several small patches of scrub have recently been cleared and burnt in this area.

5.3.10 Hautapu

Nineteen *P. turneri* were found growing in the headwaters of the Hautapu River in 1993 (W. Shaw pers. comm.). These plants were up to 3 m tall and growing with monoao *(Dracophyllum subulatum),* bog pine *(Halocarpus bidwillii),* mountain toatoa, *Coprosma propinqua, Aristotelia fruticosa* and *Myrsine divaricata.*

5.3.11 General results from the *P. turneri* sites

There are estimated to be about 12,690 *P. turneri* plants at nine locations (Table 2). However only about 100 flowering or fruiting *P. turneri* plants have been recorded over the last three years. The average diameter of 97 of these flowering plants' was 7.6 cm with the smallest only 3.8 cm in diameter (Appendix 7).

The lengths of 55 mature *P. turneri* leaves close to flowers were measured, and ranged from 10 to 37 mm, averaging 23 mm.

TABLE 2: Current records of *Pittosporum turneri* with land tenure and 1993 population estimates

Location	Land Tenure	No. of Individuals
1. Southern Mangaohane Plateau NW Ruahine Range	DoC and Maori	300
2. Erua, west of Hauhangatahi	DoC	9,400
3. Kapoors Road, Tongariro Forest	DoC	800
4. Lake Otamangakau, Rotoaira Basin	Maori (managed by NZ Forest Managers)	50
5. Kuratau River, Southern Hauhangaroa Range	DoC	800
6. Whenuakura Clearing, Hauhangaroa Range	DoC	1,000
7. Ripia Stream, Northern Ahimanawa Range	Maori/Lochinvar Station	250
8. Hautapu Stream Headwaters, South-West Whirinaki Forest Park	DoC	20
9. Waimiha No. 2 Bridge, Pureora	Carter Holt Harvey Ltd	60
		12,680

Fig. 3: A moth (*Graphania* sp.) on a *P. turneri* flower

At Whenuakura four inflorescences monitored with the time-lapse video system were visited by moths on more than 30 occasions in just one evening. Several different species of moths, including two *Declona* spp. and one *Graphania* sp., were involved (Fig. 3).

At Kuratau, seedlings grew in the cleared area under a female tree which had flowered and produced seed during the previous season. However, no seedlings were found under the two female trees at Pureora and Lake Otamangakau which had flowered two years before and no *P. turneri* seedlings grew from the soil and duff collected from under one of these trees.

An average diameter growth rate curve for *P. turneri* has been calculated from the diameter and growth rings of sampled dead trees (Appendix 5).

The average soil pH near *P. turneri* for six sites was 4.7.

6. DISCUSSION

6.1 Effect of possum browsing

There is considerable evidence that possums are having a major impact on *P. turneri* (Fig. 2) and are also killing some *Melicytus* "flexuose" plants (Fig. 1). Where *P. turneri* is flowering abundantly, (Whenuakura, Pureora and Kuratau) possum numbers have been reduced to low levels using aerial applications of 1080 poison (in conjunction with poison bait stations at Pureora). At the other major locations for this species (Erua, Kapoors Road, Otamangakau, Ripia and Ruahines) there is currently no effective reproduction of *P. turneri*. In 1993 only a few "male" flowers were observed at two of these five sites. There is now sufficient evidence to suggest that there are mature plants at all of these eight locations but no seed production is occurring at five of these because possums are severely browsing the plants.

The population of *P. turneri* in the Ruahines is the one most seriously affected by possums (and deer), if the sample of 30 trees is an accurate reflection of the whole population. From the diameter class distribution it appears to be an ageing population with no regeneration for the last 10-20 years.

The adult foliage is larger and, judging from the patterns of browsing damage, it is favoured over the smaller juvenile foliage. The larger leaves would certainly present a far better food source for possums than the small juvenile leaves on tightly interlaced branches.

Many dead and severely browsed plants have been observed at Erua, Ripia Valley and Kapoors Road. Some of these plants were probably killed by possum browsing. Plants with diameters of 11 cm or more which should have had crowns of adult foliage have been found with dead tops and only juvenile foliage. The disappearance of a well established seedling at Lake Otamangakau was probably due to browsing by possums, deer, rabbits or hares. Seedlings in the Ripia Valley have also been severely browsed but probably by sheep or cattle.

A band of aluminium around the trunk of the more mature *P. turneri* is effective protection from possums providing it is held in place in a way which prevents possums climbing over it. Banding is a relatively inexpensive method to give long-term protection to a limited number of trees. It is not a suitable method for protecting small *P. turneri* or *Melicytus* "flexuose" plants. Bands can however, provide an ideal micro-habitat for stem boring insects and serious stem damage to banded willows has been reported (D. Moore pers comm.). The bands placed around a few of the *P. turneri* trees should be checked annually to ensure that the trees are not being damaged.

Reducing the numbers of possums in an area has the advantage of reducing their impact on a wide range of native plant and animal species. Possum control using aerial applications of 1080 poison at Kuratau, Whenuakura and Pureora appears to have been effective at reducing the browsing damage to *P. turneri* to a level where healthy, mature plants are flowering and setting seed.

Aerial poisoning has advantages over ground control for large and inaccessible areas. Ground control methods utilise more local labour than aerial poisoning and can be just as effective (Warburton and Morgan 1988). However, it is too early to tell whether the ground control of possums in Block A at Erua has been effective in preventing browse damage to the *P. turneri* since possums are most likely to browse *P. turneri* in winter, when other food is scarce. Further monitoring is planned in spring, before the next flush of new foliage.

Research has shown that possums are very mobile with immature males dispersing 2-10 km (Clout and Efford 1984) and ideally, to protect an area effectively, possums in the surrounding area must also be reduced in number. Alternatively the control needs to be ongoing rather than short-term. The 107 possums killed at Erua in October and November 1993 could be replaced by others from the surrounding area in less than three years with the rate of colonisation proportional to the density in the surrounding areas (Green and Coleman 1984). Possum populations are known to increase at a rate of up to 40% per year (Warburton and Morgan 1988). With only 11.3 possums caught per 100 trap nights at Erua the possum numbers must be low but they are still causing serious damage to *P. turneri* and *M.* "flexuose". Judging from the species present (Appendix 4) there are very few palatable species in the forest understorey and even with low numbers of possums present, species not normally eaten may be browsed. With low numbers of possums, poison bait stations, perhaps using 1080, could be an effective means of possum control.

6.2 Effect of Logging Block A, Erua

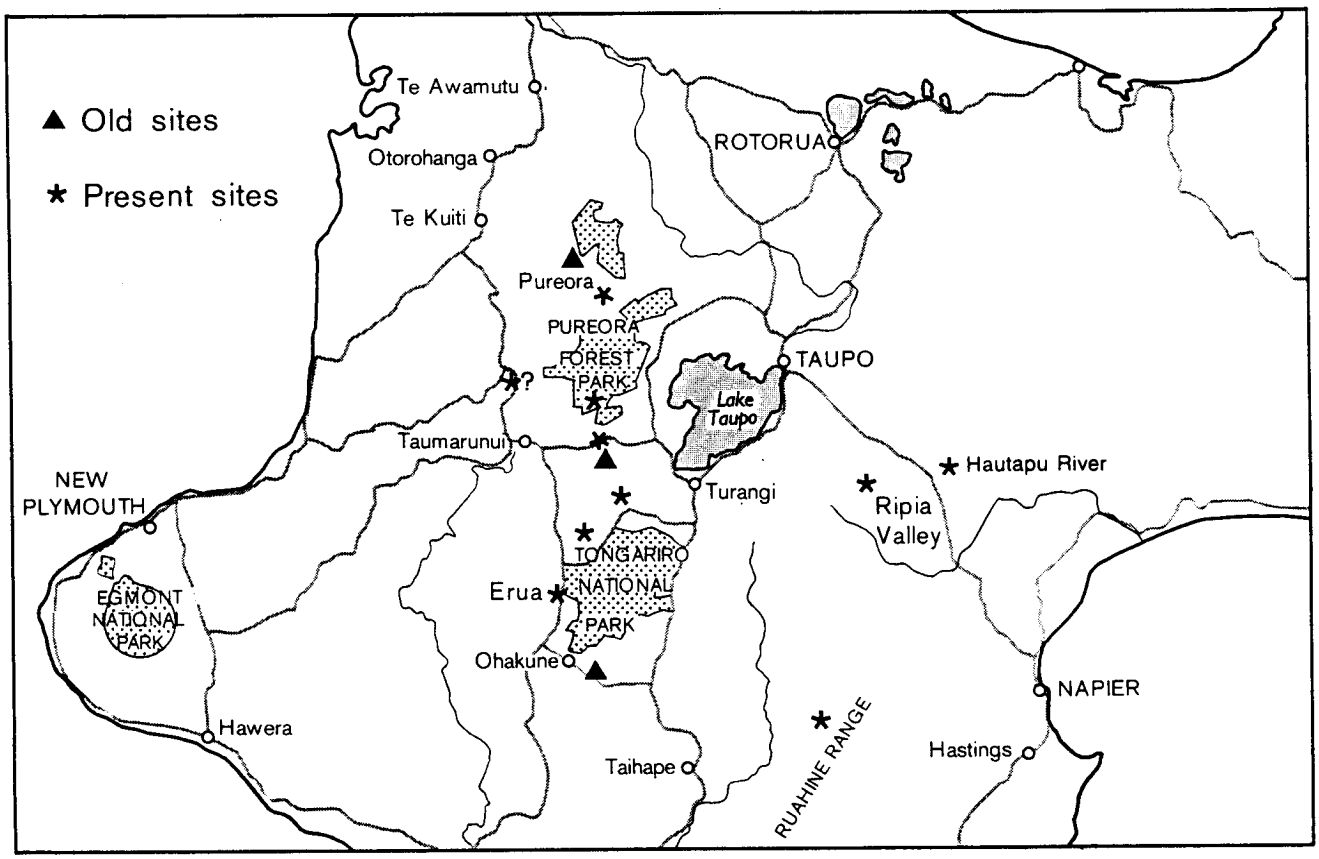
About 35% of the *P. turneri* and other native plants in Block A are estimated to have been destroyed by the logging of *Pinus contorta.* This figure is higher than estimated a year ago due to the number of damaged plants which survived initially but have died within a year of the logging. The final toll could be even higher with other damaged plants unlikely to survive much longer. The percentage of plants killed by the logging is closely correlated to the amount of slash covering the ground, also estimated to be 35%. Any further logging in this block should be avoided since the populations of *P. turneri, Melicytus* "flexuose" and *Coprosma wallii* have already been substantially reduced. There will be no increase in numbers of *P. turneri* until the present population reaches reproductive maturity and possum browsing is considerably reduced.

The debris of felled *Pinus contorta* in Block A at Erua makes access through the area difficult and provides abundant nest sites for possums.

6.3 Ecology of *Pittosporum turneri*

6.3.1 Distribution and abundance

Pittosporum turneri is currently known from nine sites from the north-west Ruahine Range to Pureora (Table 2, Map 2). It has been reported at four other sites; Taumarunui in 1992, Otaratiri Stream in 1976 (J. Bartlett), Rangataua in 1947 (NZFRI 9068) and the Waipa Valley, Rangitoto Range in 1957 (R.O. Green). These areas have all been visited recently in an unsuccessful effort to relocate the *P. turneri* but the visits were brief and hampered by a lack of precise or accurate information on their location. R.O. Green also reported it at Otorohanga but like several of his other records for rare species which seem to be in unlikely places for natural populations, he may have been referring to cultivated plants.



Map 2: Distribution of Pittosporum turneri in New Zealand

There are other records of *P. turneri* which have not been resolved for example the location "edge of podocarp (forest) in Tongariro National Park" for a herbarium specimen (AK 128896) may refer to Erua and "Wanganui River Headwaters, N.W. base of Tongariro" may be Lake Otamangakau or somewhere nearby. Does "Mangapehi", a 1930 record (AK 1997), mean Pureora or was *P. turneri* once much more widespread in this area? The Maraeroa Road population at Pureora (NZFRI 19779) was destroyed and the species was thought to be extinct in this area until plants were found near the Waimiha Bridge in 1990. It is likely that other populations have suffered a similar fate to that at Maraeroa Road as land has been developed for farming and forestry.

The total population, after allowing for the logging damage at Erua, is estimated at about 12,680 plants. However, 74% of these are at Erua and a survey in 1992 indicated that over 50% of the Erua plants were unhealthy.

6.3.2 Habitat

Pittosporum turneri grows in shrubland on forest margins, along stream banks and on the edge of bogs. Sites typically have poor air drainage and extremes of temperature are experienced. Altitude varies from 200 m near Taumarunui and 540 m at Pureora to 1300 m in the Ruahines.

It generally grows on well drained acid soils with a pH of about 4.7, but a few plants have been found growing in very swampy conditions at Erua. The substrate is rhyolitic pumice except for the Ruahine Range where it is andesitic ash (Rogers, 1988). *Pittosporum turneri* is a deeply rooting species with a strong main tap root and very few fine side roots. This makes the species less amenable to any cultivation involving root disturbance.

Pittosporum turneri usually grows as an emergent among shrubs up to 3m high, or occasionally under taller mountain toatoa. Other common associates are *Aristotelia fruticosa, Coprosma propinqua, Olearia virgata,* monoao *(Dracophyllum subulatum),* bog pine *(Halocarpus bidwillii),* weeping matipo *(Myrsine divaricata),* and *Pseudopanax anomalus.*

Many sites have been colonised by *P. turneri* after fire, flooding or other disturbance, resulting in relatively even-aged populations.

6.3.3 Life span and population structure

Assuming growth rings are formed annually, the maximum age of the dead *P. turneri* collected was 43 years for a 9.7 cm diameter sample from Kuratau (Appendix 5). This 9.7 cm diameter tree has grown faster than the average and if the growth rate of the 22 cm diameter tree at Kuratau was the same it would be 97 years old. However this tree, being larger and on a better site, has probably grown at an even faster rate and an age of 70 to 80 years is more likely. This tree equates with the largest recorded and 80 to 90 years is estimated to be the likely maximum life span of this species.

Samples of *P. turneri* collected in Block A were all aged at between 14 and 24 years. There is a good correlation between diameter and age (Appendix 5) and the diameter class data for this area also show that Block A has a relatively even-aged population (Appendix 6, no. 1).

Block A was planted in pines between 1931 and 1935 (N.Z. Forest Service 1981) and by 1968 the pines would have been mature. The fungal disease *Dothistroma* which severely defoliates *Pinus ponderosa* would have contributed to the opening of the canopy by 1976 allowing *Pittosporum turneri* and other shrubs to colonise the area. The seed source for *P. turneri* would have been adult plants within the Sanctuary and along the stream banks within Block A near the centres of high density (Appendix 1). The seed source must have been very large and seed dispersal very effective.

Diameter data for the Sanctuary show a similar structure (Appendix 6, no. 2) except that there are more older plants with larger diameters. The Pureora population peaks at a slightly larger size class and even larger plants are present (Appendix 6, no. 7).

The bank of the Kuratau River, near where the logging village of Moerangi used to be until the 1950's, is the only *P. turneri* site with abundant recent regeneration and a good representation of larger size classes (Appendix 6, no. 5). The Kapoors Road site has a good population of smaller diameter plants down to 0.5 cm diameter (Appendix 6, no. 3). Although the lack of very small plants (< 0.5 cm diameter) is common to most sites it is particularly obvious here.

The graph of diameter against frequency for Whenuakura shows several peaks, probably representing several waves of regeneration, but there are no very young established plants despite the presence of numerous adults (Appendix 6, no. 6). Cotyledonary seedlings were found under two trees in 1993 but have not been included in the graphs because they were likely to be ephemeral. There is a wide range of size classes at Otamangakau but there are too few plants to interpret the peaks (Appendix 6, no. 4).

6.3.4 Phenology

The observed flowering time from 7 November to 15 December is in close agreement with published information (Petrie 1924) and herbarium records. Flowering is earlier at the more northern Pureora site with the plants further south at Erua for example, being the last to flower. There is also usually a few days variation in the flowering time from year to year.

The buds forming the new flush of foliage usually start opening just after flowering begins. The fruit matures in June or July and the seed is dispersed, probably by birds, from early August until November.

6.3.5 Reproductive biology

Pittosporum turneri starts flowering at about age 24 years judging from the size (4.1 cm diameter) and probable age of the plant flowering at Erua, and from the information on diameters of flowering plants (Appendix 7) and growth rates (Appendix 5j. The plant with the smallest diameter seen flowering was a suppressed tree competing under a canopy of mountain toatoa. It was 4.6 m tall, but only 3.8 cm in diameter.

Pittosporum turneri plants generally only flower when they are in good condition and the flowers are always associated with adult foliage. Severe possum browsing seems to selectively remove the adult foliage and prevent flowering. However, the two *P. divaricatum* x *P. turneri* plants in the Ripia Valley were still flowering although severely browsed and nearly dead.

Pittosporum turneri is dioecious like many other *Pittosporum* species (see Ecroyd 1988, and Rogers 1988). From the ratio of 33 "male" to 31 female plants found at Whenuakura it can be assumed that there is normally a 50:50 ratio between the two sexes. Some "male" plants occasionally produce a few seed capsules, but never the abundant seed crop found on healthy adult female trees, hence the term "inconstant male" more correctly describes these individuals. In "male" flowers the ovary is reduced in size and the stigma normally aborts. Each "male" flower only lasts about five days and an umbel lasts no more than three weeks.

No seedlings were found under the 22 cm diameter tree which is probably a male. Amongst the mature *P. turneri* at Kuratau, 10 adult trees had numerous seedlings beneath them, and it could reliably be assumed that these are female. The female flowers have smaller non-functional stamens, and larger corollas and ovaries.

Flowering varies to some extent from year to year with 1992 being a relatively poor flowering season. Only three "male" trees flowered at Pureora in 1992 while six "male" and one female flowered in 1993.

The fragrant flowers are moth-pollinated and judging from the time-lapse video tape of plants flowering at Pureora and Whenuakura there is no shortage of moths to carry out the pollination.

The fruit matures in late winter or early spring when food for birds is scarce. In common with many *Pittosporums* the seed is surrounded by a sweet viscid mucilage which is probably a good food source for birds. *Pittosporum tenuifolium* has a bright orange mucilage to attract birds. However in *P. turneri* there is no such attractant as the mucilage is clear when the fruit is mature.

Bird dispersal has never been observed but seems the most likely explanation for the wide distribution of *P. turneri* under pines at Erua. Large quantities of seed were probably dispersed from the Sanctuary in the 1960's and 1970's. Not all the seed is widely dispersed, however, and much drops to the ground directly beneath the parent tree.

6.3.6 Seed germination and seedling establishment

Seed germination takes place in spring (October and November). Initially two or three long narrow, entire cotyledonary leaves are visible but within a month another five or so smaller, serrated leaves have formed. Establishment is likely to be inhibited by deep moss or litter, dense shade or strong competition from other plants. *Pittosporum turneri* seedlings probably establish more readily where soil disturbance has reduced these inhibiting factors. Occasional flooding of the Waimarino Stream may be important for the establishment of *P. turneri* at Erua.

The lack of new seedlings under trees which had flowered two seasons before suggests that the seed does not remain viable under natural conditions for more than one year but further testing is necessary to confirm this.

6.3.7 Insect pests

The beetle *Hybolasius sticticus* which breeds under the bark and eats the wood to pupate has been found in dying tops and branches of *P. turneri*. *Oemona hirta*, the lemon tree

borer, has also been recorded in *P. turneri* and is responsible for killing the occasional branch or leader. However, the damage is distinctive and restricted to the affected branch. The scale insect *Coelostomidia montana* has been recorded on the lower trunk to just below ground level on healthy and recently dead trees at Erua.

7. CONCLUSIONS

Logging of *Pinus contorta* in Block A at Erua has destroyed an estimated 35% of the *Pittosporum turneri*, and probably a similar proportion of the *Melicytus* "flexuose" and *Coprosma wallii*. The fallen trees will also provide abundant nest sites for possums which are severely browsing the *P. turneri* and debarking some of the *M.* "flexuose" As the numbers of these plants have already been substantially reduced it is recommended that the remaining *Pinus ponderosa* in this block is not felled.

Possums are having a major impact on *Pittosporum turneri*. There are adult plants at most sites but often they have no adult foliage and fail to flower due to possum browsing. Because of the possum damage to the *M.* "flexuose" and the younger *P. turneri* plants in Block A reducing possum numbers with ground or aerial possum control is recommended. The larger *P. turneri* in the more accessible areas should be protected with aluminium bands and they will need to be monitored for insect and physical damage.

Further research is needed on seedling establishment to test whether disturbance is essential for the successful regeneration of *P. turneri* and whether there is any way this could be managed or assisted. There are very few *P. turneri* plants in cultivation and more should be cultivated to act as a contingency against the failure of natural regeneration.

There are only two *P. turneri* populations (Kuratau and Whenuakura) currently producing seed and likely to maintain their population sizes in the immediate future. Considering the size of these populations, the total numbers of *P. turneri* actually flowering, and their poor health at most sites, it is suggested that the "vulnerable" category is more appropriate than "rare" for this species.

8. ACKNOWLEDGEMENTS

The Tongariro/Taupo Conservancy of the Department of Conservation provided the funding and accommodation for this project with Harry Keys and Cathy Jones giving encouragement and support. Shawn Walsh, Philip Wheble and Rebecca Moore Wheble assisted in the field in 1993 and Barry Spring-Rice assisted in 1992. Elizabeth Miller and Barbara Knowles commented on the manuscript and Mark Kimberley analysed much of the data and prepared the graphs. Geoff Walls and Geoff Rogers provided the information on the Ruahine *P. turneri* and Willie Shaw on the Hautapu population. Rebecca Moore Wheble provided the pH measurement for the Ripia. Peter Neville and Elizabeth Miller prepared the maps.

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