Ecology, management, and history of Whirinaki Conservation Park, New Zealand

An annotated bibliography

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CONTENTS

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A B S T R A C T

This annotated bibliography lists articles—published and unpublished, scientific and popular, in print and other media—relating to the ecology, management (production and protection forestry) and history (including social history) of Whirinaki Conservation Park, North Island, New Zealand. Coverage is from the early to mid 20th century onwards. Research and survey work (including some geological information) is included, as well as some information about the impact on the forest of early Polynesian presence, and Maori before and during early European settlement. The bibliography is an ongoing project and its authors welcome updates, corrections or details of relevant articles.

Keywords: bibliography, Whirinaki – ecology, Whirinaki – management, Whirinaki – history

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1. Introduction

The Whirinaki Conservation Park (Fig. 1), administered by the Department of Conservation (DOC), is located approximately 70 km southeast of Rotorua, and covers approximately 54 921 ha. (The park does not include nearby and adjacent land administered by DOC, that is, the 'conservation land parcels' of Waipunga Forest, Kokomoka Forest, Kokomoka Bush Covenant, Basin Loop Covenant and Urewera National Park.) The area was formerly known as 'State Forest 58', when under the administration of the New Zealand State Forest Service and then the New Zealand Forest Service (NZFS). In 1984 it became 'Whirinaki Forest Park'. The area has generally been referred to as 'Whirinaki Conservation Park' since DOC took over administration in 1987. In this bibliography all these terms appear. The general terms 'Whirinaki' and 'Whirinaki Forest' are also used to describe the area.

The 230 papers in this bibliography comprise all the published and unpublished items relevant to the Whirinaki Conservation Park that could be located and annotated over an 18-month period (January 2003–June 2004). Apart from some earlier prehistorical and historical aspects, the period covered by this bibliography is 1933–2004. The scope and format are comparable with those of the Pureora bibliography, published by DOC in 2000 as *Conservation Advisory Science Notes 282* (Beveridge et al. 2000: see Item 23). However, possible early Polynesian impact at both the margins and within the main tract of Whirinaki Forest, and the later impact of Maori before and during early European settlement, are of such interest and significance that some coverage is given of historical topics.

A number of papers overlap the contents of the two bibliographies, given they are both concerned with central North Island forests developed on soils derived from volcanic material; mainly that erupted from the Taupo Volcanic Zone, where the most recent eruption is now believed to have been in AD 200. Comparable podocarp/tawa and dense podocarp forest types have developed at the lower altitudes of Pureora and Whirinaki forests. Major differences between the two regions, however, include the absence of beech from Pureora (and most other west Taupo forests), and the longer and therefore more severe impact of introduced browsing animals in Whirinaki Forest (and also neighbouring Urewera forests). Where there is an overlap of subject interest, only material that makes specific reference to Whirinaki Forest is annotated in the current bibliography. General background for these papers may be annotated in the Pureora bibliography.

The earliest human influence on Whirinaki Forest may have been from fires, coinciding approximately with the time of the Kaharoa Eruption in 1314. It was another 600 years before the beginnings of a forestry industry made its impact. Removal of totara for fencing and local building material commenced in the Whirinaki Valley in the 1920s. Totara and other podocarps, including large kahikatea, were logged at a relatively low level in the 1930s until the first sawmills were built. The NZFS logging scheme commenced in 1938. In 1975, selective or partial logging replaced total logging and conversion to exotic conifer plantations, ostensibly according to the principles of a revised indigenous forest management policy.

Whirinaki Forest was gazetted in 1932 as State Forest 58, and was managed by the New Zealand State Forest Service and the NZFS until 1987. The NZFS was disestablished at that point, and control passed to DOC, with new management directions. In 1984, while still in NZFS control, Whirinaki Forest Park was formed. This followed 5 years of vigorous public debate on management of the forest, which involved environmentalists, residents of the local foresty settlement of Minginui Village, politicians, the NZFS, and many others for and against continued wood production from the indigenous forest. The Labour Government decided that all felling should cease in Whirinaki Forest Park from 1984, but salvaging of podocarp windfalls continued until 1987, and a very low level of salvage of totara for Maori cultural purposes is currently permitted.

The National Forest Survey (1945–56) produced the first scientifically collected information on the composition and pattern of Whirinaki Forest (and forests of the neighbouring Urewera region); the data were subsequently used in preparing maps of forest type, and the survey inspired papers on forest development and succession, published from the mid-1950s by Roger Cameron and Peter McKelvey. In the mid-1970s, principles for establishment of scientific reserves in state forests were announced, with the primary function of research in areas of high scientific value. When Whirinaki Forest Park was finally established in 1984, it contained five 'ecological areas', a 'forest sanctuary' within unlogged forest, and a remnant of once extensive frost flats on the western margin of the forest (see fig. 1).

Liberation of deer and possums in or near the Whirinaki region from about 1920 resulted in heavy browsing in the Whirinaki Forest, with impact peaking about 1960. Assessments of browsing impact were made from the 1950s by NZFS staff, mainly in the higher altitude or steeper forests of the Urewera Ranges and other marginal forests. Limited control measures were carried out in Whirinaki Forest from 1934, with poisoning operations initiated about the time of peak animal populations around 1960.

When the debate on management of the central North Island forests gathered momentum in 1978, little was known about the indigenous wildlife in Whirinaki Forest and their introduced predators. Interest in Whirinaki was intense and widespread for several years, and often uninformed, but attention was focussed on the intrinsic values of the forest, as well as management options. Concerns were expressed for the future employment of Minginui villagers and the viability of Minginui Forest Village, but since the last sawmill closed in 1988, alternatives to wood production, such as tourism, have slowly developed.

Topics emphasised in a number of papers in the bibliography include:

- The long-term decline of the crowns of canopy trees such as northern rata, totara, Hall's totara, and larger kamahi. Evidence indicates that browsing by possums contributes significantly to such decline, die-back, or death, though this role is not admitted by some scientists. Die-back or damage to tawa crowns is usually attributed to frost followed by recovery on most sites.
- The impoverishment of ground vegetation and shrub understorey by browsing. A corollary is the 'unresearched' reduction of fruits favoured by possums in all vegetation tiers—thus being unavailable to birds. Several papers refer to the fluctuating seed crops of tawa and podocarps, and indicate

that a good supply of fruit is necessary for successful breeding of birds such as kaka and kereru.

- An awareness of the threats posed by introduced predators to bird populations, endangered birds, and indigenous wildlife in general. Also an awareness of the threats posed to some plant species by possums, deer, and possibly pigs and rats.
- Surveys and control of invasive weed species.
- Location and protection of endangered plants and birds.
- The impact of partial logging on residual trees and lower vegetation tiers, and the regeneration of canopy trees and shrubs.
- Attempts to understand forest dynamics and regeneration patterns, especially in dense podocarp and podocarp/tawa forests. These have led to hypotheses on forest renewal after substantial disturbances such as fire, storms and volcanic eruptions. A number of international scientists have visited Whirinaki Forest, particularly over the last 25 years. After visiting the dense podocarp forest of the Okurapoto trial on 22 May 1996, Professor E. F. Bruenig, former holder of a world forestry chair at Hamburg University and author of a treatise on tropical forestry, wrote in his report that 'the ecosystem's dynamics [in Whirinaki] are obviously disturbance driven at the short and long-term scale of time'. Fuller understanding could lead to improved 'biological' or 'environmental interpretation' referred to by eminent scientists such as David Bellamy and John Morton.
- Attempts to restore podocarps by planting on disturbed sites where there is little successful natural regeneration of tree species (apart from tawa). One view is that indigenous forest restoration could be encouraged through retaining and supplementing natural regeneration of podocarp and shrub species that occur in some thinned plantations of Douglas fir and radiata pine, and retaining all fragmented remnants of indigenous forest.

In preparing this bibliography, most of the items included that were not previously in possession of the authors were located through perusal of catalogues and computer-generated lists of unpublished and published papers produced by cooperative libraries. The main bibliographies on indigenous forest and wildlife that were checked for items either specifically mentioning Whirinaki Forest, or of particular relevance to it, are those of Leamy & Hayward (1986), Boyd (1993), Shaw (1997) and Shaw et al. (1990). All annotated items in this bibliography, with one or two exceptions, have been read in full. A few items have no annotations—these are items kept by Landcare Research, mainly as file notes by John Nicholls and John Herbert on proposals for ecological areas made to a 'Scientific Coordinating Committee'. Attempts have been made to annotate some papers on soils and geology, including those concerned with eruptions from the Taupo Volcanic Zone. Some of the archives of Forest Research (formerly Forest Research Institute) have been examined, but not the Permanent Sample Plot records for which numbers are given under some titles in the bibliography. Other files examined were those of the former NZFS (Rotorua Conservancy), which are now held in the Auckland Regional Archives section of the National Archives of New Zealand. The files of DOC's Rangitaiki Area Office were also examined. Copies of items in the National Archives relating to Whirinaki Forest, and dealing with topics such as scientific reserves,

ecological discussions and totara mortality, have now been deposited with DOC's Bay of Plenty Conservancy Office in Rotorua.

All annotations, and comments [in square brackets], are by A. E. Beveridge (AEB), except where indicated by initials of co-authors (MCS and BRC). The keyword index at the back of the bibliography is a guide to activities and sites. Because of the frequency with which they appear in the bibliography and/or likely familiarity to readers, acronyms and abbreviations are used for the names of the following organisations: Department of Conservation (DOC), New Zealand Forest Service (NZFS), Department of Scientific and Industrial Research (DSIR), Native Forest Action Council (NFAC), and Environment and Conservation Organisations of New Zealand (ECO).

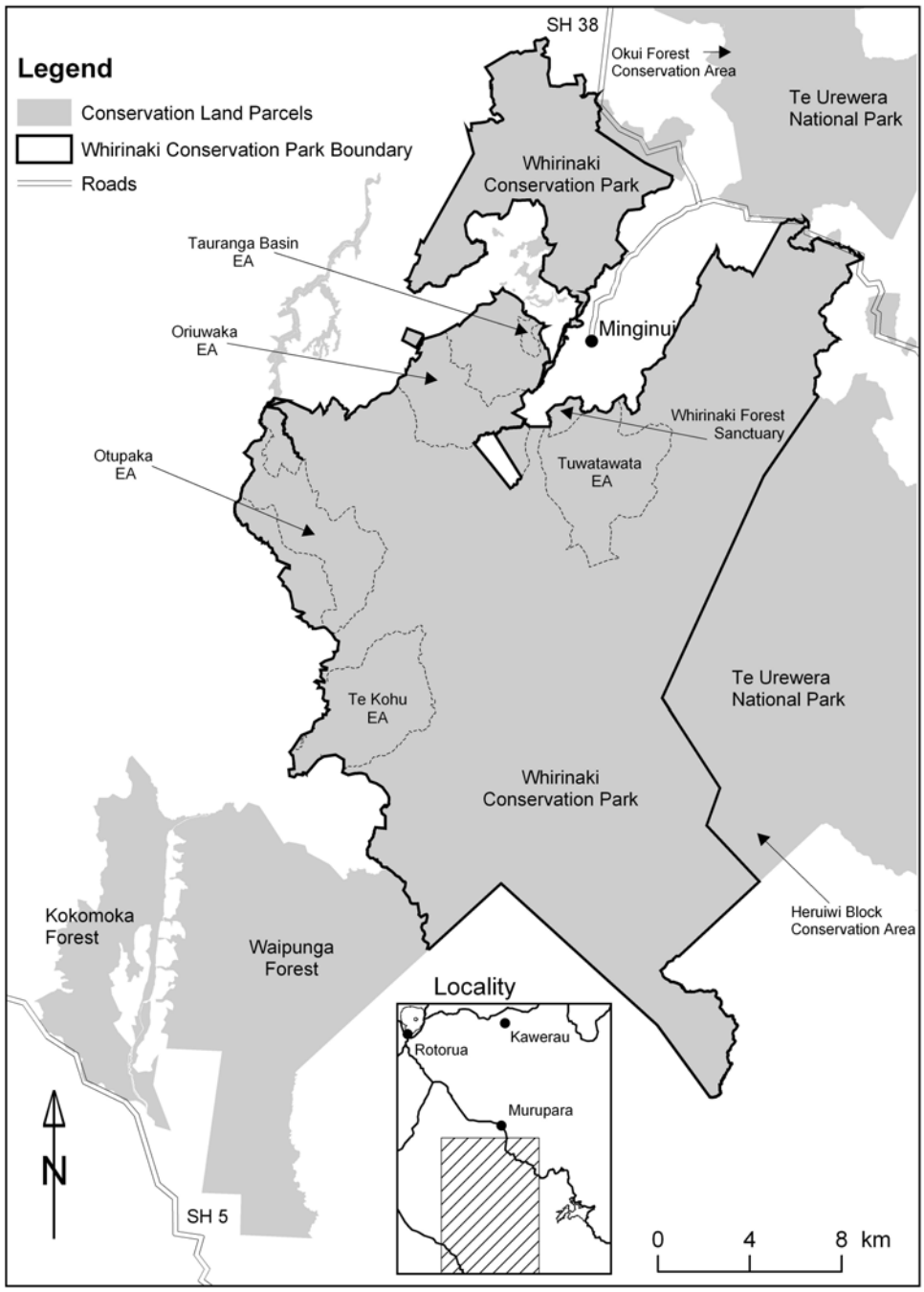

Figure 1. Whirinaki Conservation Park.

2. Bibliography

1. Anon. 1985: Environmental policy in difficulties. *Bush Telegraph 19*: 1.

A complaint that logging had not yet ceased in Whirinaki Forest, where logs were being stockpiled. A Forest Park Advisory Committee was due to be announced. [A committee was subsequently established from 1985 to 1990, chaired firstly by John Morton, and then by Willie Shaw.]

Keywords: Forest Park Advisory Committee, logging cessation

2. Balme, C.; 1989: Favourite places: five personal preferences. *Adventure 42*, supp.: 38–45.

Whirinaki State Forest Park is included among places illustrated in a supplement on walking, tramping and camping.

Keywords: recreation, wilderness

3. Barnett, S. 2004: Troubled waters: a tramp in Whirinaki Forest Park. *New Zealand Wilderness*, January: 18–21.

An account of a 4-day tramp of river and bush travel to Upper Te Hoe Hut, through the steep gorge of Te Hoe River, to Central Te Hoe Hut and three other huts. Te Hoe Gorge proved to be a difficult route, with an unmapped 10 m high waterfall. Seven blue duck were seen in a morning—three pairs and a single duck. [The author praises the high quality of most of the tracks.]

Keywords: blue duck, recreation – tramping

4. Beadel, S. M. 1988: Wild animals of the Urewera forests 1980–1987. *Technical Report Series 1.* Department of Conservation, Rotorua. 39 p.

The results of surveys of the populations of deer, possums, pigs and goats in the Urewera tract in the summers of 1985/86 and 1986/87 are compared with those of a previous survey in 1980–82. Three of the 16 survey regions, described in an appendix and shown on a location map with numbered sampling transects, are almost entirely within Whirinaki Forest Park (Whirinaki and Te Hoe regions), or partly within it (headwaters of Wairoa Stream, in the Waiau region). The density and distribution of animals were assessed by means of faecal pellet density, hunting statistics, and anecdotal reports by experienced staff. Increases in densities of deer and possum pellets suggest increases in the numbers of these animals. The lowest density of deer (2–8 individuals/10 ha) was in the Whirinaki region—a region well served with tracks and huts for hunters. Deer numbers were not as high as in the past (e.g. the 1960s). Feral pig populations, assessed through pig 'sign', were of higher density in lower altitude areas of suitable habitat, such as tawa and podocarp forests. There appeared to be no goats within Whirinaki Forest Park, though they occurred on the fringes of the broad survey area. Recommendations are made for monitoring and control of wild animal populations. It is recognised that management policies must be

flexible in dealing with complex issues. Because the main problem with browsing animals is the damage they do to vegetation, monitoring of vegetation condition must continue. The need for further research on the ecological impact of pigs in forest habitats is highlighted. [Preliminary studies have indicated strong impact on some forest types (see Thomson & Challies 1988).]

Keywords: animal control – Urewera, animal population survey

5. Beadel, S. M. 1992: Threatened and local plants of Bay of Plenty Conservancy. *Technical Report Series 13*. Unpublished report. Wildland Consultants Ltd. Department of Conservation, Rotorua. 77 p., including appendices. Many references.

A perusal of the findings for 36 threatened and local plant taxa in the Bay of Plenty Conservancy indicates that only one—*Calochilus robertsonii*, the red bearded orchid—is currently recorded in Whirinaki Forest. A number of other orchids and mistletoes are, however, recorded elsewhere in the central North Island, including Kaingaroa Forest. *Peraxilla colensoi* is recorded in Urewera National Park. The shrub *Teucridium parvifolium*, which is probably susceptible to browsing animals, was formerly recorded at Te Whaiti. Threats to conservation of the plants listed commonly include uprooting by pigs (orchids and king fern) and possum browsing (mistletoes). [See Beadel (1996).]

Keywords: threatened plants

6. Beadel, S. M. 1995: Vegetation and flora of lands administered by Bay of Plenty Conservancy. Wildland Consultants Ltd unpublished report for Department of Conservation, Rotorua. 556 p.

The Whirinaki Ecological District is 1 of 17 ecological districts in the Bay of Plenty Conservancy, and is covered by a botanical inventory (pp. 331–345). The highest conservation ranking of 'excellent' is given to the five ecological areas and the forest sanctuary in Whirinaki Conservation Park. The features and vegetation types of those areas are outlined, and extensions recommended by Willie Shaw, 'to provide better representation of the vegetation of the ecological district'. [Included in the references are papers by John Nicholls, and accounts of visits by the Rotorua Botanical Society, most of which are annotated in this bibliography.]

Keywords: conservation areas and values, Whirinaki Ecological District

7. Beadel, S. M. 1996: Field inspection: threatened and local plants: Te Ikawhenua Field Centre. Wildland Consultants Ltd unpublished report for Department of Conservation, Murupara. 10 p.

This includes an updated list of 12 threatened and local plants (cf. Beadel 1992). The taxa occurring in or near Whirinaki Conservation Park are the orchid *Prasophyllum* aff. *patens*, a 'vulnerable' plant in the Whirinaki Bog, and the mistletoe *Tupeia antarctica*, found in the Okahu Gorge. A preliminary plant checklist of 46 indigenous species is given in an appendix for the Whirinaki Bog—a wetland of exceptional botanical conservation value. Recommendations are given for further inspections and management. [See Cashmore (2003).]

Keywords: threatened plants, Whirinaki Bog

8. Beaven, B. M. 1996: Sap feeding behaviour of North Island kaka (*Nestor meridionalis septentrionalis*) in plantation forests. MSc thesis, University of Waikato, Hamilton. 81 p. 97 references.

The scope of this thesis is wider than the title suggests. Intensive studies of six kaka fitted with radio transmitters were made over a period of 12 months in 1995, in plantation forest and also at two sites within the dense to medium-dense podocarp forest of Whirinaki Conservation Park. One of these sites was at Old Fort Road, in the Tauranga Basin Ecological Area, the other was in an area known as the Totara Salvage Block, near the eastern edge of Kaingaroa Forest. References are given to previous work on sap-feeding of South Island kaka, and also sap-feeding by other species in the world. Surveys of exotic forest plantations—in eastern Kaingaroa and in plantations near the study sites in the Whirinaki region—showed that kaka damage resulting in crown death of Douglas fir and radiata pine occurred at a low level on the trees, through bark-stripping and ring-girdling, but some kaka damage was found at higher levels (on up to 3% of all trees). Within the podocarp forest, sap-feeding was mainly on tawa, but also on totara and matai at higher levels, and it occupied about 20% of kaka feeding time. The seasonal pattern of kaka foraging indicated that about equal times were spent eating fruits, seeds (including pine seed) and insects. Nectar sources (kowhai and rata) were scarce in the study areas. The average size of the core home-range for kaka in dense podocarp forest was 15.5 ha. Kaka damage in plantation forest occurred up to 1 km from the boundary with the indigenous forest, but usually within 50 m. Only one of the six tracked kaka spent time in an exotic plantation (Douglas fir). It spent most of September and October there, a period when sap 'probably has its highest level of sugars'. Kaka tap holes in the cambial area of trees to extract sap, as well as tongue-brushing it from exposed surfaces after bark-stripping. Kaka damage from sap-sucking is distinctive. Competition with possums for food sources is discussed, with the suggestion that a reduction in fruits caused by possums may lead to a high level of sap-feeding. Podocarps—particularly miro, kahikatea and matai—are the main source of fruit. Some sap-feeding occurs on matai, and its cones are said to be a food item in December [presumably male cones when pollen is ripe]. [This study should complement kaka studies at Pureora and later kaka studies in Whirinaki Forest (e.g. Blick 1998; Powlesland et al. 2003).]

Keywords: kaka behaviour, kaka sap-feeding, kaka visiting exotic conifers, Tauranga Basin Ecological Area.

9. Beets, P. N.; Hood, I. A.; Oliver, G. R.; Gardner, J. F.; Pearce, S. 2002: Allometric functions for rates of carbon loss in mature indigenous forest and relationships with fungal decomposer populations. Preliminary study: Carbon loss and decomposition after 19 years in two fallen podocarp trees. Forest Research Institute, Rotorua. 20 p.

This report gives results of an inaugural study in a larger project designed to help understand the processes of woody decay and carbon release in indigenous forests, and determine the nature and role of the associated decay fungi and insects in different tree species, regions and forest types. In this preliminary study the state of decay is described for a rimu tree and a matai—both trees having been uprooted during Cyclone Bernie in April 1982. These

trees were located in the unlogged control block of a selection management trial in Whirinaki Forest. The trial was established in dense podocarp forest in the Okurapoto Basin in 1979 (see Smale et al. 1985, 1998). The two uprooted podocarps were first measured and sampled for decay fungi in 1986, 4 years after falling, by cutting discs at regular intervals along the trunks. Further sampling for decay fungi in the wood was done in 2001. Photographs of cross sections of discs indicate the extent of decay at 4 and 19 years after windfall. Colour photographs show the fruiting bodies of *Ganoderma* and *Armillaria*, two fungal genera contributing to decay (see Hood et al. 1989). For related topics, see Hood et al. (1989, 2004).

Keywords: biomass of indigenous trees, carbon loss in indigenous forest (trees), fungal decay – windthrown podocarps

10. Bergin, D. O. 1982: Regeneration in dense podocarp forest, Okurapoto selection management trial, Whirinaki. Project Record 114. Forest Research Institute, Rotorua (unpublished report). 23 p.

This report gives results for the first of two surveys of podocarp, tawa and shrub hardwood regeneration, on disturbed and undisturbed ground, in four blocks covering 40 ha of the Okurapoto trial. Three of the blocks were logged selectively in winter 1979, the fourth was an unlogged control. This first assessment was done in April 1980, 6 months after cessation of logging. In the control block, there were 14 000 podocarp seedlings/ha. Of these, 95% either still had cotyledons, or were under 10 cm in height, 3.5% were between 10 cm and 30 cm in height and only 0.4% were over 30 cm, most of these being badly suppressed, or with insect damage and signs of browsing by deer. There were proportionally fewer podocarp seedlings in the logged blocks with recently disturbed soil. On flatter terrain, small and mainly ephemeral seedlings of kahikatea were most abundant, while rimu was most prominent on ridges. There were roughly equal numbers of rimu, miro and matai seedlings (around 2000 seedlings/ha).

Tawa regeneration was abundant and well represented in all blocks and in all size classes, with seedlings, saplings and poles present, particularly on ridges. The paucity of effective podocarp regeneration is discussed, noting that taller seedlings and saplings are more common in the dense podocarp forest of Tihoi, west Taupo, where regeneration has not been obviously browsed as it has at Whirinaki. While heavy shade in dense, tall podocarp forest with a subcanopy of tawa is one factor likely to hinder development of podocarp seedlings, it is suggested that another factor could be desiccation during the summer of small seedlings (particularly kahikatea) germinating in thick litter and humus. Natural gaps in the Okurapoto trial area and elsewhere in Whirinaki are usually occupied by ground ferns and tree ferns.

[Not only has the long-continued browsing by red deer (liberated up to 100 years ago near Whirinaki Forest) contributed to the failure of abundant podocarp seedlings to grow to the sapling densities found in the west Taupo forest, but at Whirinaki, in old-growth forest, deer have also prevented the growth of palatable shrubs such as fuchsia, pate, mahoe and kamahi. At Whirinaki, these species are generally confined to small seedlings, but at Tihoi Forest they have grown in profusion since partial logging of the dense podocarp

forest ceased. Older plants of mahoe, with coppice shoots, may be browsed back each winter at Whirinaki. See also Nugent et al. (1997), who demonstrated that even low populations of deer can prevent development of shrub hardwoods in unlogged old-growth forest at Waihaha. Kamahi, fuchsia, mahoe, and some larger-leaved *Coprosma* species have appeared on road batters at Okurapoto, and have developed into shrubs over the 30 years following substantial canopy opening in dense podocarp forest at the margins of the Mangawiri Basin (Beveridge, A. E. 2004, pers. obs., February).]

[GAS: A repeat regeneration survey of the same area was done in the 1990s. The report and data are electronically filed at Forest Research.]

Keywords: browsing damage, dense podocarp forest, Okurapoto trial, podocarp regeneration, podocarp regeneration sampling

11. Bergin, D. O. 1988: Establishment of podocarps in partly-logged forest, Okurapoto, Whirinaki Forest Park. Project Record 2082. Forest Research Institute, Rotorua (unpublished report). 9 p.

Results are given for survival and growth of podocarp seedlings 6 years after group planting in forest gaps of various sizes—the gaps made by selective logging in dense podocarp forest in 1979, removing 9–15% of the merchantable volume (Okurapoto trial). Gap size varied in the three logged blocks (covering 30 ha), reflecting the application of different tree selection criteria. Survival of rimu, kahikatea, totara and matai in each block was 89–95%. Heights at planting were approximately 50 cm for rimu and matai, and 80 cm for kahikatea. The most vigorous trees in each group of rimu and kahikatea were approximately 2 m high after 6 years. The best planting sites were the larger gaps (up to 30 m across). Slash and some topsoil were cleared from these sites by bulldozer, and this process also removed ferns. The sites were quickly invaded by dense wineberry, which soon overtopped planted podocarps, but it allowed their continued growth. Smaller gaps made by removing single trees soon closed. And with less disturbed soil and more shade, tree ferns and ground ferns tended to smother planted podocarps.

[Some early releasing from ferns was done at Whirinaki, but wineberry starts to die back and collapse after 12–15 years, with heavy tangles of *Rubus* and other vines smothering or breaking planted podocarps (Pureora experience). Thus, releasing of podocarp seedlings is required 10–15 years after planting. This releasing could not be carried out in the Okurapoto trial, and 25 years after planting some of the podocarps starting to emerge from the wineberry at 5–6 m in height have been crushed.]

[See also Steward & Pardy (1989), and Beveridge & Bergin (2000). The multi-stemmed condition of tall rimu in some dense podocarp stands may have resulted from damage caused to saplings by a collapsing pioneer 'nurse species' and falling debris.]

Keywords: canopy gaps, Okurapoto trial, podocarps (height growth, plantings, survival – planted), regrowth after logging, vine tangles, wineberry

12. Bergin, D. O. 2000: Current knowledge relevant to management of *Podocarpus totara* for timber. *New Zealand Journal of Botany 38(3)*: 343–359.

The ecology of totara and its suitability for management in planted stands are covered by this review. Cultural values and uses for totara assigned by Maori are discussed, as well as its uses after European settlement.

[From the 1920s to the 1970s a large number of totara were felled in Whirinaki Forest and wood was also harvested from fallen trees. Possum browsing is thought to have contributed to widespread and relatively sudden death of many totara over the past 50 years in Whirinaki and elsewhere, and conditions have not favoured its natural regeneration in old-growth forest. See Gamble (1979), Shaw (n.d. ?1988–90), and Bergin (2003).]

Keywords: totara ecology, totara growth, totara management

13. Bergin, D. O. 2003: Totara: establishment, growth and management. *New Zealand Indigenous Tree Bulletin 1*. Forest Research Institute, Rotorua. 40 p. 75 references.

This wide-ranging review has no direct reference to Whirinaki Forest, but it is a valuable account of the ecology of totara and its potential for management in plantations and naturally regenerated stands on farmland. It is included in this bibliography owing to the great interest in totara as a cultural tree—a symbol of strength and grandeur—providing wood for many purposes in former times and used by both Maori and European settlers.

[The Whirinaki forests contributed one of the last remaining substantial sources of totara wood until the 1970s, when the totara/matai stands of the central Mangawiri Basin were largely destroyed and replaced by radiata pine and Douglas fir. See Beveridge (1967).

Keywords: totara ecology, totara growth, totara management

14. Bergin, D. O.; Kimberley, M. O. 1992: Provenance variation in *Podocarpus totara*. *New Zealand Journal of Ecology 16(1)*: 5–13.

Whirinaki is listed among 42 provenances countywide from which totara seed was collected in 1985 in order to determine growth and form of seedlings raised in a nursery. The Whirinaki seed had to be collected from bushy trees on farmland or near marae; no productive source was found among the tall, well-formed forest trees, many of which had shown crown die-back over the previous 50–60 years (Beveridge 1967).

Keywords: Hall's totara, *Podocarpus hallii*, *Podocarpus totara*, totara provenance trial, totara seed collection

15. Best, E. 1977: Forest lore of the Maori, 2nd Edn. *Bulletin 14*. Dominion Museum, Wellington. 421 p.

The author of this book, first published in 1942, lived for 15 years (1895–1910) with the Tuhoe people in the Urewera district. While there is little specific mention of the forest in the Whirinaki Valley, he writes (p. 115) of the sound of large numbers of tui gathered to feed on fruiting kahikatea in the valley in 1900. This phenomenon has been recorded in Whirinaki Forest for tui and starlings (St Paul 1977). Similar observations have also been made in Pureora Forest in 1958—a year of heavy podocarp seeding—for tui and kereru (Beveridge 1964).

Among the mass of details on methods of capturing birds and collecting and preparing food plants in forests, there are accounts of kaka, kereru and tui (three of the bird species most favoured by Maori for food), including the habits and food preferences of the birds. In earlier times, kaka and tui gathered on flowering rata about January to feed on nectar, and also took nectar from flax and kowhai. Flocks of kaka also gathered on podocarp trees in heavy fruiting seasons, and ate a wide range of berries, including the seeds of tawari [not favoured by other birds, and growing in the podocarp/beech forest of middle altitudes].

A long list of plants producing berries or leaves eaten by kereru is given (pp. 230–232). Snares were set in miro, kahikatea, matai and rimu trees. Waka kereru ('pigeon troughs') made of totara wood, which were used to attract and snare thirsty kereru visiting miro and hinau, have been found in Whirinaki Forest in recent years. There are accounts of all the bird species still present in Whirinaki Forest in the authors's time, and it is noted that about 12 bird species had disappeared from the Urewera Forest by the time he made enquiries from the Tuhoe people he lived with (p. 116). Reference is made to flocks of whiteheads, with accompanying saddlebacks and stitchbirds in former times ('bird waves'). [Bird waves, or winter flocking, may still be observed in Pureora Forest Park, with whiteheads accompanied by other insect-seeking birds such as fantails and tomtits (Beveridge, A. E., pers. obs.; Pureora bibliography item 38). The two areas where such observations were made in recent years had been subject to predator-control operations.] Best refers to the burning of 'brushwood' to promote the growth of bracken rhizomes, an important source of Maori food in former times.

Keywords: bird behaviour, bird diet, bird flocking, bird snaring, bird waves, birds as food, forest birds, nectar feeding, tawari, Urewera region

16. Beveridge, A. E. 1964: Dispersal and destruction of seed in central North Island forest. *New Zealand Journal of Forestry 18(1)*: 28–35.

The main study area was in dense podocarp forest within Pureora Forest [see Pureora bibliography, item 16]. However, observations have been made over many years in Whirinaki Forest, and several references to seed crops and seed eaters in Whirinaki are made in this paper. A total of 45 kg of rimu seed and receptacles collected in Whirinaki Forest from the ground beneath seed trees in April and May 1958 yielded only 1.4 kg of sound seed—many seeds being split or empty. St Paul (1977) observed bird behaviour and feeding habits at Whirinaki over 17 years, from the 1940s to early 1970s. The gathering of tui, starlings and other birds to feed on heavy crops of kahikatea fruit that he recorded in 1951 and 1955 (in the journal *Notornis* as classified summarised notes) has also been observed in recent years in the Waione area. The contents of green, partly developed tawa fruits are eaten by possums in summer, and the kernels (cotyledons) of fallen seed in winter.

[Fruit or seed of podocarps and tawa remain important food sources for New Zealand pigeon and kaka in Whirinaki Forest, as recorded by Best (1977), Beaven (1996), and Powlesland et al. (2003). Seed traps placed beneath the crowns of podocarp trees in the Mangawiri Basin in the early 1980s collected seed of canopy trees only. There was an absence of seed from the palatable

shrub hardwoods, which have been browsed by red deer and possums since their introduction about 80 years ago. Two seasons of sampling regeneration in the dense podocarp forest of the Okurapoto sustainable management trial showed an abundance of podocarp seedlings. They are apparently ephemeral seedlings, being regenerated by recurring seed crops, but not growing beyond the height where they can be browsed. See Bergin (1982) for a regeneration survey.]

Keywords: bird flocking; kahikatea, podocarps, seed production, possums, tawa

17. Beveridge, A. E. 1967: Totara mortality. P. 32 in New Zealand Forest Service (Ed.): Annual report of the Forest Research Institute, Rotorua, for 1966. New Zealand Forest Service, Wellington.

This note records concern over the widespread crown deterioration of totara (*Podocarpus totara* and *P. hallii*) in the Urewera region, including Whirinaki Forest.

[Crown die-back and death of totara in Whirinaki Forest has been recorded for over 40 years now, with mounting evidence that possum browsing has been a major contributing factor in the decline of both *Podocarpus totara* and *P. hallii*. In the Mangawiri Basin, where a forest sanctuary had been proposed, many totara have exhibited crown die-back since the 1960s. The best totara/matai stand in the basin was largely clear-felled in 1973, and was replaced by a plantation of radiata pine and Douglas fir. Many of the surviving marginal totara subsequently produced long epicormic shoots from their stems. One of the few areas in Whirinaki Forest where tall totara remain, with apparently healthy crowns, is the Tauranga Basin Ecological Area. Such trees survive in the Fort Road Recreation Area (Beveridge, A. E. 2003, pers. obs., April).

Near the forest edge at Waione, small totara protected from possum browsing by the construction, in 1966, of metal platforms around the trunks, initially showed a marked increase in crown foliage compared with unprotected neighbouring trees (Beveridge, A. E., pers. obs.). However, long-term assessment of the trees was interfered with, due to unauthorised removal of the platforms. Small branches of Hall's totara collected from large forest trees in the Hautapu Catchment of Whirinaki Forest have shown damage consisting of many missing shoot tips and buds. The damage to these fresh specimens was difficult to interpret at the time, with totara known to be susceptible to damage by tortricid, other caterpillars, and phasmids. Stomach contents of possums caught in traps in the Mangawiri Basin in the mid-1960s, and examined by Ruth Mason of the DSIR (Mason 1968), showed a significant component of totara leaves and shoot fragments. Besides totara leaves, tawa fruit and leaves, and rimu foliage formed the bulk of the possum diet over the period October 1965 to April 1966. In correspondence, Les Pracy, Forestry Protection Officer, NZFS, noted that a possum population census in the Mangawiri Basin indicated a density of only 5 possums/ha, and he did not consider that possums were the agents responsible for die-back and mortality of large totara.

In the Waihaha Catchment of Pureora Forest Park, Hall's totara foliage was reported to be a main food item for possums, and many trees were dead or

dying (see Nugent et al. 1997, item 21 in Pureora bibliography). There was previously a reluctance to accept that possums were a significant contributor to decline of totara (see Pureora bibliography, item 85; Orchard et al. 1981; Forest Research Institute 1982).

During visits to the Mangawiri Basin with Andy Blick and George Pardy, on 2 February and 26 April 2004, it was found that the crowns of tall totara which were at or near the margins of forest partially logged in 1975 appeared to have recovered. What had been long, slender epicormic shoots had evidence of possum browse, and had become hedged. Two large totara with metal platforms attached (the platforms dating from 1966) were found. There were possum droppings on one lower platform, indicating there had been access to that totara crown. Totara seed was collected from the ground and photographed for a report. An epicormic branch was collected, and a sample from that was mounted and photographed by Forest Research staff, for comparison with a sample taken from the Mangawiri Basin on 14 October 1968 (specimens NZFRI 25297 and NZ FRI 7038). Apart from fungal and insect attack, other causes of loss of young shoots include storm breakage (leaving the ground littered with shoots), and mass withering of new shoots on crowns after unseasonable frosts (Beveridge, A. E., pers. obs.). NZFS records of totara die-back and mortality have been copied from National Archives for retention by DOC, Rotorua.]

Keywords: possum browsing, possum diet, Mangawiri Basin, totara die-back, totara mortality

18. Beveridge, A.E. 1973: Regeneration of podocarps in a central North Island forest. *New Zealand Journal of Forestry 18(1)*: 23–35.

This paper, also item 18 in the Pureora bibliography, is mainly concerned with podocarp regeneration in parts of the present Pureora Forest Park, particularly in the podocarp/tawa forest type, which is also strongly represented in Whirinaki Forest Park below an altitude of around 700 m. Of the two references to Whirinaki Forest, one is to the age of matai as determined from ring counts on stumps, indicating that this species can reach 1000 years, and that it takes from 100 to 150 years to reach 15 cm dbh (diameter at breast height) [cf. growth of a podocarp pole stand at Whirinaki determined by Katz (1980b).] The other reference is to the much greater impact of browsing by red deer and possums on the vegetation, including podocarp regeneration, in Whirinaki compared to Pureora Forest.

[A pattern of regeneration cycling, involving podocarps developing beneath large old kamahi and other hardwoods with thinning crowns, is common in Pureora Forest Park and nearby Mamaku Forest. However, in Whirinaki, sapling and pole podocarps are usually confined to kamahi pole stands which have either been induced by fire, or occur at old Maori occupation sites, or as forest-edge ecotones. Many of the papers in this bibliography have references to the decline of old kamahi crowns in Whirinaki, and thus removal of a potential nurse for podocarps. Kamahi is one of the few broadleaved species highly favoured by both deer and possums (Nugent et al. 1997).]

Keywords: browsing damage, forest cycles, kamahi decline, podocarp regeneration

19. Beveridge, A. E. 1979: Management of the central North Island indigenous forest. Sanderson Memorial Address. *Forest and Bird 13(4)*: 25–33.

This review of the situation in central North Island forests was written at a time of great controversy about future management of indigenous forests, particularly Pureora and Whirinaki. The report discusses past and what were then present policies for management of indigenous state forests in the central North Island, particularly Whirinaki and Pureora. (See pp. 39–41, which include a photograph of the dense podocarp forest with tawa understorey at Okurapoto, the site of the last selection management trial in Whirinaki Forest.)

[Monitoring of the two selection management trials in Whirinaki (podocarp/tawa forest logged in 1961 by South Road, and dense podocarp forest logged in 1979 in the Okurapoto Basin) has continued to the present day, to give further insights into the ecology of the forest types. Podocarps have shown negative increment in logged and unlogged forest, and both natural and planted seedlings have been slow to develop (see Smale et al. 1988).]

Keywords: ecology of podocarp forests, management trials, podocarp forest management

20. Beveridge, A. E. 1983: Regeneration of podocarp forests and maintenance of productivity. Pp. 93–108 in Thompson, K.; Hodder, A. P.; Edmonds, A. S. (Eds): Lowland forests of New Zealand. Proceedings of Symposium 27–28 May 1980, Centre for Continuing Education and Environmental Studies Unit, University of Waikato, Hamilton.

This paper was written at a time when forest management policy supported a small amount of continuing wood production. Most emphasis in this account is on the regeneration of podocarps and their main ecological characteristics relating to seed production, seedling establishment, and the conditions favouring continued growth. [See also Pureora bibliography, item 21.]

[Experience in four selection management trials in central North Island forests led to the establishment of the Okurapoto trial in the dense podocarp forest of Whirinaki in 1979. This trial, like the earlier ones, has continued to be monitored to various degrees until the present day. It offers many ecological insights that could be of interest to visitors, through 'biological interpretation' (see Smale et al. 1998).]

Keywords: biological interpretation, podocarp forests, podocarp ecology, regeneration – natural

21. Beveridge, A. E.; Bergin, D. O.; Pardy, G. E. 1985: Planting podocarps in disturbed indigenous forests of the central North Island. *New Zealand Journal of Forestry 30(1)*: 144–158.

This paper deals with the general principles and techniques for re-establishing podocarps by planting, with the objective of restoring a high forest canopy. There are a few direct references to Whirinaki Forest, where attempts have been made to establish nursery-raised podocarp seedlings, and some transplanted wildings, in gaps and clearings. The gaps were made by selective

logging. The forest clearings were in valley heads (Kopuatoto), where long periods of browsing by red deer and possums have removed palatable shrubs and ground cover, and induced a dense cover of *Uncinia* spp. and ferns.

[In the Okurapoto trial, which was established in 1979 in dense, tall podocarp forest, planted podocarps continued to grow when overtaken by dense wineberry regrowth. But when, after 20 years, the largest podocarps had reached heights of 5–6 m, many suffered breakage and smothering when the wineberry started to die and collapse beneath tangles of vines (lawyer and other lianes) (Steward, G, pers. comm.). For assessment of survival and growth of podocarp clusters, see Bergin (1988).

The performance of many thousands of podocarp seedlings—nursery stock or transplanted wildlings—planted by NZFS Rotorua Conservancy staff in the Mangawiri Catchment and other partially logged forests for over a decade before the demise of the NZFS in 1987, has not been fully assessed over the past 20 years (see Orchard et al. 1981, pp. 28–35). However, vigorous, healthy rimu saplings are now prominent in the regrowth besides many roads and around some logging skid sites, together with younger, natural regeneration of rimu and matai.

In a 1980 trial, groups of podocarp seedlings planted inside and outside small wire netting exclosures in animal-induced clearings (Kopuatoto) and in partially logged forests (Mangawiri) were measured for early assessment of growth and browsing damage (records and photographs are kept at Forest Research). In a 1961 selective-logging trial by South Road, larger exclosures and controls were established in gaps in podocarp/tawa forest. Rimu and kahikatea seedlings in the control plots were initially reduced to stubs, due to winter browsing by deer and possums. But the seedlings soon grew through the 1-metre-high exclosure covers, when growth of palatable species in canopy gaps offered an alternative food source (see Forest Research Institute 1962: Report of Forest Research Institute for the period 1 January to 31 December 1962. New Zealand Forest Service, Wellington. 86 p.). Photographic coverage is kept in the archives of the Indigenous Forest Management Group, Forest Research Institute. In this 1961 trial, later plantings of podocarps in gaps cut in the wineberry regrowth grew poorly—having to cope with the dense ground cover of *Uncinia* spp. and ferns that had been encouraged by the further admission of light (see Steward & Pardy 1989).

The 1961 plantings were made during the peak period of browsing pressure (1958–62), according to NZFS records. Later plantings have not been significantly affected by animal browsing, except for tips of kahikatea shoots, which have been eaten by deer. Totara planted in canopy gaps, or by roadsides, or along logging tracks, tend to lose vigour in competition with regrowth of ferns and shrub hardwoods, and are subject to considerable insect damage. However, a cursory inspection in February 2004 of five-tree groups of totara that had been planted in 1980 beside a logging track made during heavy partial-logging in rimu-dominant forest of the Mangawiri Catchment (see Herbert 1979) revealed survival of several totara per group. There was some loss due to crushing by falling debris, windfalls and collapsing pioneer wineberry regrowth. Tallest totara were only 3–4 m high, which is slow growth for totara (subject to insect damage under a high canopy). Nevertheless, these observations demonstrate the persistence of planted trees. Patches of healthy,

natural seedlings of totara and other podocarps were also seen, indicating that there may be some recovery of the crowns of tall totara trees, thus enhancing seed production. This may be due to alternative food becoming available to possums, with the regrowth of fuchsia, pate and other palatable species in large canopy gaps of the partially logged forest, and on roadsides (see Beveridge 1967).

Small, natural totara and kahikatea seedlings in the centre of major old log extraction tracks are sometimes browsed at Mangawiri (Beveridge, A. E. 2002, pers. obs., 26 April). Healthy seedlings of all five podocarp species are present at track margins. Rimu saplings planted from 1977 onwards, and kahikatea planted during 1976, both inside roadside netted exclosures in the partially logged forest, are now up to 8 m tall and emerging through the regrowth canopy. For a more recent account of planting podocarps on disturbed sites, and an outline of performance in the Okurapoto trial, Whirinaki Forest Park, see Beveridge & Bergin (2000).]

Keywords: animal damage, disturbed sites, exclosures, forest restoration, group planting, height growth (podocarps), podocarp planting trials, selective logging

22. Beveridge, A. E.; Bergin, D. O. 2000: The role of planting native trees in the management of disturbed forest. Pp. 51–60 in Silvester, W.; McGowan, R. (Eds): Native trees for the future. Proceedings of a forum held at the University of Waikato, 8–10 October, 1999.

An account is given of a trial involving the planting of groups of podocarps in gaps made by low intensity selective logging in the Okurapoto management trial, established in 1979. Rimu, kahikatea and matai planted on disturbed ground in the larger gaps showed high survival rates 6 years after planting (Bergin 1988). But after 20 years, kahikatea and rimu, 5–6 m tall and about to emerge from dense wineberry that had invaded the planting sites, began to be crushed by the wineberry, which was itself collapsing under vine tangles. Thus, at least one releasing operation is required at 15–20 years after planting, to free leaders of podocarp saplings. This tending was done in Pureora and Mamaku forests, where growth of podocarps planted in gaps was comparable with Whirinaki after 20 years and at Mamaku the planted trees are well-established poles (10–13 m tall) emergent from the shrub canopy after 40 years (Beveridge, A.E., pers. obs. February 2004)

Keywords: disturbed sites – restoration, podocarp planting, podocarp planting – dense podocarp forest, restoration planting, Okurapoto trial

23. Beveridge, A. E.; Smale, M. C.; Holzapfel, A. S. 2000: Ecology and management of Pureora Forest Park. *Conservation Advisory Science Notes 282*. Department of Conservation, Wellington. 87 p. Keyword index, 277 annotations.

This is an annotated bibliography of 277 published papers and unpublished reports relevant to Pureora Forest Park. Many items in the bibliography are also relevant to Whirinaki, as both forests are on the Central Volcanic Plateau, with soils derived from volcanic ash, particularly that from the Taupo Eruption of

around AD 200 (revised date). Some 40 items listed in the Pureroa bibliography also appear in this Whirinaki bibliography, though with specific annotations here for the Whirinaki content of the papers and reports. Overlapping subjects include: research on forest birds and predators; impact of deer and possums on vegetation, forest pattern, tree and stand stability, regeneration and succession; impact of selective logging; autecology of predominant species such as the podocarps, tawa and kamahi (and its decline); soils and geology; and forest policy, management and conservation issues.

Keywords: bibliography – forest park, forest ecology, forest park – management, Pureora Forest Park

24. Bingham, E. 1993: Down the track to paradise. *New Zealand Herald*, 19 January:

The lifestyles of three Tuhoe men from Ruatahuna are described in this article. They work on clearing and cutting tracks in Whirinaki Forest Park, living in huts in the park for most of the year. Hunting is their recreation.

Keyword: track-making, wilderness

25. Bioresearches Ltd 1998: Ecological survey of sections of the Rangitaiki and Wheao rivers. Report for Rotorua Electricity Authority. 60 p. Many figures and tables. Appendices on trout data and trout food.

This report deals mainly with the numbers and condition of trout and their invertebrate food, in the Wheao River downstream from the Wheao Powerhouse, and in Flaxy Lake. Because the river at the stations sampled flows mainly through plantations of radiata pine, which are well downstream from the Whirinaki Forest Park boundary, the data collected may be of marginal relevance to the ecology of the upper Wheao River, in a catchment of indigenous forest. [See Collier et al. (1996) for a parallel study in the upper reaches of the Wheao River.] However, in this study there are two sampling stations above the Wheao Dam, near East and Boundary Roads. Tabulated data for these sites give invertebrate species that are potential food for trout—mainly chironomid (midge) larvae and caddisfly larvae.

Keywords: invertebrates (rivers), trout food, trout population, Wheao River

26. Bishop, C. D.; Wiser, S. K.; Shaw, W. B.; Beadel, S. M. 1998: Remeasurement of exclosures in the Whirinaki and Matakuhia catchments, southern Te Urewera. Wildlife Consultants contract report for the Department of Conservation, Murupara. 36 p. Colour photographs.

This report is concerned with deer impact on vegetation in five pairs of deer exclosure and control plots. Data that has been subjected to computer analysis and statistical tests in order to assess deer impact are presented and discussed. The plots, established and measured in 1979 and 1981, were all remeasured in 1987, and again in 1997. Two exclosure and control pairs are within the Oruiwaka Ecological Area of Whirinaki Forest Park—one in podocarp/tawa forest, the other, named 'Whirinaki 2', in submontane silver beech/kamahi forest on a river terrace. There is no location map included, but the three other

pairs—the Matakuhia plots—are in the catchment of the southward-flowing Matakuhia Stream, south of Whirinaki Forest Park.

Colour plates and data displayed in histograms support the conclusions that deer browsing has had a strong influence on forest understoreys, and in control plots 'browsing has almost completely denuded the understorey of palatable saplings' over a period of 16 years. Density of palatable seedlings has also greatly reduced in the control plots.

Lists of plant species are given for each plot. 'The five exclosures are the only ones in southwestern Te Urewera to monitor the effects of deer on forest understorey … Deer are continuing to have major impacts on the habitat quality of these forests, and reductions in deer numbers are required to ensure regeneration of species palatable to deer.' Hunting pressure has not been sufficient to allow vegetation recovery. [See also Jane (1978b, 1980), Knowlton (1982), Knowlton et al. (1982), and Beadel (1988).]

Keywords: browsing of shrubs, deer and possum impact, exclosures, Matakuhia Catchment, Oriuwaka Ecological Area, sapling reduction

27. Blick, A. 1998: Whirinaki kaka study, 1997–1998: report on a home range study of six kaka in the Tauranga Ecological Area of Whirinaki Forest Park. Department of Conservation, Murupara (unpublished report). 22 p. Colour photographs.

This study follows that of Beaven (1996), which was a first study of kaka behaviour in Whirinaki Forest. One female and five male kaka were caught in mist nets and fitted with transmitters in an area of dense podocarp forest on the northern side of the Tauranga Basin Ecological Area, adjacent to plantations of exotic conifers. The six birds observed in this study were part of a group of ten birds caught in mist nets and fitted with transmitters.

There are descriptions of the methodology, and observations of the birds movements and home range made over periods from October 1997 to May 1998. One pair of nesting kaka were found 15 m above the ground in a hole in a rimu tree. Two of their chicks were fledged at the beginning of March. A second pair nested in a hole 10 m up a matai tree. Three of their chicks were fledged about mid-February, while the remains of a fourth chick were found on the ground nearby. Five out of the six adult birds visited exotic plantations for different periods, but spent longer in the native forest, attracted by rimu and miro fruit. A female bird was observed stripping bark in a small stand of *Cupressus lusitanica*, while others visited Douglas fir and radiata pine stands near the podocarp forest.

Keywords: kaka, kaka behaviour, kaka visiting exotic conifers, Tauranga Basin Ecological Area

28. Boyd, M. J. 1993: Conservation and management of New Zealand's indigenous forests: a selected bibliography, 1948–1990. M. J. Boyd, Auckland. 144 p.

[Among the 2230 annotated items in this bibliography are 48 with the keywords 'Whirinaki' or 'Minginui'. A full perusal of all items identifies many more that either have relevance to Whirinaki Forest, or mention it directly. For example,

there are references to the southern Urewera forests; trees including the podocarps, beeches, tawa and kamahi; the impact of deer and possums on vegetation; control of deer and possums; decline of northern rata, kamahi and totara; wildlife; stability of trees and stands; forest types; regeneration and succession in forest and scrub; forest policy; logging; and, as the title of the bibliography suggests, conservation and management. Most items refer to published material in the broad sense, but some unpublished reports are included. Papers already listed in Leamy & Hayward (1986), a bibliography of works by NZFS personnel, have been excluded. A useful feature is the inclusion of Forest Research Institute's annual reports. These include summaries of research work in progress in indigenous forests, and some preliminary results. Many items in the bibliography have also been included in the current bibliography.]

Keywords: bibliography – indigenous forest, conservation, forest ecology, forest management

29. Cameron, E. 1987: Auckland University field trip to Whirinaki Forest. *Rotorua Botanical Society Newsletter 10*: 17–20.

An outline of fieldwork undertaken from 23 to 28 March 1987. Details of the studies of frost flat vegetation at the forest edge, and the structure and regeneration of podocarp forest in the Whirinaki Forest Sanctuary, are held in the Botany Department, University of Auckland. Ages of trees in dense podocarp forest were assessed from increment cores. Miro was aged from 200 years to 480 years, and matai from 480 years to 790 years. In areas that had been disturbed by burning about 80–130 years ago, there is abundant regeneration of the five podocarp species. Rimu poles became established on the older site about 90 years ago. Several thousand podocarp seedlings per hectare (matai most abundant) have established on a later burn. Altitudinal changes in vegetation were recorded from 400 m to 1000 m. Toatoa (*Phyllocladus toatoa*) was recorded over 900 m.

Keywords: altitudinal vegetation change, forest sanctuary, forest structure – podocarp forest, frost flat vegetation, podocarp ages, podocarp regeneration

30. Cameron, E. 1988: Notes on a monoao frost flat at Waione, Whirinaki. *Rotorua Botanical Society Newsletter 15*: 24–29.

A list of plants at a monoao (*Dracophyllum subulatum*) site on the Waione stream flats is given. Voucher specimens for many of the species are kept in the herbarium of the Botany Department, University of Auckland. [See also Shaw & Smale (1988).]

Keywords: frost flats, Waione frost flats

31. Cameron, R. J. 1954: Mosaic or cyclic regeneration in North Island podocarp forests. *New Zealand Journal of Forestry 7(1)*: 55–64.

[Familiarity with the Whirinaki Valley encouraged the author of this paper to develop a hypothesis on changing forest patterns in the mixed podocarp/ hardwood forests of the North Island.]

The author suggested a six-stage cycle in the Whirinaki Forest: (i) old podocarps and mature tawa forming a closed canopy; (ii) old tawa; (iii) young tawa; (iv) invading kamahi; (v) podocarp poles and hardwoods; (vi) open canopied mature podocarp and immature tawa. However, he could not demonstrate that such a cycle actually occurs at Whirinaki. He did not believe that recent climate change adversely affected podocarp regeneration.

[Podocarp regeneration rarely progresses beyond seedling stage at Whirinaki, except on disturbed sites—those disturbed by fire, or old Maori clearings, or sites that have been partially logged. Kamahi, a major nurse for podocarp regeneration in the west Taupo forests, has been subjected to heavy browsing by deer and possums for a period of some 60 years at Whirinaki. John T. Holloway provided a critical commentary on Cameron's article in the same issue of the journal, stating that 'it has never been possible to accommodate, in the field, all stages in possible regeneration cycles'. However, such cycles have since been demonstrated in some west Taupo forests, for example by Beveridge (1973). The complex nature of succession and changing patterns in podocarp forest has been the subject of much debate over the past 50 years, with discussion by McKelvey (1973), Katz (1980a), Shaw et al. (1983), Morton et al. (1984), Norton et al. (1988), Ogden & Stewart (1995), Smale et al. (1998), and many others.]

Keywords: cyclic regeneration, forest pattern, podocarp forest

32. Cameron, R. J. 1960a: The effect of pre-European civilisations upon the forests of New Zealand. Forest Research Institute, Rotorua (unpublished report). 8 p. 25 references.

This paper was apparently a preliminary report, leading to the publication of Cameron (1961). A plea is made for investigation into the 'ecological history' of indigenous forest, and recognition of the extent to which former forests were burnt by Polynesians or Maori. Most of the paper consists of extracts from notes written by early European travellers to the central North Island or the Bay of Plenty, which refer to fires lit by Maori, and the widespread destruction of forests. Four sketch maps appended to the text show the probable progressive impact the inhabitants of the valleys of Mangawiri Stream and the lower Whirinaki River had on the forest, through clearing and burning around pa and kainga.

The first map shows the forest cover in the Mangawiri Valley before the population of the area by Polynesians in the 11th and 12th centuries. [These dates are doubtful, because no artefacts have been found below the Kaharoa ash which covered this area after the eruption from Mt Tarawera in AD 1314. Also, current scholarship suggests the earliest settlement of Polynesians in New Zealand, or at least the Bay of Plenty, was in the 14th century.] The Punawaea Plain, near the confluence of the Mangawiri Stream and the Whirinaki River, carried no forest except for a few groves of totara. The second map shows the probable location of seven pa or kainga occupied by the people of Toi (Te Marangaranga) in the 16th century, situated on the Punawaea Plain, just to the north of Whirinaki Forest, and described by William Colenso in 1841 as a barren plain devoid of forest. The third map shows the probable distribution of the forest at the end of the 18th century, with locations of a dozen pa and kainga in

the lower catchment of Mangawiri Stream. The fourth map shows the distribution of forest in 1960, with a large area of cleared land in the eastern catchment of the Whirinaki River, and patches of clearings or scrub in the western catchment.

[A more detailed map, showing the forest types in the upper catchment of the Mangawiri Stream and flanking the cleared land beside the Whirinaki River southwest from Te Whaiti, is that of Nicholls (1966). Forest classes N1 (indicating removal of podocarps by crown fires), and L (dense podocarps) are located along the forest margins of the Te Whaiti–Minginui cleared land. Together with the L2 type (dense podocarps with tawa understorey) mapped in the Mangawiri Catchment, these forest classes may indicate the impact of pre-European fires. In particular, the dense podocarp stands of the Mangawiri and Whirinaki valleys, with further stands of comparable type on the western edge of Whirinaki Forest adjacent to the scrub and exotic plantations of the Kaingaroa Plateau, suggest that they resulted from ancient Polynesian fires. Cameron's views on the extent of pre-European burning in the Whirinaki district were formed from his field observations, together with accounts of early travellers. Some scientists have more recently suggested that the dense podocarps in Whirinaki resulted from early fires, and this would be an interesting topic for further study—investigating soils and the ages of podocarp trees. Totara in the Mangawiri Basin have been aged at 390–490 years, from ring counts on stumps of a few felled trees. See also McGlone (1983). Further ageing of totara could be carried out using the stumps of windthrown trees.]

Keywords: dense podocarp forest, fire – Polynesian (impact on forest), Mangawiri Valley, Polynesian fires – forest impact, totara ages

33. Cameron, R. J. 1960b: Natural regeneration of podocarps in the forests of the Whirinaki river valley. *New Zealand Journal of Forestry 8(2)*: 337–351.

A study of growth rates of mixed podocarp regeneration developing on sites of former Maori clearings near Okarea Pa (these cultivation sites were abandoned about 1840). The study was started in 1950 in broadly even-aged stands of sapling and pole podocarps, then emerging through a broadleaved nurse canopy. Most of the regeneration was established about 1890. The author observes that many other old Maori clearings carry comparable stockings of podocarps, making it possible to trace the complete linear succession, from bare clearing, to dense young podocarp forest with rimu and totara dominant, together with matai, kahikatea and miro.

On establishment of permanent sample plots in 1950, various treatments were given to provide more light to the podocarps and to reduce competition from 'nurse' broadleaved species. After remeasurement in 1958, a detailed account was given of podocarp growth over the 2 ha covered by the sample plots. Over the different treatment plots, rimu had a mean diameter of 10–17 cm and a mean height of 9–11 m. Totara grew 15% faster than rimu. [The records of permanent sample plots R221, R222 and R223, established in 1950, are held at Forest Research. The plots were last measured in 1980 (see Katz 1980b).]

The author comments on the scarcity of podocarp regeneration in high forest at Whirinaki, and the need for considerable disturbance to allow it to develop. The

significance of the heavy impact on vegetation caused by browsing of possums and deer over the previous 20–25 years was recognised. These animals were absent over the period when the podocarps initially established on the sites of old Maori clearings. Different forms of silvicultural treatment, including the use of fire to induce nurse species for podocarps, and other methods of management, were suggested for Whirinaki Forest at a time when the highest volume podocarp forests were destined for clear-felling and conversion to exotic conifers (from the 1940s). The early development of multi-stemmed podocarps in the sample plots was thought to be caused by damage to leaders during passage through the canopy.

[The collapse of pioneer broadleaved shrubs under heavy tangles of vines has been observed as a cause of damage to planted rimu saplings (see annotations for Beveridge et al. 1985; Bergin 1988; Beveridge & Bergin 2000). The paper contains a photograph of plot R221 with interplanted *Eucalyptus gigantea* (syn. *E. delegatensis*). Another photograph shows dense podocarp forest adjoining the plot (serving as a source of podocarp seed to be distributed by birds to the plot site). The eucalyptus have not proven necessary as shelter for this stage of podocarp development. But they have proven to be a useful nurse in establishment of podocarps planted on cleared sites at Pureora (see Pureora bibliography, item 195; Beveridge & Bergin 2000).]

Keywords: Maori clearings, podocarp regeneration, podocarp pole stands

34. Cameron, R. J. 1961: Maori impact upon the forests of New Zealand. *Historical Review 9(3)*: 131–141.

A general account of the destruction of forest by the pre-European Polynesians and Maori, mainly by the use of fire, either deliberately or unintentionally, which resulted in reduction of New Zealand's native forests to approximately half their primeval area. There is some evidence that there was a movement of people in the 14th century, from predominant populations in coastal regions to inland areas. The author states that 'In the Murupara–Mangawiri–Te Whaiti areas the Ngatimanawa, Ngatiawa, and Ngatiwhare seemed to have consistently selected sites [for new kainga] half a mile or more from the forest edge.' In Ngati Awa–occupied areas of the Mangawiri Valley, the most ancient dwelling sites (17th century) are located close to the confluence of the Mangawiri Stream with the Whirinaki River [which is some miles within the forest], while the most recently inhabited sites (1860–70) are located at the present forest edge or some distance from it. Clearings were generally made for habitations (and their area increased for security), tracks and hunting.

The first European to describe the Kaingaroa Plateau, William Colenso, wrote in 1841 of 'stunted vegetation of monoao and tussock that remained in a waterless, desert heath land', but soil studies have shown that dense forest there was destroyed by the Taupo Eruption (about AD 200) and a high forest developed again over parts. Forest in northern parts of the plateau was again destroyed by volcanic eruption about AD 1300 [Kaharoa ash now dated AD 1314]. Forest subsequently developed by the 15th and 16th centuries, but then fires destroyed much of that.

The author writes of the introduction of the potato in the last decade of the 18th century and of forest clearance under a shifting-cultivation system that

would have allowed cultivation of potato in colder districts such as Whirinaki. [See also McGlone (1983).]

Keywords: forest destruction, forest fires, Kaharoa ash, Mangawiri Valley, Maori clearing

35. Cameron, R. J. 1962: Determination of the relative ages of podocarp and podocarp/tawa forest in Whirinaki Forest. Forest Research Institute, Rotorua (unpublished report). 5 p.

A hypothesis was tested that dominant podocarps in forest type M2 (podocarp/tawa forest, the most widespread lower-altitude type of forest at Whirinaki) are significantly older than those in forest type L2 (dense podocarp, with a tawa understorey), and that type M2 has developed from type L2. In Whirinaki Forest, the ages of 16 matai trees in forest type M2, and 21 matai in type L2, were assessed by counting growth rings on the stumps of felled trees. Counting was along one or more smoothed radii per stump. Growth rings of matai are easily counted, and are assumed to be annual. Data for growth-ring counts per tree were tabulated in an appendix, and ranged from 544 to 1093 rings for matai trees in type M2, and 329 to 883 rings for matai in type L2. Comparisons were made of stump diameter and breast height diameter of some trees cruised before felling. Following statistical testing, the assumption was made that stumps of similar diameter in types L2 and M2 forest are of similar age. [Katz (1980a) reports no strong relationship between diameter and age in a dense podocarp stand at Okurapoto.] Figures given by McKelvey (1973) for diameter-class distributions of matai show a greater number of matai over 100 cm in diameter in type M2, compared with in type L2. Cameron concluded that the average stump diameter of matai in type M2 was 15 cm greater than that of matai in type L2, representing a mean age difference of around 270 years, and that type M2 forest has developed from type L2.

Attached to this preliminary report is a control plan reviewing past work on determining ages of podocarps from ring counts of trees in Whirinaki Forest. A table is given of ring counts in forest types L1, L2 and M2, collected by Crutwell in 1949, and Hampton in 1961. [Cameron's reports are held in the archives of the Indigenous Forest Management Group of Forest Research Institute. For the extent and description of forest types mapped as L2, L1, and M2 in Whirinaki Forest, see Nicholls (1969).]

Keywords: altitudinal vegetation change, forest succession, forest types, podocarp ages, vegetation change (altitudinal)

36. Cameron, R. J. 1963: A study of the rooting habits of rimu and tawa in pumice soils. *New Zealand Journal of Forestry 8(5)*: 771–785.

A study of the rooting systems of rimu and tawa in M2 type forest (podocarp/tawa) on pumice soils, in central North Island forests, including Whirinaki. The rooting systems are illustrated by drawings of excavated seedlings, saplings and poles. Rimu seedlings had weak, superficial root systems when grown in shaded conditions, and were confined to the deep, raw humus in the root mats of mature podocarps. By contrast, tawa (with food reserves from large seed) developed a taproot capable of penetrating a thick layer of raw humus and

acting as a 'perennating organ', since the stem may die back (through insufficient light) and be replaced many times. Tawa seedlings with well-developed taproots are better equipped to establish themselves under rimu trees. The ecological significance of the contrasting root systems of rimu and tawa are discussed.

[Photographs and descriptions of the root systems of windthrown rimu and other podocarps at Pureora (the pumice having been washed away by a high-pressure hose), are in the archives of the Indigenous Forest Management Group, at Forest Research.]

Keywords: rimu roots, root structures, seedling establishment, tawa roots

37. Cameron, R. J. 1964: Destruction of the indigenous forests for Maori agriculture during the nineteenth century. *New Zealand Journal of Forestry 9*: 95–101.

The introduction of the potato in the late 18th century provided Maori with their first staple food crop capable of growing in colder regions [excluding bracken rhizomes]. The system of shifting agriculture used to grow the potato—where fertility is gained from burning—greatly increased the demand for land. (MCS) [It is probable that cultivation for growing potatoes occurred in the Whirinaki Valley in the 19th century (see Millyn & Nevin 1978).]

[AEB: Contemporary accounts suggest that the rate of native forest clearance increased greatly during the first half of the 19th century, to be comparable with that caused by European settlers in the second half of the century. This helps explain the substantial areas of secondary forest dating from that period.]

Keywords: forest clearings, forest destruction – potato cultivation

38. Cashmore, P. 2003: Notes on monitoring of endangered plants in Whirinaki Forest Park. Department of Conservation, Rotorua (unpublished file note).

Dactylanthus taylorii, a root parasite, has been monitored for flowering and seed setting at several localities over some seasons since 1999, both within exclosures and outside. Unprotected plants have usually been browsed by possums. Trapping and poisoning of possums has been done at times, but the neccessity for further protection of some populations by cages is indicated. Some rat damage has been noted. [For general accounts of the distribution and ecology of *Dactylanthus taylori*, see Pureora bibliography, items 23 and 24.]

Ophioglossum petiolatum, an endangered fern, was discovered near Arahaki Lagoon in 2000. *Centipeda minima* (in the family Compositae) has also been found at this locality. Surveys for *Peraxilla* spp. (red-flowered mistletoes) were carried out in January 2002 and 2003, using methods recommended by the Mistletoe Recovery Group, DOC. Recruitment plots have been established. *Peraxilla colensoi* is usually hosted by silver beech growing on ridges, while *P. tetrapetala* is often associated with *Quintinia serrata*. Many mistletoe plants found have appeared unhealthy or dead, and mistletoes in Whirinaki appear to be in rapid decline. It is suggested that possums are likely to be contributing to mistletoe decline, but their impact is not clear. The surveys over two seasons indicate that mistletoe numbers are low in Whirinaki Forest. But there is the

possibility of benefit from possum control measures (directly) and mustelid trapping (indirectly, because a reduced mustelid population should result in an increase in the numbers of birds pollinating the mistletoe flowers).

Keywords: endangered plants, *Dactylanthus taylorii*, mistletoes, *Ophioglossum petiolatum*, *Peraxilla* spp., *Centipeda minima*

39. Christensen, B. R. (forthcoming): Monitoring, survey and inventory in the Rangitaiki Area, Bay of Plenty Conservancy. Department of Conservation, Rotorua.

The inventory of biodiversity information covering the Rangitaiki Area, Bay of Plenty Conservancy, DOC (Eades & Shaw 2000) is updated and expanded. This updated inventory provides electronic access to data, GIS (geographic information system) data manipulation, and other analytical tools. (BRC)

Keywords: Inventory

40. Close, I. 1996: Whirinaki revisited. *Forest and Bird*: 40–43.

The editor of *Forest and Bird* gives his impressions of Whirinaki Forest 12 years after 'chainsaws finally ceased' in 1984. [Salvage logging of windfalls continued until 1987. Totara was logged from the 1920s, but clearance of the indigenous forest and scrub, and conversion to exotic plantations finally totalling 6000 ha, did not start until the 1940s.] Reference is made to the clearing of totara/matai forest in the Mangawiri Basin [a proposed forest sanctuary] that occurred because it was thought that the totara were dying. [Marginal surviving totara had degrees of crown die-back contributed to by possum browsing, but crowns of some trees appear to have recovered by 2004. (See Beveridge 1967, with later comments.)] The battle for either continued logging or its cessation was waged from 1979 to 1984. [This is referred to in a number of annotations in this bibliography—it ended with DOC taking over management of the forest from the NZFS in 1987.] The problems of predators of birds, decline of rata, and spread of *Pinus contorta* are mentioned [and have received much attention from DOC over the past 10 years]. The research of Brent Beaven on the diet and breeding of kaka, and their habit of sucking sap from the inner bark of radiata pine in Kaingaroa Forest, is referred to [see Beaven (1996) and Blick (1998)]. The point of a fellow conservationist is made that Whirinaki has its special human history, and that 'Whirinaki is as much an historical resource as an ecological one.' In commentary on the low level of tourism, mention is made of a concession for an approved commercial trekking operation, and the training of local people as guides. [See Pu Kaea (2001).]

Keywords: logging cessation, Mangawiri totara, tourism

41. Collier, K. J.; Collier, E. J.; Bowman E. J.; Halliday, J. M. 1996: Short-term changes in water quality and benthic invertebrate faunas following post-harvest manipulation of woody debris in some Whirinaki streams—preliminary report. *NIWA Science and Technology Series 44*. National Institute of Water and Atmospheric Research, Wellington. 22 p.

The water quality of three first-order tributaries of the Whirinaki River—the Otutakahiao, Mangamingi and Waimurupaha streams—was sampled after

removal of different volumes of post-harvest radiata pine. These streams are near the western edge of Whirinaki Forest. Access to the sampled sites was from Te Rake Road. Grid references for sites, all on map NZMS 260 Sheet V18 Whirinaki, are 268772, 264783/84 and 284797. This is a progress report for a study that was to be completed in 1998.

Keywords: Whirinaki tributaries – water quality study

42. Commission for the Environment. 1979: Whirinaki State Forest management plan proposals: an appraisal. Commission for the Environment, Wellington. 6 p. Map.

This measured appraisal notes the vigorous public debate over management proposals for Whirinaki State Forest Park, and the different values of those supporting some logging versus those supporting total preservation of the indigenous forest. While the 1979 proposals of the NZFS attempted to follow government direction, as expressed in *Central North Island indigenous forest policy* (NZFS 1978a), the Commission for the Environment suggests that, in considering the management of Whirinaki Forest, the Forest Service had not given sufficient weight to the loss of much of the lowland forest in the North Island already. The Commission supports the completion of the current selective-logging trial in 'Block 10' (Okurapoto), but doubts that there is sufficient knowledge to support a sustained yield of 5000 m^3 of podocarp timber by 1989. The future of the Minginui Village is seen to depend on the retention of the Minginui Sawmill and its conversion to mill mainly exotic timber species. [Minginui Sawmill closed in 1988. Felling of trees in indigenous forest ceased in 1984, and salvaging of windfalls ceased in 1987.]

Keywords: management plan proposals, management plan submission

43. Cosslett, C.; Buchan, D.; Smith, J. 2004: Assessing the social effects of conservation on neighbouring communities: guidelines for Department of Conservation staff. *Department of Conservation Technical Series 29*. Department of Conservation, Wellington.

A technical guide describing the social impact assessment (SIA) process, and its importance for DOC. Whirinaki Conservation Park (termed Whirinaki Forest Park in this guide) is used as one of the case studies for the SIA process. The process comprises six key steps: (i) screening of projects, to determine whether the project warrants a SIA, and the scale of assessment required; (ii) profiling, or gathering background information on a proposal, and on potentially affected communities; (iii) identifying and evaluating possible effects, by comparing the profiles of the project and the communities that may be affected, and evaluating the significance of the potential effects; (iv) developing mitigation and enhancement measures, so that the risks and negative effects are minimised, and the benefits for communities are maximised; (v) identifing indicators to measure effects, so they can be used for monitoring predicted effects and measuring actual effects, relative to the baseline [BRC: This process, as described, does not include an end viewpoint, the incorporation of which would greatly increase the strategic value of such a process]; and (vi) monitoring, where the measurement of social effects due to the actions taken are used to provide feedback on the management process.

A brief examination is given in the profile of Whirinaki Forest Park, focusing on the history and management of the area, employment and income, recreational users, changes in community structure and services, effects on Tangata Whenua, and effects on the forest park neighbours. A short section outlines the mitigation and enhancement measures relating to recent possum control operations managed by DOC within the Whirinaki Forest Park. The authors state that the process of developing these measures and acceptable solutions, through consultation and negotiation, has helped increase local iwi support for the work of DOC (BRC). [See also Stokes et al. (1986), and Hutton & Neumann (2001).]

Keywords: employment, forest management, history – forest management, social impact assessment

44. Crawley, M. C. 1981: Studies of the kokako, forest bird populations and vegetation in some central North Island indigenous forests: summary report and recommendations. New Zealand Wildlife Service, Kokako and Forest Bird Coordinating Committee of Forest Bird Research Group,Wellington. 41 p.

This item is included as item 53 in the Pureora bibliography, where a long annotation focuses on the bird populations and vegetation of Pureora. This annotation is concerned with three study areas in Whirinaki Forest, where the impacts of selective logging on forest composition, forest structure, and bird populations were assessed. Logging impact in the 'Waione' and 'Hydro Access' study areas soon after logging, and 20 years after logging in a third area, a 1961 trial by South Road are described by Leathwick (1981).

Bird populations were sampled by 5-minute counts in the Waione and Hydro Access study areas and incorporated a measure of bird conspicuousness and climatic conditions. Only 15 indicator bird species gave sufficient data for detailed analysis. In the Whirinaki study areas there were statistically significant differences between the counts in unlogged and logged blocks of forest for only a few species, all in the Hydro Access study area. Apparently parakeets favoured the unlogged block, while rifleman, robins, and grey warblers favoured the logged block. 'Overall, no significant differences in bird numbers directly attributable to selective logging were found.'

[Only 7–9% of total podocarp volumes were removed from the freshly logged forest of the Waione and Hydro Access study areas. This low logging intensity was far below nominal levels of logging prescribed for the bird research study areas or for management operations, though it is comparable with that of the 1979 Okurapoto selection management trial (see Smale et al. 1998). In the 1961 trial, 30–40% of trees were logged, followed by considerable windfall in both logged blocks and unlogged controls over the following 20 years. The first operational logging in the Mangawiri Basin removed 50% of trees and led to much damage to residual trees, slash accumulation and windfall (Herbert 1979).]

Keywords: bird populations – selective-logging impact, 5-minute bird counts – Whirinaki, forest-bird populations, Forest Bird Research Group, forest composition, forest structure, phenology, selective logging – impact on birds, selective logging – impact on vegetation, vegetation assessment

45. Crook, I. G.; Merton, D. V.; Moran, L. B. 1971: Distribution and habitats of native bird species in indigenous State Forests of the Rotorua and Taupo Districts. Fauna Survey Unit Report 1a. New Zealand Wildlife Service, Department of Internal Affairs, Wellington (unpublished report). 8 p. 18 figures.

Parts of northern and western Whirinaki Forest were surveyed for the presence of yellow-crowned parakeets and kaka in 1970–71, and their distribution is recorded on a map (included as fig. 10). There were large populations of parakeets though their distribution was localised, mainly in dense podocarp forest. Whirinaki parakeet populations varied from 0.2 birds per observation station to 0.9 birds per station. Highest populations of kaka occurred in areas where parakeets were most abundant. Red-crowned parakeets were not recorded in Whirinaki Forest.

Keywords: bird distribution, dense podocarp forest, kaka distribution, parakeet – yellow-crowned

46. de Monchy, P. 1999a: Okahu/Tuwatawata, Whirinaki Forest Park northern rata condition assessment. Contract report for Department of Conservation, Murupara. 12 p.

A method of assessing the crown condition of northern rata (*Metrosideros robusta*), called the 'rata view' method, was used in 1998 to assess 115 trees in two blocks of northern Whirinaki Forest Park, where there was concern about the decline of rata attributed to possum browsing. A map shows the location of the two forest blocks, and the nine rata view sites. The three components of the rata view methodology for assessing crown condition are: (i) a rata view score for overall condition, on a scale of 1 (dead) to 6; (ii) a crown foliage thickness score, on a scale of 1 (no leaves) to 6; and (iii) a 'perimeter die-back' percentage. 'All these scores were averaged by taking the mean of all trees scored in each treatment area.' Results are given in bar graphs, with comparisons of similar assessments in Waikato Conservancy, and also Little Barrier Island (where there are no possums). There were no significant differences in scores between the two Whirinaki blocks, and each was considered to have rata in poor to moderate condition on the basis of ranking the means of the rata view scores for overall condition. Compared with the Whirinaki sites, both mean rata view and mean crown thickness foliage scores were higher for rata on Little Barrier Island, and perimeter die-back was lower.

While northern rata is a favoured food of possums, the author mentions that other workers have identified factors that may contribute to the death of northern rata and increase its vulnerability to possum browse. These include insect browse, disease, drought, tree maturity, soil fertility, and foliar nutrient concentrations. The effect of these factors on canopy condition 'may be similar enough at both Little Barrier and mainland Waikato sites to allow comparison'. Differences in canopy condition are thus assumed to be primarily due to possums. The 1998 survey in Whirinaki serves as a baseline that can be used to monitor changes in northern rata condition and assist with possum management decisions. Further monitoring is recommended. [See also Hosking (1994) and Numata (2001).]

[Crown fires have contributed to damage or death of large rata—as well as rimu and other podocarps—growing on ridges in Whirinaki Forest and the Urewera Ranges (McKelvey 1973). The 'torching' in high winds of scattered large trees, loaded with epiphytes, has been witnessed during land clearing adjacent to Horohoro Forest (a high rainfall area) and also during a 'dry' electrical storm at Whirinaki (Collins, R., pers. comm.).]

Keywords: crown fires, possum browsing, rata condition, rata-crown decline, Tuwatawata Ecological Area

47. de Monchy, P. 1999b: Possum impacts and indicator species condition: Otupaka Ecological Area, Whirinaki Forest Park. Contract report for the Department of Conservation, Rotorua. 23 p. Map.

A baseline assessment was done in October 1998 in an ecological area of mixed podocarp forest that has been given a high priority for conservation management. A map shows the location of the Otupaka Ecological Area, near the western margin of Whirinaki Forest, and the positions of six sampling lines. The assessment used the 'foliar browse index' method to assess the health of possum-preferred indicator species, and the impact of possums on them. Kamahi and mahoe were the primary target species, but small samples of five other species were assessed. The authors observed large areas of standing dead kamahi, also many dead tawa and Hall's totara, particularly on north-facing slopes. They comment 'that the Foliar Browse Index can assess possum damage on live trees only; the true extent of possum impacts in the ecological area are likely to be underestimated in this report'. They also observed that there was severe damage by deer, and that deer-preferred species were virtually absent from the understorey and subcanopy tiers.

The condition of indicator species preferred by possums at Otupaka varied from poor to moderate, and possum impacts were very high when compared with the situation in the Waihaha Ecological Area (west Taupo), where possum control has reduced possum impacts to very low levels. Data for mean foliar browse index scores in the Otupaka Ecological Area are presented for each species in a series of histograms, with data for 'percentage frequency distribution of foliage cover' and 'stem use' scores (there are 35 figures). Data sheets are included in an appendix. Recommendations are given for the introduction of possum control measures. Various options to be considered for deer control are outlined. It was thought that trees should be assessed annually, in October, to give a basis for future management decisions.

Keywords: deer browsing, deer control, foliar browse index, Hall's totara mortality, kamahi mortality, possum browsing, possum control, possum impact – indicator species, Otupaka Ecological Area, vegetation damage assessment, tawa mortality

48. Department of Conservation n.d.: Whirinaki Forest: production to protection. Video. Cardno Productions. Department of Conservation, Rotorua.

This 10-minute video shows some forest views and gives an historical outline of the changes that have occurred in management of Whirinaki Forest over about

100 years, since 1895, when the road to Te Whaiti was surveyed. A settlement had established there by the 1880s. Exploitation of timber developed from the initial pit-sawing of totara, to the construction of sawmills in the 1930s for milling kahikatea and other podocarps. The dense podocarp forests of Whirinaki [that have borne the brunt of logging] are said to be the tallest and most dense podocarp forests existing. Dr David Bellamy is seen on his 1984 visit to Whirinaki giving his views, in his usual enthusiastic manner, on the need to urgently protect the last remaining 5% of this forest type. (It evolved on the Gondwanaland continent, he says, up to 200 million years ago, and was inhabited by dinosaurs over 100 million years ago.) By the time Minginui Forest Village was built in 1946 there were three sawmills. These were replaced by a single bandsaw mill in 1976. Sustained yield management was introduced in the 1950s [but this applied to the plantations of exotic conifers planted after logging and clearing of indigenous forest, from 1940].

Early inhabitants of the sawmilling communities make brief appearances. Policy change in 1975 resulted in the first selective logging in Whirinaki Forest and heralded the confrontation between villagers and environmentalists about continuation or cessation of logging the indigenous forest. A number of those holding opposing views appear briefly: Guy Salmon, Stephen King, and Ian Shearer give the environmentalists' perspective; various village representatives make the case for continued logging to sustain employment and lifestyle. Political changes and public pressure led to the establishment of Whirinaki Forest Park in December 1983, cessation of felling indigenous trees in 1984, and the establishment of DOC bringing total protection of the remaining forest in 1987.

[Several outlines of history of the Whirinaki Valley have been compiled: see Field & Garratt (1979), New Zealand Forest Service (1979a), Orchard et al. (1981), Field (1983), Stokes et al. (1986), and Hutton & Neumann (2001).]

Keywords: forest history, forest policy, video – forest production/protection

49. Department of Conservation. 1995: Whirinaki Track: Whirinaki Forest Park. Department of Conservation, Rotorua. 1 p.

One sheet describing features of the Whirinaki Track. It passes from dense podocarp forest on river terraces in the Oriuwaka Ecological Area, to high-altitude beech forest. The track is of a high standard. There is accommodation at three huts. Reference is made to map NZMS 260 Sheet V18 Whirinaki.

Keywords: recreation, Whirinaki Track, wilderness

50. Department of Conservation 1997: Whirinaki Forest Park: short walks. Department of Conservation, Rotorua. 2 p.

A pamphlet outlining 13 short forest walks in Whirinaki Forest Park. A map shows the tracks and huts between Okui Hut in the north and Mangamate Hut in the south.

Keywords: forest walks, recreation

51. Department of Conservation. 1987: An application to the Minister of Tourism for a CAPS grant for Whirinaki Forest Park. Department of Conservation, Rotorua. Text 8 p. 12 appendices.

This report presents a case for a government grant to assist with the upgrading and extension of tracks in Te Hoe Valley, Whirinaki Forest Park, where a commercial entrepreneur proposes to promote a 3-day guided walk. The enterprise would also involve building two lodges to accommodate up to 22 persons per night. The walk would start at the southern boundary of the park, continue up Te Hoe River to Central Te Hoe Hut, then up Bullring Creek to the Okahu Road-end. A 6 km section of track would need to be upgraded, and bridges would be needed between Central Te Hoe and Te Wairoa huts. The venture company presents a preliminary marketing plan and a case for promotion of tourism: there would be employment opportunities for Minginui villagers, with jobs such as track maintenance, lodge care, guiding, and interpreting forest lore and Maori culture.

The 12 appendices include a preliminary marketing report, an economic analysis of proposals, and prescriptions for track work and bridge construction prepared by DOC staff. Colour photographs include scenes of the proposed lodge sites—one at the Bullring Clearing and the other by Moerangi Stream. Appendix 2 is an analysis by Chris Jenkins (DOC) of 29 submissions on 'The Whirinaki Concession' shows a majority in favour. The analysis lists 25 issues arising from submissions, and the conclusion is that there is no reason to decline the concession application if expressed safeguards are actioned. Support for the project in principle is given in letters from government ministers, the local communities, and others.

Keywords: Te Hoe Valley, tourism venture

52. Department of Conservation 1989: Whirinaki Forest Park: tour notes on Whirinaki Forest Park for Commonwealth Foresters' Conference field trip, 21 September 1989. Department of Conservation, Rotorua. 8 p.

A brief historical account is given of the pre-European people—Polynesian and Maori—in the Whirinaki Valley. This is followed by an outline of forest management, from the building of Minginui Forest Village in 1946, to creation of a forest park in 1984, to the replacement of the NZFS by DOC as managers in 1987. There were three main forest stops on the field trip: the site of a first attempt at operational logging in dense podocarp forest of the Mangawiri Basin [see Herbert (1979)]; the Okurapoto selection management trial, in dense podocarp forest [see Smale et al. (1998)]; and virgin dense podocarp forest in the Oriuwaka Ecological Area.

Three 4-page, colour-illustrated brochures are attached, entitled 'Whirinaki Forest Park', 'Reserves in Whirinaki Forest Park', and 'Maori of Whirinaki Forest Park'. [Those attached were 1989 reprints. There have been further editions in 1999; they are included and annotated in this bibliography as Items 53 and 54.]

Keywords: forest history, publicity brochures, tour notes

53. Department of Conservation 1999a: Whirinaki Forest Park. Department of Conservation, Rotorua. Folded booklet, four A4 pages with photographs and map of the park.

The main features of the 55 000 ha park, with its fine podocarp forest, are described. There are brief accounts of wildlife, Maori history and association

with the forest, and early visits by Pakeha leading to establishment of sawmills and logging of totara from 1928. Recreational facilities are referred to, and a map shows the locations of huts and main walking tracks. This booklet is similar to the 1994 edition, with minor revision of the text and some different photographs.

Keywords: forest history, recreation, Whirinaki Forest Park

54. Department of Conservation 1999b: Whirinaki Forest Park: short walks and tracks. Department of Conservation, Rotorua. 15 p. Photographs.

Brief accounts are given of both short and long walks in the park. A map shows the locations of tracks, huts and roads for the northern section of the park only, as far south as Mangamate Hut. The track in Te Hoe Valley is described in the text, but not shown on the map.

Keywords: recreation, forest tracks, forest walks

55. Department of Scientific and Industrial Research 1991: Radiocarbon date on totara sample from Whirinaki Sanctuary. No. NZ7901/16110. Nuclear Sciences Group, Department of Scientific and Industrial Research, Lower Hutt.

A sample of totara wood taken from a tree at Whirinaki by an Auckland University student (see Ebbett 1992) was dated by the DSIR. The radiocarbon dating method gave an age of 890 ± 28 years. [The wood at the centre of the tree could not be sampled because it was rotten, so the sample was taken as close as possible to the centre. Based on the date provided by the DSIR, and the position of the sample in the tree, Ebbett (1992) estimated the actual age of the tree to be nearly 1000 years.]

Keywords: totara – radiocarbon date, Whirinaki Forest Sanctuary

56. Department of Survey and Land Information 1987: Infomap 260-V18 Whirinaki. Department of Survey and Land Information, Wellington.

Coloured, folded topographic map, scale 1: 50 000.

Keywords: topographic map – Whirinaki

57. Donaldson, L. 1995: Designer trekking. *New Zealand Fitness 15*: 92–93.

This article describes a 2-day guided walk named 'Trek Whirinaki', in Whirinaki Forest. The walk includes helicopter access and comfortable tent camping. It finishes at the Okahu Road-end, with a welcome at the Murumurunga Marae.

Keywords: tramping – tourism

58. Eades, P. A.; Shaw. W. B. 2000: Survey and Monitoring in the Rangitaiki Area, Bay of Plenty Conservancy. Volume 1: Summary & Analysis, 79 p. Volume 2: Inventory, 293 p. Wildland Consultants Ltd unpublished report for Department of Conservation, Murupara.

A compilation of biodiversity information for land parcels administered by DOC within the Rangitaiki Area. There is a wide range of information, including botanical and fauna conservation rank (measures for conservation management prioritisation), flora and fauna lists, information on threatened species, references to vegetation maps, and information on threats to protected areas, including those posed by introduced plant and animal pest species.

Volume 1 contains basic tabular analysis, with some concentration on botanical issues, and provides recommendations on survey and monitoring priorities. [The authors do, importantly, identify the need to 'fill in key gaps in survey information', recommending the collection of biodiversity information that is currently lacking.]

Volume 2 provides the inventory on each land parcel, including topographical maps. The land parcels and management units administered by DOC in the Whirinaki Conservation Area (c. 2000) include: Whirinaki North Management Unit, Whirinaki Conservation Park (northern part), Basin Loop Covenant, three Forest Corporation covenants, Whirinaki Management Unit, Otuwairua, Whirinaki Conservation Park (southern part), Okahu, Upper Mangamate, Upper Whirinaki, Waione, Otupaka Ecological Area and its extension, Oriuwaka Ecological Area, Tuwatawata Ecological Area, Tauranga Basin Ecological Area, Te Kohu Ecological Area, and Whirinaki Forest Sanctuary.

[This is a large body of work, and a useful first attempt to gather such information. Numerous information gaps are apparent, especially for fauna and threats, although clearly this work is a highly important step for conservation management of the Rangitaiki Area. The majority of information is botanical, and this was derived primarily from Nicholls (1969) and Beadel (1995). This work was supported to a large degree by knowledge and information provided by DOC's Bay of Plenty Conservancy employees at the time, c. 1998–2000. There is a far greater amount of biodiversity information for the Whirinaki Conservation Park land parcels listed here than there is for smaller sites within the Rangitaiki Area, with the exception of islands. The collated information from this work is being used as a base for an updated and expanded biodiversity information resource (see Christensen et al. forthcoming).] (BRC)

Keywords: Inventory

59. Ebbett, R. L. 1992: Ecological characterisation of dense lowland podocarp forest, Whirinaki Sanctuary. Master of Environmental Science/Botany thesis, University of Auckland, Auckland. Text 119 p. Appendices 50 p. 104 references.

An intensive study was made of a 4 ha site in the Whirinaki Forest Sanctuary, west of Minginui Stream (see Fig. 1). The vegetation is dense, mixed podocarp forest with a tawa subcanopy (forest type L2 of Nicholls (1996)), growing on a terrace covered in deep pumice alluvium. A thorough quantitative analysis was made of the vegetation on the study site, and a vegetation map was prepared. The map shows the positions of individual trees of all five podocarp species, and also tawa, and each tree is assigned a size class. It also locates the positions of stumps, windthrows and standing dead trees, and shows the position and size of all canopy gaps. Four colour-coded vegetation map-sheets are placed in a back pocket of the thesis. The main purpose of the vegetation map was to

provide a baseline, enabling long-term studies of gradual changes in forest composition and structure.

Past work on the history and development of dense podocarp forest in the central North Island is reviewed. The data collected by the author led to suggestions about regeneration processes of the podocarps, including their site and environmental preferences. Each of the podocarp species has a particular set of ecological characteristics and a different degree of shade tolerance. Shade tolerance was assessed by experimental work. Bagged seedlings of the five podocarp species were grown for 16 months in a university glasshouse, and then measured for changes in height, diameter, and dry weight. In the forest, seedlings within netted cages were observed under different canopy types and measured light intensities.

In this study, podocarp seedlings were considered established if over 50 cm in height, and saplings were taken to be small trees over 1.5 m in height and with a dbh (diameter at breast height) of up to 10 cm. Over the 4 ha study site there was a scattering of miro seedlings, only two rimu seedlings, and no matai or totara seedlings. Only two saplings were recorded—one miro, and one kahikatea. It was concluded that the present canopy of tall podocarps, with the tawa subcanopy, was too dense to allow regeneration at present.

Early stages of dense podocarp forest development were recognised at the study site, being represented by a pole stand of mixed podocarps, about 90 years old, growing at the margin of the study area on an old Maori burn site (or old occupied site) that had been abandoned about 1840. Late stages of forest development were also recognised. There is a group of three giant, old totara on a ridge site in the study area. One of these (illustrated as a frontispiece), growing near the southern boundary of the sanctuary, received a radiocarbon date of 890 ± 28 years (DSIR 1991). The dated sample came from a core with a rotten centre (the rotten centre would be older), so Ebbett estimated another 100 years should be added to this date, giving an age for the tree of almost 1000 years. There are also 20 large, old totara (2.0–3.5 m diameter) on an alluvial terrace in the forest sanctuary, but only 8 of these are still living.

Since probable complete destruction of the former forest of Whirinaki by tephra from the Taupo Eruption in about AD 180, the author suggests the new dense podocarp forest developed through fern, manuka, kanuka and kamahi—along the lines of the local podocarp pole stand (see Cameron 1964; Katz 1980b – Forest Research Institute sample plot R223). Totara would be the pioneer podocarp after the Taupo Eruption, as it is the most light-demanding, and probably would have been followed by matai. About 1000 years ago (the estimated age of the oldest totara), a lightning fire or other catastrophe may have opened up a forest clearing, allowing the present totara to establish on the study site (the site is now at the stage of senescence, with no totara seedlings present).

Miro is the podocarp with the highest shade tolerance, being able to establish under a canopy and develop with sidelighting, or establish in small gaps. In the study area, kahikatea prefers the moist or high nutrient conditions on raised sites, such as rotting logs. It is speculated that regeneration of gaps can occur after storm damage (storms can produce extensive gaps) or death of one or a full group of canopy trees (creating smaller gaps). The existing dense podocarp

forest may remain on the study site, with gradual replacement of podocarps, or extensive renewal after a catastrophe.

An appendix lists ages recorded for 1650 trees, of which 221 were miro, 904 rimu, 54 matai, and 47 kahikatea (appendix 6). Maximum ages recorded are 750 years for miro (a few are 400–650 years), 1175 years for rimu (a few are over 800 years, but most are 500–800 years), 600 years for kahikatea (a few are over 500 years, but there is a suspicion that growth rings are not always annual), and matai are all between 500 and 800 years. [The ages listed must be for podocarps in the central North Island. The maximum age of 750 years for miro is exceptionally high, as is 1175 years for rimu. Ewen Cameron (1987) gives ages for trees in the Whirinaki Forest Sanctuary, including miro of 200–480 years. Katz (1980a) gives ages for trees in the Okurapoto Basin, including kahikatea and miro, of 300–500 years. Maximum ages given by Ebbett match those tabled on pp. 272–274 of Enright, N. J.; Ogden, J. (1995): The southern conifers—a synthesis. (Enright, N. J.; Hill, R.S. eds: *Ecology of the Southern Conifers*. Melbourne University Press, Melbourne. 342 p.). Growth-ring counts from podocarps in Whirinaki Forest (forest types L1, L2 and M2) are given by Roger Cameron (1960b).

A summary of the history of Maori occupation is given in an appendix of this thesis. Some 25 reference papers listed in the thesis have been annotated in the current bibliography.

Keywords: dense podocarp forest – ecology, dense podocarp forest – pattern, Maori occupation history, podocarp regeneration – shade tolerance, podocarp seedlings – light requirement, totara – radiocarbon date, vegetation map – forest sanctuary, Whirinaki Forest Sanctuary

60. Ebbett, R. L.; Ogden, J. 1998: Comparative seedling growth of five endemic New Zealand podocarp species under different light regimes. *New Zealand Journal of Botany 36*: 189–201.

The comparative growth of seedlings of the five species of podocarp that grow in Whirinaki Forest was assessed at four different light levels in the dense podocarp forest (type L2) of Whirinaki Forest Sanctuary. Light levels were between 5% and 30% of full sunlight. Nursery-raised seedlings, 2–3 years old, were transplanted to planter bags, and the bags placed on the forest floor under different canopy types, within netted enclosures. Seed sources were not local—the source of the kahikatea and totara were unknown, and the rimu and miro were from South Island provenances. Mean height of seedlings transplanted to bags ranged from 21.1 cm (kahikatea) to 45.5 cm (matai). Measurements were made of height, stem diameter, and dry weight increases over a 15-month period, from August 1990 to November 1991. Seedlings were also placed in an Auckland University glasshouse and measured over the same period.

In the forest, miro showed the greatest mean height growth, with the leaning leaders, when held upright [leaders of miro seedlings tend to grow towards a horizontal position in shade], measuring 10.7 cm. Mean height increments were 7.8 cm for totara, 7.5 cm for kahikatea, 5.0 cm for rimu, and 1.9 cm for matai. The generally accepted order of shade tolerance (in order of decreasing shade tolerance) is miro, rimu, matai, kahikatea, and totara. However, in this study, miro showed a growth response to higher light levels, whereas rimu and matai

did not. Previous studies of podocarp seedling growth rates are reviewed, and regeneration strategies of the five podocarp species are discussed.

Keywords: dense podocarp forest, light intensity – growth, podocarp seedling growth, shade tolerance in podocarps, Whirinaki Forest Sanctuary

61. Edmonds, A. S. 1979: The forests at Whirinaki. Paper presented at Auckland seminar on the Forests of Whirinaki, held by the Native Forest Action Council. Biological Sciences Department, University of Waikato, Hamilton (unpublished report). 6 p. [Copy held by Landcare Research, Hamilton.]

This paper makes the NFAC case for challenging both the current (1979) activities of the NZFS in Whirinaki Forest, and also their proposals for future management, as prepared by the Rotorua Conservancy (NZFS 1979a).

[Much information was not available or was ignored in 1979 (e.g. Nicholls 1966, 1969; Forest Research Institute annual reports; McKelvey 1973) on matters such as forest stability, growth rates, and regeneration in Whirinaki podocarp and podocarp/tawa forests. Much information has appeared in unpublished reports or published papers since that time, and is included in this bibliography. In long-monitored trials in central North Island forests, including Whirinaki, there has been volume decrement of podocarps in both unlogged virgin forest and in controlled, selectively logged forest, at about the same rate. At Whirinaki there has been little response in the way of podocarp regeneration to the opening of the canopy by natural mortality, or the creation of small gaps by partial logging.]

Keywords: conservation issues, forest ecology, forest management, landscape

62. Edmonds, A. S. 1982: Indigenous forests of the central North Island. *New Zealand Entomologist 7(3)*: 271–276. 19 references.

Abstract in NZ Science database: A general account of indigenous forests in the central North Island, including historical aspects. Reference is made to the Whirinaki Basin as one of two areas on the Central Volcanic Plateau with dense podocarp forest—a forest type now very restricted in distribution, but once very extensive. Podocarp/hardwood forests are more extensive, but still, in the North Island, a total of only 56 000 ha of these two types of forest remain unlogged, and should therefore not be felled.

Keywords: central North Island forests, forest ecology

63. Enright, N. J.; Hill, R. S. (Eds) 1995: Ecology of the southern conifers. Melbourne University Press, Melbourne. 342 p.

This is a seminal and definitive work, with over 600 references. It is an excellent source of information for those who wish to understand the complex southern conifer forests and attempt biological interpretations of the podocarp forests of the central North Island. [For specific reference to the community dynamics of New Zealand conifers, which may be of more relevance to Whirinaki Forest, see Ogden & Stewart (1995).]

Keywords: ecology of indigenous conifers

64. **Environment and Conservation Organisations of New Zealand (ECO) 1979: A submission to the Conservator of Forests, Rotorua, on Forest Service Management Plan proposals for Whirinaki State Forest, August 1979. In: Submissions on Whirinaki State Forest. New Zealand Forest Service, Wellington. 7 p.**

This submission covers the views of ECO and the NFAC, both opposing NZFS management proposals for Whirinaki Forest. [See NZFS (1979a).]

Keywords: conservation issues, management plan submission

65. **Field, D. A. 1983: Developing a forest management plan: the Whirinaki State Forest, New Zealand. Pp. 139–215 in Hamilton, L. S. (Ed.): Forest and watershed development and conservation in Asia and the Pacific. Westview Press, Boulder, Colorado.**

This account by a professional NZFS forester, included in an international volume, supports (at the time of writing, c. 1980) the revised indigenous forest policy being applied to the management of Whirinaki State Forest. The author of another paper in the same volume provides a summary of the 'case study' on 'Whirinaki State Forest Management Policy' (pp. 5–7). There is a useful reference list of 37 papers (some unpublished) and about half are included in this or the Pureora bibliography.

[A rapid series of events after 1980 led to the dissolution in 1987 of the NZFS and its multiple-use philosophy, and replacement by DOC, with main concerns for protecting forest, plants and wildlife, and the proscription of any wood production (except for occasional use of totara for Maori cultural purposes). This paper is, however, a useful description of the history of logging in New Zealand and Whirinaki State Forest. It describes the evolution of a revised indigenous forest policy, which led to cessation of clear-felling in Whirinaki State Forest in 1975, and the start of partial logging, which was to lead to a form of selection management.]

'Landmarks' in the development of the Whirinaki Forest management plan finally issued in 1981 by the NZFS (Orchard et al. 1981), were:

1932: NZFS assumed control of Whirinaki State Forest, to administer the logging of Crown-owned land.

1938: NZFS introduced a logging plan.

1945: Establishment of exotic forest plantations commenced.

1945–47: Minginui Forest Village established.

1974–75: Clear-felling indigenous forest and replacing with plantations of exotic species ceased. Selective or partial logging was initiated in the Mangawiri Catchment. [See Herbert (1979).]

1977: Publication of a revised policy for management of New Zealand's indigenous state forests (paper included as an appendix).

1978: Management proposals announced for west Taupo forests. Seminar and vigorous public debate on management of central North Island forests.

1979: Management proposals for Whirinaki State Forest submitted for public comment. They were strongly opposed by environmental groups but supported by Minginui Forest villagers. The villagers mounted protests against

the more radical environmentalists, and feared unemployment if logging of native forest ceased and mills closed.

1981: NZFS issued a management plan for Whirinaki Forest.

In the current paper, the author provides a background to the controversy surrounding management of Whirinaki State Forest, and gives information about the forest administration. Some descriptive material has been taken from a 1980 draft of the management plan. [See also NZFS (1979a) on management plan proposals, NZFS (1979b) on submissions and their analysis, and Orchard et al. (1981) on the NZFS management plan.]

Keywords: forest policy, logging history, Whirinaki management plan – case study

66. Field, D. A.; Garratt, K. J. (Study Convenors) 1979: Whirinaki State Forest: a study of the National Parks Authority. New Zealand Forest Service and Department of Lands and Survey, Wellington. 57 p. Maps, appendices.

This study was carried out as a result of fierce controversy about the future status and management of Whirinaki Forest, intensified by the publishing of the NZFS draft management plan in May 1979 (NZFS 1979b), which invited public submissions. Environmental interest groups such as the NFAC and ECO were pressing for 31 000 ha of Whirinaki State Forest (the state forest had a total area of 60 000 ha, including exotic plantations) south of Minginui Village (less modified than the northern part, with its exotic plantations) to be added to the Urewera National Park. The National Parks Authority asked the two government departments—the Forest Service and the Department of Lands and Survey—to carry out a joint study with the objective being 'to identify areas of Whirinaki State Forest which are of national park quality in terms of the National Parks Authority'.

The joint study based much descriptive material on the NZFS management plan proposals (NZFS 1979b), and considered the criteria for national park status. Assessments by landscape architects of visual and aesthetic values were included. The study did not attempt to assess the social and economic implications of national park status for the southern part of Whirinaki State Forest, but concluded that the proposed additions of part of Whirinaki Forest to Urewera National Park do 'meet the natural and physical criteria for national park quality, despite some modification by roading and selective logging'. Changes would be needed to recreation and hunting policies. [In view of the establishment of Whirinaki Forest Park in 1984, with no further logging of native trees, and the transfer of the park to DOC in 1987, much of this report is of historical interest only. No addition to the Urewera National Park was made.]

The most distinctive vegetation types of Whirinaki were said to be the dense lowland podocarp forests, and the monoao (*Dracophyllum subulatum*) frost flats, with representative examples included in ecological areas. In a section on landscape, the physiography of Whirinaki is described, emphasising the impact of successive volcanic ash showers on the vegetation, and also how the topography contrasts with that of the ancient sedimentary rocks in the Urewera National Park. The four [later five] proposed ecological areas in Whirinaki State Forest, totalling approximately 7670 ha, are referred to, with brief descriptions of the forest types and broader forest pattern of each.

Modification of forest edges by fires, before and after European settlement, is mentioned, and so is the long history of impact on vegetation from introduced wild animals, starting early in the 19th century for deer and possums, with a peak period in 1958–62. There is a section on recreation policy in Whirinaki, and also Urewera National Park, listing compatible and incompatible uses and different management policies in the two areas. Another section outlines the history of wood production from Whirinaki Valley, extending back to the 1930s when Crown and Maori land was logged for totara fencing material, including part of the Okurapoto Basin (Hunting Block 10). 'Salvage logging of dead and dying totara' continued in the 1950s.

Keywords: animal impact, environmental values, landscape values, physiography, recreation values, Urewera National Park, Whirinaki Forest – proposed additions to Urewera National Park

67. Field, D. A. 1985: Public involvement in management planning for Whirinaki State Forest. Pp. 53–57 in: Institute of Foresters of Australia and New Zealand Joint Conference, 20–24 May 1985, Hobart, Tasmania.

An amendment to the Forests Act in 1976 facilitated public involvement in management planning for state forests. Full use of this provision allowed vigorous and often emotional public debate, with submissions being invited on the NZFS management proposals for Whirinaki Forest in 1979. This debate, fuelled by the news media, lasted until 1984, when a new government announced that logging of native trees would cease immediately. (Salvage operations to extract logs from windfallen trees continued for a further 3 years.) Opinions were polarised between environmental organisations wanting full protection of Whirinaki Forest, with part added to the Urewera National Park, and those supporting NZFS proposals, notably residents of Minginui Forest Village and those employed in logging and sawmilling. Minginui villagers organised strong opposition to visits by some environmentalists. Whirinaki became a forest park in 1984, with no addition to the Urewera National Park. The debate became strongly influenced by political views, and the author deplored the lack of objectivity on many issues. A Forest Park Advisory Committee was to be established in 1985.

[See annotations for NZFS management plan proposals (NZFS 1979a), submissions (NZFS 1979b), and management plan (Orchard et al. 1981). See also Field & Garratt (1979), Field (1983), and Morton et al. (1984).]

Keywords: forest management, forest policy, public debate – forest management

68. Fleming, C. A. 1977: The history of life in New Zealand forests. *New Zealand Journal of Forestry 22(2)*: 249–262.

A leading New Zealand scientist of his time, the late Charles Fleming offered a broad perspective on the values of New Zealand's indigenous forests, in which the oldest life goes back more than 100 million years to the time of Gondwanaland. The forests are most like Gondwanaland's Mesozoic forests. [Present-day interpreters of the environmental values of Whirinaki Forest could receive inspiration from this account.] The final sentence reads: 'The

intellectual value of the indigenous forests, their long history and the relationships of their component species enhances the recreational and aesthetic values that the environmental movement has emphasised when urging their preservation on behalf of future generations of New Zealanders.'

Keywords: forest values, history – forest life

69. Forest Industries Review 1979: Minginui: a village fighting for its life. *Forest Industries Review 10(5)*: 2–3.

This article refers to the 'battle' by the residents of Minginui Village (population 450) to oppose conservationists who had mounted a 'campaign' to cease logging of native trees in Whirinaki State Forest and add part of the forest to the Urewera National Park. The villagers feared that without cutting of native timbers the local sawmill would close, and they perceived a threat to their way of life and future employment in the forest. The manager of Minginui Sawmills Ltd confirmed that the mill would not be a viable proposition without native timber. The villagers' immediate confrontation was with visitors from the most radical group of conservationists, the NFAC. Government policy, exercised through the NZFS, envisaged reduction of native timber production to a level thought sustainable by 1990, with the mill depending mainly on cutting timber from exotic plantations.

[Milling of native timber salvaged from windthrow ceased in 1987, with the establishment of DOC. Minginui Sawmills closed its mill in 1988. There has been no adequate assessment of the longer-term impact of operational selective logging, conducted from 1975 to 1984, or of the later performance of podocarps planted by NZFS Rotorua Conservancy staff from 1977 to 1984. Monitoring of selection management trials—for stability of residual trees, tree mortality, podocarp regeneration and success of planted seedlings—has continued to the present time. See Smale et al. (1998), and Steward (1998).]

Keywords: confrontation (Minginui residents and NFAC), logging native timbers – cessation, Minginui Village – lifestyle, sawmill operations – closure

70. Forest Research Institute 1975: Biological reserves and forest sanctuaries. *What's New in Forest Research 21*. Forest Research Institute, Rotorua. 4 p.

This article set out to explain the need for scientific reserves in indigenous forest, the principles for establishing them, and the use of scientific expertise from interdepartmental committees in defining them. Data from the National Forest Survey of 1945–56, and a later ecological survey, had been used to produce maps of forest types, and these were the basis for recommending reserves. The term 'ecological area' has supplanted the label 'biological reserve' and a 'Scientific Coordinating Committee' was formed to consider recommendations by Forest Research Institute scientists. The scientific reserves were to be established not only as 'museums' for protection of animal and plant species, but as areas for scientific research. [See NZFS (1984) for the five ecological areas and the single forest sanctuary established in Whirinaki Forest.]

Keywords: ecological areas, forest sanctuary, scientific reserves

71. Forest Research Institute 1982a: Age and growth of podocarps in a dense podocarp stand, Whirinaki. Pp. 13–14 in: 1981 Annual Report of the Forest Research Institute, Rotorua. New Zealand Forest Service, Wellington.

A summary is given of work in progress in the Okurapoto trial area. Growth rings on prepared sections of podocarp stumps indicate ages ranging from 300 to 700 years. The oldest rimu had 617 rings. The mean annual diameter increment of rimu was 1.9 mm. Dense mixed-podocarp forest is developing in 80-year-old stands on old Maori clearings. A full account of these pole stands is given by Katz (1980b). A photograph in this report shows a logged gap in a rimu-dominant stand at Okurapoto, freshly planted with podocarp seedlings. There are understorey tawa at the margins of the gap, which have generally shown increased growth rates in response to the increased light. [Tawa growth rates have been monitored and data are on electronic file at Forest Research. Further accounts of the Okurapoto trial are given in Forest Research Institute (1984), Smale et al. (1985, 1987, 1998), and Steward (1998).]

Keywords: dense podocarp forest, Okurapoto trial, podocarp ages, podocarp pole stands, rimu growth – diameter

72. Forest Research Institute 1982b: Totara dieback. *What's New in Forest Research 110*. Forest Research Institute, Rotorua. 4 p.

A study of small totara trees at the eastern edge of Pureora Forest Park showed that trees with crown die-back had buds and shoots damaged by a complex of insects and fungi, but it was considered that the cause of the die-back was inconclusive. Possum browsing was not severe and extensive. The oldest trees in this study were in Whirinaki Forest (Mangawiri Basin), where six representative totara were aged from ring counts at 390 years to 490 years. [This is not as old as other cohorts of totara in Whirinaki, mainly suffering from some measure of crown die-back or death while standing. Possum browsing of totara has since been found to be widespread in some central North Island forests, as shown by analyses of the stomach contents of possums from Waihaha Forest and the Mangawiri Basin. See Mason (1968), Beveridge (1967), and Nugent et al. (1997).]

Keywords: Mangawiri Catchment, possum browsing, totara die-back

73. Forest Research Institute 1984: Whirinaki State Forest: a management study in dense podocarp forest. *What's New in Forest Research 130*. Forest Research Institute, Rotorua. 4 p.

A preliminary account of the Okurapoto trial, written 5 years after the 1979 selection logging which removed 9–15% of the merchantable volume of trees in a rimu-dominant forest with a tawa understorey and no effective podocarp regeneration. Topics covered include the original composition of the forest, different tree selection criteria for three blocks, damage to residual trees caused by logging, stand stability, and prospects for change in forest composition. [Some aspects have been monitored for a further 20 years (Smale et al. 1985, 1988; Steward 1998).]

Keywords: dense podocarp forest, forest composition, forest stability, Okurapoto trial, selection management

74. Forest Research Institute 1987: Exclosures: a means of assessing the impact of browsing animals on native forests. *What's New in Forest Research 156*. Forest Research Institute, Rotorua. 4 p. 3 colour illustrations.

A concise account of the results of establishing 17 fenced exclosures with controls in the Urewera National Park, to assess the impact of red deer on the vegetation. A visual assessment and photographs show marked differences in vegetation between exclosures and control plots after 12–20 years. These observations were confirmed by quantitative assessment of size and density of saplings and tall seedlings. Saplings of palatable species were almost eliminated in the controls, with an increase of unpalatable species such as horopito (*Pseudowintera colorata*). The increase in sapling density and growth within exclosures is striking. [A more detailed account is that of Knowlton et al. (1982). See also Bishop et al. (1998).]

Keywords: browsing animal impact, exclosures, understorey depletion

75. Forest Research records 1949–2004: Archives on the ecology and management of central North Island indigenous forests. Compiled by A. E. Beveridge.

Records relevant to Whirinaki Forest held by Forest Research are as follows:

Permanent Sample Plot records for studies in the NZFS's Rotorua Conservancy (e.g. R1979 containing records for a selection management trial in dense podocarp forest of Whirinaki State Forest, with work plan, some correspondence, inspection reports, and interim reports of results).

Copies of sample plot records that were held by the Rotorua Conservancy, NZFS. Field copies are retained in the records of the former Indigenous Forest Management Group, together with full plot data.

All published papers by NZFS and Forest Research authors referred to in this bibliography are held in the National Forest Library at Forest Research.

Project reports and other unpublished reports are held in the technical records of Forest Research.

Archives of the Indigenous Forest Management Group, Forest Research Institute, consist of filing cabinets with copies of internal and external correspondence, file notes, informal notes, diary and inspection notes, annual report extracts, maps and photoprints, newspaper and journal extracts, etc. Also, two lever arch files on 'Podocarp Forests, Whirinaki', labelled '28/4/2/1', contain most relevant technical items extracted from Forest Research correspondence files. These include the views of experienced ecologists, such as John Nicholls and John Herbert, on the status and dynamics of the Whirinaki forest types. (Landcare Research holds other maps and ecological items.)

Correspondence on research in Whirinaki Forest, starting in 1949, makes reference to studies of the ages of mature podocarps from ring counts on stumps in different forest types. Ages range from 230 to 680 years, with matai trees being the oldest. [Totara may reach an age of 1000 years (DSIR 1991), but as largest trees often have defective cores they were not aged in this earlier study.]

In old-growth forest, no podocarp regeneration beyond the seedling stage was found, but it had been induced by disturbance from fire or clearing. Advanced regeneration (to pole stage) was later found to cover some 300 ha. Records of 'poles' in old-growth forest are often found to be in rimu- and matai-dominated stands, in the 10–30 cm diameter size category. Apart from plots established in pole stands by Grant in 1950 (sample plots R221–223), and the National Forest Survey (Masters et al. 1957), little research was recorded until the mid-1950s when the papers by McKelvey and Cameron were published.

There was no timber exploitation in Whirinaki Forest before the 1920s, and logged areas tended to be burnt into the 1930s. Cameron's views on research requirements were outlined in a memo to Rotorua Conservancy dated 7 July 1955—he commented on a working plan revision for Whirinaki State Forest. Cutover inspections, and growth studies of podocarp seedlings in observation plots, were made in following years. Podocarp seedlings were raised in the Te Whaiti Nursery, which was established in 1938, but abandoned in 1946 after planting about 12 ha of cutover and scrub. Some remnants may have become well established (Blick, A. 2004, pers. comm.). A research programme was prepared by Cameron in 1957 (memo dated 14 October 1957), and the first selective-logging trial was established in 1961 near South Road, in podocarp/tawa forest. Subsequent work is covered by papers annotated in this bibliography, except for trial group planting of podocarps within small exclosures and controls (Mangawiri Basin). This was carried out in 1976 after heavy operational selective logging, and in 1980 in animal-induced clearings (Kopuatoto). Inspection in June 1984 indicated that leaders of planted rimu and kahikatea were being removed on some seedlings, and in general seedlings were more vigorous at margins of animal-induced clearings in the Kopuatoto area. The progress of seedlings planted by Rotorua Conservancy staff, from 1977, are reported on by R. Hammond, Rotorua Conservancy, and P. Wilcox, Forest Research (file note, 23 November 1984).

Other correspondence of historical or ecological value includes the following: accounts of windfall and damage from Cyclone Bernie in April 1982; accounts of windfall in trial areas; discussions between the NZFS and the DSIR on reserves and forest management; replies to ministerial questions and questions from the NFAC and others; an appraisal of the book *To save a forest: Whirinaki*, by Morton et al. (1984); and suggestions for restoration by planting totara in an area cleared for exotic conifer planting in the Mangawiri Basin (June 1985).

A search of NZFS's Rotorua Conservancy files in the Auckland Regional Archives section of the National Archives New Zealand has provided information on NZFS intent and objectives since 1938. Before 1950, an occasional inspection of recently cutover (logged) indigenous forest (mainly former dense podocarp sites) gave impressions of poor podocarp regeneration (mainly short-lived kahikatea seedlings after heavy seed crops). Enthusiasm diminished, both for obtaining adequate podocarp regeneration, and aiming for sustained yield management.

[After either clear-felling or substantial logging, a period of 20–30 years is required for establishment of podocarp seedlings underneath regrowth vegetation. A similar period is required for regeneration beneath fire-induced vegetation such as manuka/kanuka. Inspection in April 2004 of rimu-dominant

forest on the margins of the Mangawiri Basin—subjected to heavy partial-logging in 1975 (Herbert 1979) followed by windthrow of residual canopy trees and collapse of pioneer wineberry regrowth—revealed that this type of 'catastrophe' has prompted abundant small podocarp regeneration. See comments of Beveridge et al. (1985) on vigour of kahikatea and rimu planted beneath a canopy opened by logging and windthrow. See Gamble (1979) for comments on the impact of partial logging from 1945 to 1965, and see NZFS (1979a) for a reference to retention of news media items.]

Keywords: archives (Forest Research), management correspondence, Whirinaki ecology

76. Gamble, J. C. 1979: The past effect of logging on regeneration in Whirinaki State Forest. Bachelor of Forestry Science thesis, University of Canterbury, Christchurch. 90 p. 30 colour photographs.

Podocarp regeneration was sampled by means of 61 circular plots (each 0.04 ha, with a diameter of 11.28 m) in four areas of partially logged forest, classed as P5 (matai-totara on pumice alluvium) by the National Forest Survey. The locations of the plots are shown in an enclosed map of Whirinaki State Forest. Matai dominates P5 forest on river terraces. The sampled localities had been logged from 1944 to 1965, mainly for totara, with some rimu, matai and kahikatea in places. The four localities were Old Te Whaiti Road (logged 1944–45), River Road (logged 1944–45), Okurapoto (logged 1945–46) and Waione (logged 1964–65). In the first two areas only totara were logged, for splitting or sawing into fencing material, and horses were used for wood extraction, as well as steam haulers (Old Te Whaiti Road) and early tractors (River Road). It was estimated that 20% of the total merchantable volume was removed from these areas, all as 'dead and down' totara. In the Okurapoto and Waione areas, totara was logged as both dead and live trees, as were some other podocarps. An estimated 40% of volume was removed, by older extraction methods or by D7 tractors in the Waione area. In the four sampled areas there were considerable differences in the original forest type, topography and soils. Local disturbance of canopy and ground varied with different wood extraction methods.

Results of sampling are expressed in many tables and graphs, and in appendices which include all details recorded for the circular plots. Many plots contained abundant or frequent podocarp regeneration, though mainly in a suppressed condition, less than 3 m high. Most abundant were kahikatea and matai—as ephemeral seedlings less than 10 cm high, or as more established seedlings 10–100 cm high. Striplings, 1–3 m high, were also common, but few stems were over 1 cm in diameter. Rimu seedlings were more frequent on dry ridge-tops of the Okurapoto and Waione areas, which had rimu-dominant forest with a tawa subcanopy in places. Forest previously dominated by matai and totara was mainly situated on river terraces with deep pumice deposits.

The Old Te Whaiti Road site [which could be described as cold and droughty, with an understorey of cold-adapted and relatively browse-resistant shrubs] had no tawa trees or tawa regeneration, and was found to be matai-dominant now, with regeneration of matai, kahikatea, and totara, often in a suppressed condition with a heavy coating of moss and lichen, and stems malformed by

vines (*Rubus* spp., *Muehlenbeckia* spp.). [It appears that in this area, with gaps made by continuing windfall and mortality of old trees, there could be a slow eventual return to forest comparable with the old-growth forest, but with a much lower component of totara.]

In the Waione area, where all old-growth totara was reported to have 'died suddenly', no totara regeneration was found in plots. Mortality was tentatively attributed to possum browsing. Totara were removed in a salvage-logging operation. Dense wineberry thickets have appeared on ground disturbed by logging, and beside new roads. Wineberry appeared to initially suppress newly germinated podocarp seedlings on extraction tracks, but as it started to die back, from about 20 years in age, and collapse at 20–30 years, some podocarp seedlings survived and gained in height.

Ages of 24 podocarp seedlings and striplings (mainly those of 5–10 mm diameter and 30–100 cm height) from the four sampled areas were estimated from ring counts on stems. Ages attributed generally ranged from 5 to 30 years for kahikatea, rimu, matai, and (two) totara. Most appeared suppressed, often with moss on stems or branchlets, but occasional healthy seedlings grew at the edge of extraction tracks or in gaps made by windfalls.

There is a discussion of factors affecting regeneration of podocarps in Whirinaki Forest, with a comparison of the situation in west Taupo forests, and references to earlier work. The impact of animal damage on podocarp seedlings was most marked in the Waione area, where the podocarp seedlings were umbrella-shaped in many places, due to the continual nipping off of the main leaders. Palatable species had been removed by browsing. Mortality of a ridge-top kamahi/rata/Hall's totara stand in the Waione area, caused by possum browsing, is illustrated (photograph 17). An animal-induced clearing is also shown (photograph 18).

A useful history of timber exploitation is given, with information derived from local staff, older village residents employed in logging, and earlier management plans (1950–60). Logging in the 1920s and 1930s was mainly for dead and dying totara (used for fencing), and, until 1938, was under the control of the Department of Lands and Survey. Where wood was removed by horses or steam haulers, tracks were narrow and ground disturbance minimal, with subsequent covering of tracks by regrowth (mainly wineberry and ferns). Logging became more intensive in the 1940s, with milling of most podocarps or extraction of the best logs for peeling. Tractor logging became standard from 1945, and more intensive, with a network of extraction tracks and metalled roads. The NZFS logging scheme was initiated in 1938, with the expressed intention of introducing a selection system on a sustained yield basis. It was envisaged that planting stock would be required to supplement natural regeneration. A nursery was established at Minginui from 1938 to 1946, but attempts at establishing podocarp seedlings by planting largely failed, and so were abandoned [until further large-scale planting in selectively logged forest from 1977 to 1984].

Keywords: logging history, logging impact on regeneration, logging practices – earlier, podocarp regeneration – growth and age, podocarp regeneration sampling, regrowth after logging, totara exploitation, totara mortality, Waione rimu/tawa forest, wineberry regrowth

77. Grant, P. J. 1963: Forests and recent climatic history of the Huiarau Range, Urewera region, North Island. *Transactions of the Royal Society of New Zealand (Botany) 2(12)*: 143–172.

This is a broadly descriptive account of the forests of the Huiarau Range. It includes hypotheses on climate change since about AD 1700, involving increased temperature and windiness, with periods of physiological drought, making most forest types unstable. It is based on experience of fieldwork with the National Forest Survey around 1950, and includes that part of Whirinaki Forest on the western fall of the Huiarau Range, extending as far as the Te Whaiti fault.

It is suggested that the forests may have suffered catastrophic damage by a severe storm about AD 1650. Since that time, there has been little effective podocarp regeneration, except on disturbed sites. Disturbance events could have included alluvial deposition following local erosion (podocarps on alluvial deposits have been aged at about 300 years, from ring counts), fires, and clearing by humans.

Depletion of lower forest tiers by animals (possum and deer) was found to be severe, but the author believed that podocarp seedlings and saplings are seldom browsed or otherwise damaged by animals (p. 155). [Browsing of podocarp seedlings and saplings has been demonstrated in more recent years in Whirinaki Forest (e.g. Gamble 1979).] Severe frost damage to tawa was also noted (p. 164). A feature of 'a large area east of the Whirinaki Valley' is the number of short-boled terrestrial rata, possibly developed without competition, indicating devastation of the forest by gales or fire by AD 1700 (p. 156). It is suggested that isolated stands of beech could have resulted from direct dispersal by wind during the postulated forest catastrophe around 1650. [Other writers have considered beech seed to be dispersed mainly by water, and groups of beech survived during the Taupo Eruption of around AD 200.]

Keywords: animal impact, climate change hypothesis, forest catastrophe hypothesis, forest ecology, forest instability, forest types, podocarp regeneration, rata – terrestrial, Urewera Ranges

78. Green, R. D. 1986: Deer utilisation by the Forestry Corporation at Whirinaki State Forest Park. Bachelor of Forestry Science thesis, University of Canterbury, Christchurch.

Six deer capture pens had been established by the NZFS in Whirinaki Forest Park, some of a total of 50 pens operating in the park. This thesis gives an economic analysis of four possible management strategies for the red deer resources of the park. The most profitable venture, from a commercial viewpoint, was to 'establish a 40 ha deer farm on the river flat, above Whirinaki River'.

Keywords: deer capture, deer management, deer utilisation

79. Grindley, G. W. 1960: Geological map of New Zealand, 1:250 000, Sheet 8 Taupo. New Zealand Geological Survey, Department of Scientific and Industrial Research, Wellington.

Whirinaki Forest is covered by sheets N95 and N104 of the map series NZMS 1. The main geological features of Whirinaki Forest are described: the Urewera

greywacke, east of Te Whaiti fault, at the western side of the Ikawhenua Range; Te Whaiti ignimbrite, in the valley of the Whirinaki River and Mangawiri Stream, bound on the west by the Rangitaiki fault; and Rangitaiki ignimbrites, west of the Rangitaiki fault, near the eastern margin of the Kaingaroa Plateau. [See the account of geology for Whirinaki Forest in Orchard et al. (1981) and NFAC (1979a).]

Keywords: geology, map – geological

80. Halkett, J. C. 1985: Whirinaki: a New Zealand exercise in forest conservation. Pp. 59–64 in: Institute of Foresters of Australia and New Zealand Joint Conference, 20–24 May 1985, Hobart, Tasmania.

This paper takes a broad view of current and recent events in forest management at Whirinaki. A background section covers much the same information as the papers by Field (1983, 1985), and the NZFS 1981 management plan (Orchard et al. 1981). At the time of writing, the author considered that 'Whirinaki is a model for both preservation and conservation'. Continuing wood production from the salvage of windfallen podocarps was thought to be likely, and in line with the previous multiple-use concept for indigenous forest management on a sustained yield basis. The author refers to a decline of old-growth podocarps and replacement in part by broadleaved species, and to the lack of developing podocarp regeneration in the old-growth forest in a virgin state.

[Further studies in central North Island forests confirm a decline of the older podocarps. But both the virgin and the selectively logged forest is being perpetuated, albeit with changes in composition. With the exception of tawa, however, a sustained yield of wood was unlikely to have been achieved. In Whirinaki Forest, salvage of windthrown podocarps ceased with the establishment of DOC in 1987. There has been no assessment over the last 20 years of natural regeneration after operational partial-logging or operational planting of podocarps by the NZFS. Podocarp regeneration in a suppressed state is common in some areas of Whirinaki logged for totara 40–70 years ago (Gamble 1979), but vigorous development of pole podocarps has been confined to old clearings or fire-induced vegetation.]

Keywords: forest conservation, forest management, forest policy, multiple use of forests, podocarp decline, podocarp regeneration, recreation, sustained yield concept

81. Harrison, M.; Saunders, A. J. 1981: A comparison of bird populations in logged and unlogged indigenous forest areas within Pureora and Whirinaki Forests. New Zealand Wildlife Service, Forest Bird Research Group, Wellington. 86 p. 26 tables, 53 graphs.

This intensive study, involving six thousand 5-minute bird counts, was carried out in Whirinaki and Pureora forests by the Forest Bird Research Group over a 2.5 year period during 1978–81. The general objective was to assess the impact of operational selective logging on bird populations. [As all logging in central North Island state forests ceased in 1984, due to changes in government forest

policy, the findings have had little relevance for forest management. However, the discussion and analysis of the study methods, which involved recording seasonal bird conspicuousness, forest type and forest structure, should be valuable for future workers undertaking assessments of bird populations in indigenous forest. The observations of bird habits and the vegetation descriptions are of general ecological value.]

Two of the three study areas were in Whirinaki Forest. The 'Hydro Access Road' study area, in the northern part of the forest, comprises low volume tawa/podocarp forest on steep terrain. The 'Waione' study area, in the south of the forest, comprises mainly dense podocarp forest on easy terrain of the Wheao Catchment. Maps showing locations of the study areas are missing in the copy viewed and annotated. Each study area contained an unlogged control block and a forest block that had recently been selectively logged. Only 7–9% of the volume of podocarp logs had been removed [from felling individual trees, not groups], a much lower figure than the nominated removal of 30–60%. Salvage logging was carried out several times in each Whirinaki study area during the 1978–81 period.

Of the 30 bird species recorded in the Whirinaki study areas, 15 were selected as indicator species. In Whirinaki, differences between bird numbers recorded in logged blocks compared with unlogged blocks were significant in four cases of apparent preference, all in the Hydro Access Road area. Parakeets favoured the unlogged block, while robins and grey warblers appeared to favour the logged block. It was concluded, however, that no significant differences were detected that could be directly attributed to the selective logging.

Graphs display the annual pattern of conspicuousness of indicator bird species for each study area. Theories on what factors might affect conspicuousness of the 15 indicator species were tested, and the limitations of the methodology, and other constraints in the study, are discussed. Most recommendations deal with precautions to be taken if selective logging continued. But it was considered that further research should be undertaken urgently to investigate the ecology of New Zealand falcon, kaka, parakeet and pigeon.

[See Leathwick (1981) for a study of the vegetation in the bird-count areas, and Crawley (1981) for a summary of studies by the Forest Bird Research Group. Information from this bird study is currently being used in further investigating other forests (Innes, J. 2004, pers. comm.).]

Keywords: bird population survey, forest birds, hydro-access study, selective logging – impact on birds, Waione study

82. Healy, J.; Vucetich, C. G.; Pullar, W. A. 1964: Stratigraphy and chronology of late Quaternary volcanic ash in Taupo, Rotorua and Gisborne districts. *New Zealand Geological Survey Bulletin 73*: 7–48.

The origin and nature of the pumice and ash which covered Whirinaki Forest from the eruptive origin of Lake Taupo in c. AD 131 [date revised to c. AD 200] is described. A vivid account is given of the eruptions of the Taupo pumice (pp. 37–38), which produced in succession Hatepe lapilli, Putty ash, Rotongaio ash, Taupo lapilli, Rhyolite block and upper Taupo pumice members. The persistent members of the Taupo pumice easily recognised at Minginui are Taupo lapilli,

Rotongaio ash and Hatepe lapilli (p. 50). The Kaharoa ash erupted c. AD 1000 [date since revised to AD 1314] from the Okataina volcanic centre. It covered a large area as a thin layer, and probably caused little disturbance to vegetation (pp. 44–48). [Presumably the Kaharoa ash reached northern parts of Whirinaki Forest, such as the Mangawiri Catchment.]

Keywords: Kaharoa ash, Taupo Eruption, Taupo pumice

83. Herbert, J. W. 1978: Whirinaki ecological area proposals: North Island frost flats. Letter dated 2 May 1978. Forest Research Institute, Rotorua (unpublished). Held in file FRI 31/6/10/8, Landcare Research, Hamilton. 3 p.

Keywords: ecological area proposals, frost flats

84. Herbert, J. W. 1979: Results of selective logging of dense podocarp forest in the Mangawiri Basin, Whirinaki State Forest, and a comparison with trials in Tihoi State Forest. *Indigenous Forest Management Internal Report 10.* Forest Research Institute, Rotorua (unpublished report). 8 p.

This report, though not made freely available, was used by the NFAC and other conservationists to attack the first attempt by the Rotorua Conservancy (NZFS) to carry out an operational partial-logging in dense rimu-dominant podocarp forest. The operation was intended to follow a recently announced, government-approved, revised forest policy for indigenous forest management, which was to cease clear-felling and conversion to plantations of exotic species, and introduce forms of selective or partial logging (NZFS 1977). However, with no tradition of these forms of logging, the result was close to devastation. Over the ensuing 3 years, the Indigenous Forest Management Group assessed the situation. There was a high degree of damage to residual trees, heavy accumulations of logging slash, and high levels of windthrow. Virtually every alternative merchantable podocarp was felled. After 3 years, 17% of residual podocarp trees and 21% of tawa trees in the logged area were windthrown or had died standing. This compared with 1.4% of podocarp loss and no loss of tawa in a nearby control block that had an intact canopy, despite earlier removal of some dead and dying totara.

[One outcome of this partial-logging operation, and the assessment report, was that the Okurapoto trial was established in a comparable dense podocarp forest in 1979. Extreme care in logging, and careful selection of trees to be removed at a level of 9–15% of merchantable volume, showed that it was technically feasible to leave the residual forest in a relatively stable condition with comparable mortality in logged blocks and an unlogged control. The Okurapoto trial has been monitored over a period of 25 years, with results given in both published papers and unpublished reports, all annotated in this bibliography. See Katz (1980a), Bergin (1982), Forest Research Institute (1982a, 1984), Smale et al. (1985, 1998), and Steward (1998).

Wilding podocarp seedlings were transplanted to the heavily logged area, but no assessment of planted species or natural regeneration has been made (see Forest Research Institute annual reports for 1976 and 1977). A brief inspection in February 2004 indicated that windthrow and windbreak have left a sparse

upper canopy of tall, thin-crowned rimu over tawa. Pioneer wineberry has generally died and collapsed. However, podocarp regeneration appears to have been initiated by the substantial opening of the high canopy, a result which is perhaps comparable to that of a catastrophic storm. See Beveridge (1967), and Beveridge et al. (1985).]

Keywords: assessment of partial logging, dense podocarp forest, Mangawiri Basin, Okurapoto trial, partial logging – intensive

85. Herbert, J. W. 1984: Reservation of monoao-dominant vegetation in central North Island. Forest Research Institute, New Zealand Forest Service, Rotorua (unpublished report). Held in file 31/6/12/5, Landcare Research, Hamilton. 5 p.

Keywords: monoao heathland

86. Herbert, J. 1985: North Island podocarp and podocarp–hardwood forests. Pp. 18–28 in: Ecology and management of indigenous forests. Section of a summary prepared at the request of the New Zealand Forest Service. Forest Research Institute, New Zealand Forest Service, Wellington. 18 references.

A useful summary of studies in selection management trials in Whirinaki and Pureora forests between 1961 and 1979, with emphasis on ecological aspects. Most references are to papers included in the Whirinaki and Pureora bibliographies.

Keywords: ecology of indigenous forests, management of indigenous forests, podocarp forests, podocarp/hardwood forests

87. Herbert, J. W.; Steward, G. A.; Shaw, W. B. (Eds) 1987: Indigenous Forest Management catalogue of unpublished reports. Forest Research Institute, Rotorua. 39 p.

The listed titles include ten on Whirinaki Forest, and most of these are included in this bibliography. There are also a few file notes dealing with ecological reserves, scientific values, and forest types in Whirinaki. [A more complete listing of Forest Research Institute's file notes, including many on Whirinaki, is given in a catalogue compiled by Steward (1988).]

Keywords: catalogue – unpublished reports, indigenous forest management, technical records – indigenous forest

88. Hill, M. T. 2003: Diet, dispersal and distribution of kereru (*Hemiphaga novaeseelandiae novaeseelandia*) in a lowland podocarp–hardwood forest. MSc thesis, Massey University, Palmerston North.

Relationships between food availability, nutrient content, diet, feeding behaviour, home range, and movement of kereru were studied in Whirinaki Forest between 1999 and 2001. Mist-netting, radio-tagging and radio-tracking were used to follow individuals and observe their behaviour. Fruit of six plant species and foliage of two species were analysed for nutritional content. The four main food species (foliage and/or fruit) appeared to be miro (*Prumnopitys*

ferruginea), tawa (*Beilschmiedia tawa*), wineberry (*Aristotelia serrata*) and kowhai (*Sophora tetraptera*). There were two main fruiting groups: species fruiting in summer and those fruiting in autumn. Tawa was the preferred fruit in summer (ripe seed fall in Whirinaki in February–March); miro in autumn. When these were not available, kereru functioned as generalist feeders. Diet reflected the habitat in which birds were feeding. Nutrient analysis suggested there has been some co-evolution of kereru and their main food species. Home ranges varied from 14 ha to 704 ha. (MCS)

Keywords: kereru – diet, kereru – dispersal, kereru – distribution, kereru in podocarp/hardwood forest, forest birds

89. Historic Places in New Zealand 1998: Trust asks for action on damaged archaeological site. *Vol 22, September 1988: 16*. New Zealand Historic Places Trust.

The Historic Places Trust requests Timberlands to repair damage to the historic Te Tapiri Pa (built in 1865) after partial destruction by bulldozers during control of a planned burn-off. Te Tapiri Pa and nearby Okupu Pa are shown in an aerial photograph, situated within the northwest boundary of Whirinaki Forest Park, near plantations of exotic conifers. [Te Tapiri Pa was built during the Hauhau struggle, outlined in Nevin & Nevin (1980).]

Keywords: historic places in forest, Te Tapiri Pa

90. Hood, I. A.; Beets, P. N.; Kimberley, M. O.; Gardner, J. F.; Oliver, G. R.; Pearce, S. 2004: Colonisation of podocarp coarse woody debris by decomposer basidiomycete fungi in an indigenous forest in the central North Island of New Zealand. *Forest Ecology and Management 196*: 311–325.

[Refer to Beets et al. (2002).]

Keywords: biomass of indigenous trees, fungal decay – windthrown podocarps

91. Hood, I. A.; Sandberg, C. J.; Kimberley, M. O. 1989: A decay study of windthrown indigenous trees. *New Zealand Journal of Botany 27*: 281–297.

Fungal communities were studied in six trees each of rimu and matai, 4 years after they were windthrown in the cyclone of April 1982. The trees were located in the 1979 sustainable management trial in the upper Tauranga Catchment of Whirinaki Forest. Fungal populations declined progressively inside trunks, more so in matai than rimu, and were less common in heartwood than in sapwood. The condition of the root systems of windthrown rimu, matai, miro and tawa trees was also evaluated in the same forest. In rimu and matai, central roots were more decayed, on average, than marginal ones. The central roots of rimu and matai were also more decayed, on average, than those of miro and tawa. (MCS)

[For tree stability and windthrow in 1979 Okurapoto trials, see Smale et al. (1998), and Steward (1998).]

Keywords: podocarp decay, podocarp stability, windthrown podocarps

92. Hosking, G. 1994: Report on northern rata dieback: Minginui Faces. *Conservation Advisory Science Notes 66*. Department of Conservation. Wellington. 4 p. Map.

Detailed examination of canopy samples showed 'compelling evidence of recent, but not current, severe possum damage', in declining crowns of northern rata, and also kamahi, tawa and red beech. Field inspections were made in the period 24 January to 2 February 1994, and collections were made of litter and also foliage from wind-broken branches lying on the ground. Few possum-damaged examples were found in litter, but only one sample of crown foliage was undamaged. New flushes of shoot growth on rata and kamahi were undamaged.

The type of damage displayed on crown samples was consistent with severe possum browse, and much of it appeared 'to have occurred in late winter or early spring, leading to the high incidence of dead fine twigs still present'. The feeding pattern appeared to 'involve the complete removal of shoots or stripping of foliage. Such a pattern would account for the lack of individual damaged leaves, both in the crown and in the litter … numerous partly-eaten green tawa fruit were collected from the ground.'

Photographs of possum damage to rata, kamahi, tawa, and red beech are included in the report. [See Beveridge (1967) for comments on totara die-back, Hosking & Numata (2001), and Numata (2001) for comments on northern rata die-back.]

Keywords: kamahi decline, possum browsing, possum feeding pattern, rata die-back, rata foliage assessment, red beech (decline), tawa decline

93. Hosking, G. 2002: Rata litterfall and canopy condition. Hosking Forestry Ltd unpublished report for Department of Conservation, Rotorua. 5 p. 4 references.

[BRC: This is a draft report of Hosking (2003).]

Keywords: possum browsing, rata crown assessment, rata litterfall

94. Hosking, G. 2003: Rata litterfall and canopy condition, Whirinaki Forest Park, New Zealand. *DOC Science Internal Series 103*. Department of Conservation, Wellington.

This paper reports the results of a small field trial to determine the health of rata (*Metrosideros robusta*) by examining the leaf litterfall. Falling leaves were collected in funnel traps underneath 11 rata trees of various crown sizes. No relationship could be determined between crown size and crown health. Recommendations concerning methodology are given for any future investigations, for example, use a single sampling period, and air-dry samples prior to sorting.

[This is the published version of Hosking (2002). It presents the results of the last year's work in a long-running (8 year), ad hoc and probably inadequately planned investigation on rata litterfall within Whirinaki Forest. It is unlikely that any statistical and possibly scientific guidance was obtained prior to the initial work being carried out in the early 1990s. Statistical power seems to be

seriously lacking, with only five samples gathered over time for each of the 11 trees, which is most probably insufficient to warrant interpretative analysis.

The first objective was to examine the variation between two traps collecting litterfall under the same tree; this could not have been measured, as two data points (i.e. the traps) at any one time could have only provided a range and not a variation. The overall work does have merit in that it was interest-driven for the site (i.e. it attempted to answer and measure an observation of declining canopy rata condition). What did emerge is that funnel traps seem useful for collecting rata leaf litterfall, and can capture some key information on the seasonal habits of rata (see Hosking & Numata 2001). But the overall project, including this work, can provide a case study on a potentially poorly considered and planned research project.] (BRC)

Keywords: possum browsing, rata-crown assessment, rata litterfall

95. Hosking, G.; Numata, M. 2001: Rata litterfall as an indicator of crown health: a review and proposed strategy. Unpublished report for Department of Conservation, Rotorua. 16 p. 8 references.

Large, old northern rata are a feature of Whirinaki Conservation Park. Death of these trees, or severe crown die-back, has been attributed to possum browsing. Monthly litter sampling was initiated in 1994 to determine whether or not damage to leaves could be used to measure possum impact on the rata trees. Initially, 10 trees up-slope of Whirinaki Forest Sanctuary were sampled. Litter was collected in funnel traps, with one trap placed beneath each tree. Later in the project, and continuing until 2000, sampling of 14 trees was carried out, with two traps per tree (data for these trees are presented). Treatment and analysis of samples are described. Limitations of the methodology are discussed, for example possums eating whole leaves not just parts of them, and the difficulty of separating out insect-damaged leaves. Such problems led to a misleading result: less than 2% of the total number of rata leaves collected were identified as showing possum damage.

A review of previous work that was carried out in hindsight suggested that possum-damaged leaves in litter samples would not provide a useable technique for measuring possum pressure on rata canopy. Thus, a strategy for further work is outlined, which involves assessing crown health, crown density, and total litterfall over time. (In previous work, comparisons of the total number of rata leaves in litter collected before 1080 poison operations and litter collected over the same period of time, but a year later, did not establish a definite trend.) It was suggested that the re-evaluation of leaf litter data previously collected could form a sound basis for a redesigned study. Specifications are given for a redesigned field trial, covering aspects such as crown classification, litter traps, sampling periods and sample treatment. [See comments on Hosking (2003).] (BRC)

Keywords: possum browsing, rata-crown assessment, rata die-back, rata litterfall

96. Hutton, J.; Neumann, K. 2001: Ngati Whare and the Crown, 1880–1999. Crown Forestry Rental Trust, Wellington (unpublished report). Text 817 p. Sources and references 25 p.

This scholarly and well-referenced work deals broadly with the social history of communities at Te Whaiti and Minginui in the Whirinaki Valley. The report was written to provide evidence for the Treaty of Waitangi claim 'Wai 66', and refers to the 'social impact of the alienation of Ngati Whare land since 1880'. There are detailed accounts of the logging and milling of podocarps in the valley from 1928 to 1984, with references to the relations between Maori and the NZFS in the timber-milling communities over the same period. The cultural values and perceptions of Maori concerning land and forest in the region are emphasised. The authors deal in depth with issues of forest policy, forest management, the impact of the rising environmental movement and political decisions that have affected the communities and forests in the Whirinaki Valley. A search of the National Archives of New Zealand, in Wellington and Auckland, has resulted in many excerpts from the correspondence files of the NZFS and its forerunner the New Zealand State Forest Service—particularly the files of the Rotorua Conservancy and the Minginui District Office. Five of the chapters in the report are of particular interest, making reference to many published and unpublished articles and reports on Whirinaki. Of these, 28 are of direct relevance, and are included in this bibliography.

In chapter 5, accounts are given of timber milling at Te Whaiti from 1928 to 1938, following earlier post-splitting and pit-sawing of totara; also timber milling at 'Top Minginui' (the name given to small milling communities into the mid-1960s) from 1930 to 1946. This chapter includes a section on the Te Whaiti Logging Scheme, established by the State Forest Service in 1938 with the declared objective, from successive directors of forestry, of initiating sustainable management of the indigenous forest, with adequate regeneration of podocarps. Reasons for failing to implement this objective are discussed, with reference to the first working plan for Whirinaki Forest, prepared by the NZFS in 1950 and covering the period 1950–60. [See Forest Research (2003), noting comments of R. J. Cameron. Few practical measures for sustainable management were taken before 1961, besides temporary reservation of old-growth strips as seed sources for regeneration, establishing a forest nursery for raising podocarp seedlings, and planting out of some 12 ha of logged areas (1938–46). Conversion of logged areas to plantations of exotic conifers continued until 1975.] The 1951 working plan referred to the slow rate of growth and perceived silvicultural intractability of all the major forest species 'as the main reason for failure to implement sustained yield management.' Further sections in chapter 5 are headed 'Post splitting' and 'Timber milling at Te Whaiti 1938–49'.

Chapter 6 describes the establishment of Minginui Forest Village in the late 1940s, called 'a model village' by the NZFS, and built to support the Te Whaiti Logging Scheme. This chapter covers the period from the late 1940s to the late 1970s, and deals with the first three working plans for Whirinaki Forest Park (1950–71). [Copies of all working plans, and some monthly and annual reports of the Forest Service, are kept in the Forestry Library at Forest Research, Rotorua.] There is a comment (p. 502) that the NZFS 'was committed to the wholesale exotic conversion of large areas of State Forest 58, well before its officers had acquired a good understanding of podocarp regeneration, or more generally, of the nature of the forest that predominated [in] the area'.

Chapter 8 analyses the controversy involving various conservation organisations, the NZFS and Minginui villagers in the late 1970s and early 1980s. It pays particular attention to the controversy surrounding the 1979 management proposals for Whirinaki Forest. Changes in the Government's forest policy, and politicisation of issues leading to cessation of logging the indigenous forest in 1984 are discussed. The views of all protagonists are freely quoted and there are many references to, or excerpts of, news media items.

Chapter 9 is entitled 'Minginui in crisis 1984–1999', and covers the devolution of the NZFS, the consequences for people living in Minginui and Te Whaiti, and the return of Minginui Forest Village to Ngati Whare in 1988.

Chapter 15, entitled 'Kereru and possums', presents Maori views on harvesting pigeons as an item of traditional diet, and questions DOC's views on control of possums with 1080 poisoning. [The results of recent trials, such as that by Powlesland et al. (2003), were not known to the authors.] An account is given of the introduction of possums to the region and the slow awareness of the problems they cause. The 1950 working plan did not include mention of possums, but the first aerial drops of 1080 poison baits were carried out from 1960 to 1964, with only partial success. There is a comment that 'it was not until 1991 that possums were found to be bird nest predators, with kereru, brown kiwi, and kaka among their targets' (Innes, J., pers. comm., on 'the impact of possums on native fauna' in a workshop on 'Possum as Conservation Pests 1995').

The authors make statements about the lack of research and understanding of podocarp regeneration and the nature of podocarp forest. They say the application of sustainable management techniques was not attempted operationally until the late 1970s. For example, the question is raised (p. 699) 'why the Forest Service had not developed these techniques much earlier, and why so little research had accompanied decades of indigenous forest management'. [In fact, forest management in the central North Island, on a more than experimental scale, was practised with crude beginnings for less than a decade (1975–84). Little practical experimental work was done until the early 1960s, with establishment of selection management trials in Pureora and Whirinaki forests, and development of successful nursery practice and experimental plantings of podocarps. The problems of podocarp regeneration were fairly well understood by those involved with forest research at this time. It is suggested that research and experimental work would have been required from the 1920s to allow reasonable implementation of sustained yield management (or sustainable management) of Whirinaki Forest from 1940 (as was the objective of the Director of Forestry) when the State Forest Te Whaiti Logging Scheme commenced. A few desultory inspections of early cutover forests led to pessimistic views of the capacity of podocarps to regenerate. However, it is suggested that, with retention of seed sources, had development of indigenous regrowth been allowed to proceed, improved by supplementary planting, then replacement young podocarp forests would exist today. By 1960, however, views in favour of forest clearing and conversion to plantations of exotic conifers were firmly entrenched and confirmed by forest policy.

This and the Pureora bibliography together list several hundred papers that have been written, mainly since 1970, on research and management of the podocarp forests in the central North Island. Researchers have long been aware

of the episodic nature of podocarp forest renewal, though there is little knowledge of the natural catastrophes that may have occurred to trigger renewal, apart from volcanic eruptions. Fire and other human-influenced disturbances have led to regenerating podocarp forest at Whirinaki. Recent observations of dense podocarp forest that has suffered severe disruption of the canopy by a crude form of partial logging in 1975, and subsequent extensive windfall, indicate that dense podocarp forest with tawa may regenerate naturally, supplemented in places by planting of podocarps. But a thorough survey is required to better understand this. For discussion on the nature of dense podocarp forests see Ogden & Stewart (1995). For earlier accounts of podocarp regeneration see Beveridge (1964, 1973).]

There are many items of ecological interest scattered through this large report (that has no index). Some further points of interest are:

A section entitled 'The great frost of 1898' comments: 'on 20 January and over the following weeks an unseasonable and dramatic series of frosts swept through the [Urewera] region, destroying food crops and causing famine' (p.130). [The impact on frost-susceptible trees such as tawa must have been considerable, and probably also on species such as matai and totara, with their full flush of new growth susceptible to damage by unseasonable frost.]

In the 1940s there was a suggestion of creating a reserve in the Mangawiri Basin, in particular to include the main 600 acre totara stand (p. 57).

Under a section entitled 'A conservationist awakening', an excerpt is given from a 1971 letter to the NZFS deploring felling of 'dying' totara in the Managawiri Basin because of an unidentified 'disease'. If the area needed to be cleared it should have been replanted in totara (p.632). [This had an echo in 1985 when there were suggestions for totara planting, and again in 2004 after harvesting of the radiata pine and Douglas fir planted on the former totara forest site. No totara disease has been found, and crown recovery has occurred on some surviving trees over the past 20 years. See Beveridge (1967).]

Keywords: archives – NZFS, forest policy, milling history, Maori history (Ngati Whare)

97. Jane, G. 1978a: The opossum in the Urewera forests. New Zealand Forest Service, Rotorua (unpublished report). 52 p.

While much of this report deals with possum densities and possum impact on vegetation in the northern Urewera forests, comments on the situation in the southwestern Urewera forests have relevance for both the beech and the tawa forests of Whirinaki and adjacent areas. Past work on possum habits and their impact on vegetation in different forest types is reviewed. The progressive depletion of shrub and tree species with increasing possum population is described. With increasing colonisation by possums, vegetation mortality may follow a sequence with fuchsia and other highly palatable shrub species being affected first, then wineberry, and then kamahi. Kamahi tree mortality is widespread in the Urewera forests; dead trees are graphically illustrated by colour photographs taken of kamahi in beech and tawa forests.

Feeding patterns are described. In podocarp/tawa forest the fruits or seeds of tawa, matai, hinau, miro and pigeonwood are important sources of food for

possums in autumn and winter [thus competing with kaka and kereru, see Hill (2003), and Powlesland et al. (2003)]. There is reference to Mason's (1968) study of possum diet in the Mangawiri Basin of Whirinaki Forest and elsewhere in the Urewera region.

Keywords: possum diet, possum feeding habits, possum impact, possum populations

98. Jane, G. 1978b: The impact of wild animals on the forests of the Southern Urewera. New Zealand Forest Service, Rotorua (unpublished report). 63 p. 9 photographs, pocket maps.

This report gives results of a deer and possum population survey carried out by the NZFS over two summers from 1975 to 1977. Animal numbers were assessed by counting faecal pellets on transects. The composition of canopy trees, shrub tiers, and ground cover was described for about 14 forest types over seven survey units, of which Whirinaki Forest was one. Parts of three other survey units bordered the Whirinaki Catchment (upper headwaters of Te Hoe River, and Matakuhia and Waiau streams). Most of the survey work was done in beech forest above 700 m altitude, but assessments were also made in tawa and podocarp/tawa forest at lower altitudes in the Whirinaki Valley. [Both deer and possum populations were thought to have peaked some years earlier, but no evidence of vegetation recovery was presented.]

Tables giving percentages of plant species in each forest type illustrate that the most highly palatable shrubs were lacking, and cover in the lower tiers was mainly ground ferns, tree ferns, bush oat grass, and sedges. Kamahi was still a major component of the subcanopy in a number of forest types, but there are many references to its die-back or mortality. The author considered deer populations to be surprisingly high in the Whirinaki Valley, and suggested that private and commercial hunters should be able to reduce them to moderate levels without Forest Service control. There were current hunting operations to reduce goat populations in the Te Hoe Catchment. Feral cattle disappeared from the Whirinaki Valley in the 1950s. Maps show survey regions and densities of deer and possums. [See Knowlton et al. (1982), and Knowlton (1982).]

Keywords: browsing impact on vegetation, deer density, faecal pellet survey, kamahi die-back, possum density, possum populations, Urewera – southern

99. Jane, G. T. 1980: Vegetation conditions in selected southern Urewera catchments. New Zealand Forest Service, Rotorua. 53 p. Colour photographs.

This is a further report on forest condition and the impact of deer and possums in the southern Urewera. See Jane (1978b) for results of a 1975–77 survey. Four areas where there was concern about damage caused by high animal densities were selected for a more intensive study. These areas are shown on a location map, and are within or near the southeastern part of Whirinaki Forest, in the upper catchments of the Whirinaki, Waiau and Matakuhia streams. The sampled areas were mainly between 600 m and 900 m altitude, in variants of beech-dominant forest, but tawa forest was included at a lower altitude in the Waiau Catchment. The composition of these forests is described in detail, with data on density of different species in the canopy, shrub tier and ground cover

presented in tables. There are nine colour photographs of forest and/or ground conditions, some showing a heavily depleted state. Forest modification on some sites has been severe, with erosion, animal impact and possibly fire damage. Palatable shrubs have often been removed, as demonstrated by exclosures, and regeneration of canopy species has rarely reached sapling or pole stages. Commercial hunting has been ineffective in reducing animal impact. There has been strong development of unpalatable species in some areas, with abundant pepperwood, *Dicksonia lanata* and other tree ferns, ground ferns and herbaceous species. In tawa/podocarp forest on river terraces and spurs, dead stems of kamahi are common and pigs often disturb the soil near streams. A kamahi canopy or subcanopy is, however, present in several types of beech forest. Animal impact in the surveyed areas is compared with the situation in other parts of the Urewera and elsewhere. In summarising changes and trends in the forest under the impact of animals, it is concluded that changes have been great despite deer and possums being present for less than 100 years, or even less than 20 years in some areas. Large areas have opened up in some of the beech forests, due to possums killing trees. The reduction in regeneration of the principal canopy species and development of an unpalatable ground cover will slow down forest recovery, even if all deer are removed.

Keywords: animal impact, forest changes – depletion, Urewera – southern

100. Johnson, P.; Rogers, G. 2003: Ephemeral wetlands and their turfs in New Zealand. *Science for Conservation 230*. Department of Conservation, Wellington.

A review of current knowledge (c. 2003) of ephemeral wetlands and their associated turf communities. Description is based on physiography (landform settings), vegetation processes and patterns, and flora, including threatened species. The appendices include a colour plate and zonation table for Arahaki Lagoon (flora composition (estimated percentage cover) in concentric zones). [Whirinaki as an example of a seasonally wet hollow upon tephra.] (BRC)

Keywords: Arahaki Lagoon, wetlands

101. Katz, A. 1980a: Structure and growth of dense podocarp forest in Whirinaki. *Indigenous Forest Management Report 25*. Forest Research Institute. Rotorua (unpublished). 13 p.

Growth rings on sections from cut stumps in the Okurapoto selection management trial area were counted to determine age and mean diameter of podocarps (especially rimu). The oldest trees were matai, from 500 to 800 years old. Rimu was the next oldest, with 75% of the trees sampled being from 450 to 550 years, the oldest tree being 650 years. Kahikatea and miro were from 300 to 500 years old. Thus, the stand was not even-aged, and there was no strong relationship between diameter and age. Despite difficulties in counting rimu growth rings, allowance can be made for abnormalities, and ages can be based on growth rings. Results of age determinations in Whirinaki are compared with those made in dense podocarp forest at Tihoi, west Taupo (Herbert 1980, item 116 in Pureora bibliography) where forest structure is comparable, and the forest about 50 years younger. Hypotheses are discussed on forest development since c. AD 200, when volcanic ash and pumice from the Taupo Eruption caused widespread destruction of central North Island forests.

Keywords: dense podocarp forest – growth and age, forest development, forest structure – podocarp forest, growth rings – podocarps, Okurapoto trial, podocarp growth rings, Taupo Eruption

102. Katz A. 1980b: Growth of podocarp pole stands on former Maori-cleared sites in the Whirinaki River Valley. *Indigenous Forest Management Report 24*. Forest Research Institute, Rotorua (unpublished report). 30 p.

The author gives detailed mensurational data and descriptions from the 1979 measurement of three sample plots in stands previously assessed by Roger Cameron in 1960. Some areas were thinned or had 'overwood' trees removed in 1950, and *Eucalyptus delegatensis* planted to provide shelter and improve form of podocarps, many of which (mainly rimu) were multi-stemmed. Most podocarps established over the period 1890–1900, which was 50–70 years after abandonment of the Okarea Pa site and associated clearings. Mean stem diameters and total heights of the podocarps varied according to treatments they received in 1950, also variations in site, and variations in stem density. But by 1979, rimu had reached a diameter of 20 cm and a height of 14 m. Photographs of plots compare their appearance in 1959 and 1979. Height growth rates of rimu, totara and the few matai and kahikatea was maintained at 20–25 cm per annum. The eucalypts are not considered to have served any useful purpose and they drop a heavy litter. [The best form of removal would be to place an arboricide into bored holes in stems to allow slow disintegration, rather than using ring-girdling, which causes stem breakage.]

Appendices give descriptions of soils, a soil profile, and descriptions of understorey species. The colonising sequence in control plots, suggested by McKelvey (1955) and Cameron (1960b), is dense bracken fern for 10–15 years, then manuka, kanuka and other pioneer hardwoods. The hardwood component in a control plot in 1979 was predominantly kanuka, with remnants of the original nurse crop of mahoe, *Pittosporum*, and cabbage trees.

Keywords: forest sanctuary, Okarea Pa clearing, podocarp pole stands, podocarp regeneration – disturbance induced

103. Knight, S. 1992: A natural sanctuary. *Pacific Way 50*: 64–67.

The rainforest, with its ancient trees, interesting birdlife, and sense of Maori history, gives the Whirinaki area a special character, and was reported to be attracting moderate numbers of tourists, coming to enjoy the walking tracks and other recreational activities. Reference is made to information available from DOC, and local accommodation.

Keywords: forest conservation, tourism, wilderness

104. Knowles, F. B.; Beveridge, A. E. (Comps) 1982: Biological Flora of New Zealand 9: *Beilschmiedia tawa* (A. Cunn). Benth. et Hook. f. ex Kirk (Lauraceae) Tawa. *New Zealand Journal of Botany 20*: 37–54.

This account has few direct references to observations and studies in Whirinaki Forest. However, it reviews the general ecology of tawa, which is a major

component of several forest types in Whirinaki Forest, mainly those between 350 m and 650 m altitude.

[Tawa foliage is low on the preference list for browsing deer in Whirinaki Forest, and therefore forms an important understorey and subcanopy in podocarp/tawa forest and rimu-dominant dense podocarp forest, where there is abundant tawa regeneration from seed or by coppice shoots. However, at Whirinaki possums open the green, developing fruits in tree crowns in summer, and consume fallen tawa seeds devoid of pulp in winter, especially where preferred species like kamahi and palatable shrubs are not present, or have become scarce through browsing. A study of the stomach contents of 161 possums killed in the Mangawiri Catchment in 1966, in rimu-dominant forest with a tawa understorey, revealed tawa leaves in 34 stomachs and tawa seed in 91 stomachs (Mason 1968). In Whirinaki Forest, kaka peck the pulp from some tawa fruits (Beaven 1996). The native pigeon feeds extensively on tawa fruits in February and March, and is the main distributor of tawa seed.

Exposed tawa crowns in the Whirinaki Valley and Urewera forests have been recorded as damaged by frost in early winter (Mackenzie & Gadgil 1973), but most eventually recover. The cause of foliar wilt and branch death on subcanopy tawa saplings and poles, from late winter, has not been determined. This phenomenon has been observed even where tawa trees are sheltered by a tall rimu canopy in the Whirinaki Forest Sanctuary and the Waione Ecological Area. Cold air may 'pond' in depressions, so raising frost level to lower slopes (Beveridge, A. E., pers. obs.).

Tawa were not generally logged in Whirinaki, so the areas selectively logged for podocarps from 1975 to 1984 have a high component of tawa. Some forests with a tawa canopy and very few or no emergent podocarps may have resulted from crown fires killing the podocarps, particularly rimu (McKelvey 1973). Some fires may have occurred through lightning, as the heads of podocarps with heavy loads of epiphytes have been lit during 'dry' electrical storms (Collins, R., pers. comm.). Most fires that have left tawa as the dominant canopy tree on ridges have occurred since arrival of humans, which in the Whirinaki Valley was possibly about 300 years ago (for settlement). See Nicholls (1966, 1969), and the annotation for this paper as item 151 in the Pureora bibliography.]

Keywords: Mangawiri Basin, tawa browsing by possums, tawa ecology, tawa seeds eaten by possums

105. Knowlton, J. 1982: Deer and possum distribution patterns in the southern Urewera forests: results of the 1981–1982 animal survey. New Zealand Forest Service, Wellington. 11 p. Appendices, maps.

This report gives results of a second survey of the forested Urewera tract south of State Highway 38, including Whirinaki State Forest, mainly south of Minginui in the headwaters of Te Hoe River. See Jane (1978b) for results of the previous survey in 1975–77. Similar techniques were used in the two surveys, which based estimations of deer and possum numbers on faecal pellet counts along sample lines. Significant decreases in deer numbers were found within the catchments of the Whirinaki and Te Hoe Rivers since the previous survey, a

result attributed to intense helicopter deer recovery operations. Possum populations were considered to have remained stable, with greater numbers in the lowland forest compared with the beech forest at higher altitudes. Maps show the densities of deer and possum populations, and sampling data are presented.

Keywords: deer density, faecal pellet survey, possum density, possum populations, Urewera – southern

106. Knowlton, J.; Allen, R.; Payton, I. 1982: Deer browsing effects on vegetation of the Urewera forests: results of a detailed appraisal of exclosure plots in the region. New Zealand Forest Service, Rotorua. 14 p. Appendices of tabulated data, colour photographs, graphs.

This quantitative assessment was done in 1980 to record vegetation in 17 pairs of deer exclosure and control plots. All plots were located within or near Urewera National Park, and included one called 'central Waiau' in the headwaters of the Waiau Catchment, near the southern boundary of Whirinaki Forest. The central Waiau plot, at 550 m altitude, has a tawa-dominant canopy, and the vegetation of the exclosure and control (shown in photographs) are comparable with other plots in tawa-dominant podocarp forest at lower altitudes. Colour photographs of the vegetation both inside and outside exclosures show the contrasting vegetation, generally reflecting the severe depletion of the understorey by red deer. Damage by red deer commenced in the 1920s, soon after they were liberated. The first animal control plan was not prepared by the NZFS until 1960.

Deer browsing effects were most marked in the sapling class, as shown in graphs for each plot, and by data collected on seedlings and ground cover. Saplings of *Coprosma grandifolia* and *C. lucida* appeared in profusion in some exclosures, and there were marked differences between exclosure and control plots in the abundance of species considered highly palatable to deer. Ephemeral podocarp seedlings, and seedlings of *Parsonsia* and supplejack, were present inside and outside many exclosures, but browse effects were negligible on very small seedlings. It was considered that a reservoir of palatable species 'can be found throughout the lowland forests on sites such as very steep riparian strips where animal access is very difficult'. The presence of podocarp seedlings inside and outside the exclosures indicates the potential that exists in these areas for the redevelopment of a high forest canopy. [For a concise, illustrated account of exclosures, see Forest Research Institute (1987).]

Keywords: deer browsing impact, exclosures – deer

107. Lander, R.; Warne, R. 2001a: Possum impacts and indicator species condition: a comparison between 1999, 2000, and 2001, Minginui Faces possum control area, Whirinaki Forest Park. Department of Conservation, Murupara (unpublished report). 30 p. Map.

This study is comparable with that by the same authors for the 'Whirinaki Rata Block' (Lander & Warne 2001b). In the 'Minginui Faces Block', in the Okahu

Valley, possum control using 1080 baits was done in 1996 and 1999. 'Foliar browse index' assessments were carried out in February 1999, 2000 and 2001. The condition of indicator plant species was rated as moderate to good, with overall improvement between 1999 and 2001. Kamahi and mahoe were the primary species assessed, but smaller numbers of nine other species were also assessed. The study found that '100% of mahoe, fuchsia, lancewood, totara, five-finger, and northern rata (four trees sampled) showed no evidence of possum browse or trunk use in 2001 when kamahi showed a low amount of browsing'. It was concluded that possum control had been effective in improving the condition of possum-preferred species, and that no further possum control was required immediately, but should be considered in 2–3 years. A map shows locations of five assessment lines. Graphs show data for foliar cover of each species at each of the three annual assessments.

The results from this study of the Minginui Faces Block are compared with those from the 'Whirinaki Rata Block' study (Lander & Warne 2001b). No possum control had been done in the Rata Block, and indicator species were in worse condition there.

Keywords: foliar browse index, possum control, possum impact – indicator species, vegetation recovery

108. Lander, R.; Warne, R. 2001b: Possum impacts and indicator species condition: A comparison between 2000 and 2001: Whirinaki Rata Block, Okahu Valley, Whirinaki Forest Park. Department of Conservation, Murupara (unpublished report). Text 28 p. Appendices, map.

The bulk of this report consists of figures in the form of histograms on the level of foliar cover and possum trunk use, with a 'foliar browse index' for several species used as indicators of possum browse on more than 10 sample trees. Assessments were made in February 2001 in the 'Whirinaki Rata Block' of podocarp/hardwood forest on eight lines and results were compared with those of a baseline assessment in 2000, and a 2001 assessment of the same species on a block named 'Minginui Faces'. A map shows the location of foliar browse index lines in two blocks. No possum control had been carried out in the Whirinaki Rata Block (apart from activity by a private trapper), whereas control operations had been carried out in the Minginui Faces Block in 1996 and 1999 (Lander & Warne 2001a).

The immediate aim of the Whirinaki Rata Block assessment was to monitor change in tree condition of each indicator species over a 1-year period, and assess the need for possum control. A longer-term objective was to monitor decline in the northern rata canopy (with a view to arresting the decline). However, only six northern rata were assessed in this study. Kamahi and mahoe were the primary species assessed, along with smaller numbers of nine other species. It was concluded that the indicator species in the Whirinaki Rata Block were in moderate condition. Relatively speaking, kamahi was in the worst condition, showing decline between 2000 and 2001. Lancewood and pate also showed decline over this period. Wineberry improved markedly with decreased possum browse and trunk use. All the indicator species, particularly kamahi and mahoe, were in worse condition with more possum browse and trunk use in the Whirinaki Rata Block compared to the Minginui Faces Block. Statistical tests

were made where appropriate. Lancewood and pate were also in a significantly worse condition in the Rata Block.

The authors recommend that possum control should be started in the Whirinaki Rata Block, to improve the condition of indicator species, particularly kamahi which is termed a 'vulnerable' species. Continued monitoring of the Whirinaki Rata Block should be done each February for 5 years, to determine trends in tree health.

Keywords: foliar browse index, kamahi decline, possum control, possum impact – indicator species, Whirinaki Rata Block – possum impact

109. Lander, R.; Warne, R. 2001c: Okahu/Tuwatawata–Whirinaki Forest Park: Northern rata condition assessment. Department of Conservation, Murupara (unpublished report). 18 p. Map.

This reports on an assessment made in 2000 of the condition of northern rata crowns in the 'Okahu/Tuwatawata Block' and 'Minginui Faces Block' of Whirinaki Forest Park. The study repeats an earlier, 1998, study of rata crowns by de Monchy (1999a). The same methods were employed, and the same number of rata trees were assessed (21 trees in the Okahu/Tuwatawata Block and 94 trees in the Minginui Faces Block). Any changes in crown condition over the 2 years since 1998 were to be described.

The Okahu/Tuwatawata Block had no possum control. The Minginui Faces Block had 1080 bait drops in 1996 and 1999. From 1996 to late 1998 there was a rapid increase in possum numbers there. However, the residual trap catch was 1% after the 1999 operation.

The comparison between 1998 and 2000 results showed an improvement in the Minginui Faces Block in all three 'rata view' scores—rata view for overall condition, crown foliage thickness, and perimeter die-back (see de Monchy 1999a)—but only the latter score had significantly improved in statistical testing. Data from assessments are shown in histograms and figures, and results are discussed in the light of some apparent anomalies in assessment of crown condition. In 2000, 4 years after initial possum control, rata trees in the Minginui Faces Block had shown only small signs of recovery, indicating that recovery is a slow process. It was recommended that the monitoring of rata crowns be continued, with assessments every 2 years to clearly establish trends.

Keywords: possum control, possum impact – rata, rata crown condition, Tuwatawata Ecological Area

110. Land Information New Zealand 2000: Topographic map 260-V17 Murupara. Land Information New Zealand, Wellington.

This 1:50 000 map covers the area of Whirinaki Forest Park north of Minginui Village, showing roads leading to Te Tapiri fire lookout, Mangawiri and Kopuatoto catchments, and enclaves of exotic forest plantations. The park boundaries are not delimited.

Keywords: map – topographic – Murupara

111. Land Information New Zealand 2000: Topographic map 260-V18 Whirinaki. Land Information New Zealand, Wellington.

This 1:50 000 map covers the area of Whirinaki Forest Park south of Minginui Village, showing the former plantations of the NZFS along the western boundary of the park (park boundaries are not delimited). The catchments of all five ecological areas in the park are shown.

Keywords: map – topographic – Whirinaki

112. Leamy, K.; Hayward, J. 1986: Indigenous forestry: a bibliography: works by the New Zealand Forest Service personnel. New Zealand Forest Service, Wellington. 142 p. 1397 references.

A bibliography of items published by the NZFS. Some items have direct relevance to Whirinaki Forest Park, and so are also included in the current bibliography. A number of others deal generally with principles or policies that have had application in Whirinaki Forest, but because they are less specifc in terms of making any reference to Whirinaki, they may not be included here. Some examples of topics and papers included in the Forest Service bibliography, but not the current bibliography, are as follows: Urewera National Park, or the 'Southern Urewera' forest parks (NZFS, item 1255); recreation and amenity in indigenous state forests (McKelvey, item 1200); scientific reserves, biological reserves and forest sanctuaries (item 1022); scientific reserves in state forest (Bassett & Miers, item 1016); ecological districts (Nicholls, item 1258); scientific reserves (Thomson & Nicholls, item 1356); forest protection (McKelvey, item 596); impact of browsing animals and their control in Urewera Forest (Allen et al., item 537); and possums and their link to rata/kamahi forest die-back (Batchelor, item 543). The NZFS bibliography has an author index and a species index.

Keywords: bibliography, indigenous forestry, NZFS

113. Leathwick, J. R. 1981: The vegetation of kokako and general bird study areas in some central North Island indigenous forests. Forest Bird Research Group, New Zealand Wildlife Service, Wellington (unpublished report). 300 p.

The greater part of this report is concerned with the vegetation of parts of Pureora and other central North Island forests and an annotation is given as item 154 in the Pureora bibliography. The current annotation covers the two general bird study areas in Whirinaki Forest, named 'Hydro Access' (640 ha) and 'Waione' (330 ha). The Forest Bird Research Group studied bird populations in these areas, in both unlogged and selectively logged forest, over the period 1978–81. [See Crawley (1981).] Each of these study areas is described in terms of environment, logging, and forest type, and their structure and composition is assessed by the 'point height intercept' (PHI) method.

The Hydro Access area is a low-volume podocarp forest on steep terrain. Selective logging through removal of single podocarps (not groups) was carried out between 1976 and 1981 at nominal removal rates of 40–80% of total volume. Actual removal, however, amounted to an average of only 7% of total volume for the whole study area. Five forest types were recognised. The natural cover consists of tawa/podocarp forest and gully hardwood. Vegetation types that have emerged following disturbance are kamahi/rewarewa, presumably

fire-induced; wineberry, on soil disturbed by machinery; and kanuka, on old burn sites. The Waione area is a high-volume podocarp forest. Selective logging was carried out between April and September 1979 at a nominal podocarp removal rate of 30% of merchantable volume. Actual removal was assessed at only 9%. The main forest types recognised were podocarp forest and gully hardwood. A disturbed podocarp type, with scattered 'emergents' of tawa, was thought to have resulted from old crown fires. Strips of almost pure kamahi poles were found on the western margin.

Detailed results from the PHI assessments are given in diagrams, tables, and in appendices. The report is well illustrated by photographs of the different forest types. There are useful summaries concerning the liberation and dispersal of introduced mammals in Whirinaki Forest (pp. 121–124), and selective-logging trials and operations in central North Island forests (pp. 10–17). A brief account is given of phenology studies for 19 tree and shrub species in Whirinaki Forest (listed on p. 298). [See Leathwick (1984) for a full account of phenology studies.] Logging impact descriptions include the Hydro Access and Waione study areas, and also the site of a 1961 selection management trial by South Road, where 40% of total merchantable volume in podocarp/tawa forest was removed (pp. 183–206). [See Pardy (1984), and Smale et. al (1987).] The discussion of logging impacts mentions constraints on the interpretation of data.

The author summarises logging impact as follows: 'It appears that selective logging as carried out in these trial blocks (four in Pureora and Whirinaki) results in a relatively small level of canopy reduction, with forest structure remaining relatively intact.' Different types of ground disturbance in the Waione and Hydro Access trials amounted to approximately 24% of the total ground area disturbed by selective logging in Whirinaki Forest. In the 1961 Whirinaki trial, the increase in abundance of both wineberry and the ground fern *Blechnum fluviatile* was a result of ground disturbance caused by logging. Browsing by red deer and possums had hedged plants of other species and prevented height growth.

Keywords: bird populations, crown fires (in podocarps), fire (induced succession), forest composition, forest structure, phenology, possum diet, selective logging – impact on vegetation, vegetation assessment

114. Leathwick, J. R. 1984: Phenology of some common trees, shrubs, and lianes in four central North Island forests. *Forest Research Institute Bulletin 72*. Forest Research Institute, Rotorua. 46 p.

This annotation is concerned with the study in Whirinaki Forest only. See also annotation in the Pureora bibliography, item 156. The paper reports on work carried out at Whirinaki from August 1979 to July 1981. The work was part of wider studies undertaken at Whirinaki by the Forest Bird Research Group (Crawley 1981; Leathwick 1981). In Whirinaki Forest there were two study areas, one by the Hydro Access Road (altitude 400–550 m) the other in the Waione Ecological Area (altitude 550–670 m). The 'Hydro Access' study area was on steep terrain with scattered emergent rimu over a dense tawa canopy. The 'Waione' study area was in rimu-dominant, dense podocarp forest.

A graph is given for average annual rainfall and average annual temperature for these sites over the study period and also over longer periods. Seasonal patterns of flowering, fruiting and vegetative growth are shown in charts for each species examined, with text explanation. In Whirinaki, phenology studies were made of usually 6–12 specimens of the following flowering species: wineberry, tawa, putaputaweta, rimu, hinau, broadleaf, pigeonwood, *Melicope simplex*, mahoe, red matipo, kaikomako, tarata, kahikatea, miro, matai, pepperwood, supplejack and lawyer. A number of species were omitted from the Whirinaki study but were included in studies of the other central North Island forests—such species include kamahi, totara, and some shrub species highly palatable to possums or deer. [These shrub species often produced regular and heavy seed crops at Pureora before possums arrived in the 1960s and had an impact on the vegetation. For example, abundant ripe fruit was seen on wineberry at Pureora from 1958 up until the 1960s (see Beveridge 1964, 1973; McEwen 1978; Jane 1978a). But in the current study 'fully ripe fruit was rarely seen' (in all four central North Island forests).]

Keywords: dense podocarp forest, Hydro Access Road study, phenology, rimu/tawa forest, Waione study

115. Masters, S. E.; Holloway, J. T.; McKelvey, P. J. 1957: The National Forest Survey of New Zealand 1955. Vol. 1. The indigenous forest resources of New Zealand. Government Printer, Wellington. 106 p.

This survey was conducted from 1946 to 1955, mainly in the lower altitude indigenous forests of New Zealand. [It was followed by the ecological survey of the early 1960s.] Fieldwork and plot data were used to produce a volumetric classification (relating to merchantable timber) and an ecological forest classification for New Zealand's forests. Maps showing the distribution of the forest types and forest classes (ecological) in the Whirinaki and Urewera regions accompany the report. [The 'volumetric' maps were never published. See Steward et al. (1987).]

[See McKelvey (1955, 1973), McKelvey & Nicholls (1957), Nicholls (1966, 1969, 1974, 1978), and NZFS (1978). Unpublished file notes by Nicholls, and by Herbert, on forest types and forest classes, are held at Landcare Research. A number of these appear as listed items in this bibliography.] (MCS)

Keywords: forest survey – national, forest types

116. Mason, R. 1968: Report on stomach contents of opossums from the Urewera. New Zealand Forest Service, Rotorua (unpublished report).

A study of possum diet items in totara/matai and rimu/tawa forest of the Mangawiri Basin from 1965 to 1968. Initially, stomach contents were analysed for 161 possums killed from October 1965 to April 1966. Totara leaves, tawa fruit and leaves, and rimu leaves were the main items of possum diet, with a few of some other more palatable species. Continuation of the study for a further 6 months was considered essential to determine seasonal browsing patterns [and from memory, this did take place].

[The full results of Mason's study have not yet been traced at Forest Research. Indigenous Forest Management Group records contain a memo from Les Pracy, Forestry Protection Officer, Wellington, dated 3 May 1966. The memo gives some results from Ruth Mason's (DSIR) study. Pracy considered that browsing by possums did not cause the decline of totara crowns in the Mangawiri Basin and mentioned that a possum population check indicated a density rating of only 5.5 possums/ha. See further work on totara decline: Forest Research Institute (1982), and Beveridge (1967). The title and date of Mason's report are given in the bibliography on Te Urewera National Park by Shaw et al. (1990).]

Keywords: Mangawiri Basin, possum diet – totara foliage and tawa seeds, totara mortality

117. McEwen, W. M. 1978: The food of the New Zealand pigeon (*Hemiphaga novaseelandiae*). *New Zealand Journal of Ecology 1*: 99–108.

This paper was included as item 168 in the Pureora bibliography. Of 177 birds confiscated from poachers, 80% were shot in central North Island forests, mainly in autumn. Only 12 came from Urewera forests. The contents of the alimentary tracts of all birds were analysed. The combined observations, from all the birds countrywide, indicate that at least 104 plant taxa contribute to the diet of the New Zealand pigeon. Podocarp and tawa fruits are important food sources in forests such as those in Whirinaki, where seed crops, fluctuating in abundance, occur from March to late winter. Miro is a favourite item. Of all the fruit-producing plants that occur in Whirinaki, those that were found to be part of pigeon diet are tawari, mahoe, supplejack, hinau, maire, pigeonwood, broadleaf, wineberry, lawyer, mapou, kaikomako and pepper-wood. Plants in Whirinaki with leaves that are eaten by pigeon include kowhai (flowers are also eaten), lacebark and *Parsonsia*. Exotic species at Whirinaki known to be food for the New Zealand pigeon include fruits of hawthorn, ripening in autumn on terraces of the Whirinaki River, and leaves of willows.

[Much of the fuchsia that once existed in Whirinaki, producing ripe fruit over a long period in summer and early autumn, has been killed by possums. Possums are likely to compete with birds for the succulent fruits of other species also, such as shrubs and lianes, some of which have suffered from possum browsing of new shoots and flowers. Wineberry, the abundant pioneer shrub on disturbed ground at Whirinaki, is known to be relatively palatable to possums. See Leathwick (1981) for phenology of some common plant species at Whirinaki and other central North Island forests; Best (1977) for food sources of pigeon in the Urewera, observed before the arrival of possums; St Paul (1977) for observations in the period 1946–61, in Whirinaki Forest; and Hill (2002) for recent work on kereru.]

Keywords: New Zealand pigeon – diet, New Zealand pigeon – feeding habits, seed dispersal

118. McGlone, M. G. 1983: Polynesian deforestation of New Zealand: a preliminary synthesis. *Archaeology in Oceania 18*: 11–25.

Although this wide-ranging review does not specifically mention Whirinaki Forest, there are many comments relating to the role of fire in changing forest

patterns which could apply to the Whirinaki Valley during the earlier time of Maori occupation. [It is recognised that fire has played a role in forest development at Whirinaki. There are patches of podocarp poles that have arisen since the abandonment of pa sites and associated clearings, mainly in the early 19th century, ridge-top pole stands of kamahi, and areas of tawa where crown fires probably removed the old podocarp trees. Clearance by Maori for travel, dwellings, fortifications and security are referred to by the author (p. 20). Podocarp pole stands near the site of Okarea Pa are set among tall, dense podocarp forest. Clearing large areas of this forest type may have been desirable for security reasons. The review refers to papers by McKelvey (1955, 1973a, b) and Cameron (1960b, 1964), who consider the effect of the cultivation of potatoes in the 19th century. Areas were cleared and the natural fertility of the soil exploited for 2 or 3 years, before clearing and burning further patches of forest for planting.Although some of the older, dense podocarp forests of Whirinaki, with rimu aged up to 700 years and some matai over 800 years, may be too old to have been induced by early Polynesian fires, fire has been invoked for their origin, at least in the Mangawiri Basin (Cameron 1961, 1962).]

Keywords: crown fires in podocarp/rata, fire-induced podocarp regeneration, fire – Polynesian (impact on forest), forest clearings, kamahi pole stands

119. McKelvey, P. J.; Nicholls, J. L. 1957: A provisional classification of North Island forests. *New Zealand Journal of Forestry 7(4)*: 84–101.

This pioneering classification of native forest types of the North Island was based on data collected by the NZFS during the National Forest Survey of 1946–55, which focussed on merchantable forest. It describes 77 unlogged and logged, primary and secondary forest and scrub types, grouped in 18 classes. The classification was the basis for subsequent forest-type mapping at the scale of 1:63 360 (never completed). For each type, the dominant tree species are listed, together with other less abundant species. Distribution of the types are listed by region. Forest classes D (northern rata–rimu–tawa), H (beech–podocarp–tawa), I (beech–rimu), J (beech–Hall's totara), K (beech), L (podocarp), M (matai–rimu), N (*Beilschmiedia*), P (*Weinmannia*), and R (scrub), all occur within or near Whirinaki Forest Park. (MCS)

[The forest types described in this paper were used in the Whirinaki forest-type maps of Nicholls (1966, 1969) and McKelvey (1973a, b). After a complementary ecological survey undertaken in the early to mid 1960s, in mostly unmerchantable forest, the original National Forest Survey classifications presented in this paper were considerably expanded and revised (Nicholls 1976; Nicholls & Herbert 1995).]

[Unfortunately, no correlation between the original and revised classifications was ever published, limiting the usefulness of the original forest-type maps that were produced.]

Keywords: classification of indigenous forest, forest types

120. McKelvey, P. J. 1955: A note on the forest edge at Te Whaiti. *New Zealand Journal of Forestry* 7: 77–80.

This report suggests the expansion of the forest edge at Whirinaki, resulting from recently instituted fire control (the margin of the forest being fire-induced), follows three distinct successional pathways: (i) bracken invaded by 'scrub hardwoods' [small, short-lived angiosperm trees, principally of the genera *Pittosporum and Pseudopanax*], in turn invaded by podocarps; (ii) more commonly, bracken invaded by manuka and kanuka, followed by 'scrub hardwoods' and scattered podocarps; and (iii) bracken invaded by manuka and kanuka, followed by dense podocarps. [MCS: Descriptions are given of the different stages in these successional pathways; stages ranging in age from 5 or 10 years, to 70 or 100 years.] Podocarp invasion, a slow and irregular process, depends on: (i) concentrations of seed-dispersing birds; (ii)'scrub hardwoods' attracting fruit-dispersing birds; (iii) moderate browsing pressure from deer; and (iv) podocarp seed years. (MCS)

Keywords: fire (induced succession), forest-edge succession, succession – fire induced

121. McKelvey, P. J. 1959: Animal damage in North Island protection forests. *New Zealand Science Review 17(2)*: 28–34.

This paper relates the long-term effects of continued browsing of vegetation by possums and deer in protection forests, including the Urewera highlands (which are veneered with Taupo pumice on easier terrain). The protection forests of the main mountain axis of the North Island are principally beech, with extensive areas of podocarp/mixed-hardwood forest along lower forest margins in the Urewera highlands. [These forest types occur at Whirinaki, where the depletion of palatable understorey shrubs and ground cover has occurred over a period of some 50 years.]

The author states that possum impact is most severe in podocarp/mixed-hardwood forests, and that there are large areas with complete mortality of kamahi and rata where there are high possum populations. 'Mortality is also common in fuchsia, wineberry, mahoe, and even tawa and totara.' [This is an early mention of totara mortality, presumably mainly referring to Hall's totara at higher altitudes. Totara, kamahi, and northern rata have suffered mortality or damage in the Whirinaki Valley. Exposed tawa crowns are subject to frost damage. See Mackenzie & Gadgil (1973).]

Keywords: animal damage – protection forest, deer damage, mortality and decline of indigenous trees, possum damage, possum populations, Urewera highlands

122. McKelvey, P. J. 1973a: The pattern of the Urewera forests. *Forest Research Institute Technical Paper 59*. Forest Research Institute, New Zealand Forest Service, Rotorua. 48 p. 1:250 000 forest class map.

A comprehensive overview of the forest pattern of the Urewera mountains and the contiguous Whirinaki tract to the west, based on plot data collected during the 1946–55 NZFS National Forest Survey (Masters et al. 1957) and further ecological data collected up to the mid-1960s. Altitude is the overwhelming determinant of forest pattern in the Urewera Ranges, but there are broader transitions, resulting from widespread volcanic modification or disruption of

earlier forest, most recently caused by the Taupo Eruption of AD 200. The author applied the 'centripetal volcanic succession' hypothesis to the Whirinaki forest tract—a hypothesis he had proposed originally for the west Taupo forests (McKelvey, P.J. 1963: The synecology of the west Taupo indigenous forest. *NZFS Bulletin 14*, 127 p.). The spatial sequence of decreasing conifer densities with increasing distance from the eruption centre of Lake Taupo was interpreted as a temporal sequence—the three concentric forest zones distinguishable around the lake corresponding to three stages of succession towards 'climax' forest, with conifers declining progressively in importance over space and time, and hardwoods increasing. (MCS) [Subsequent work has validated the hypothesis in broad outline, although a wider variety of successional pathways than envisaged by the author are operating, and many appear essentially 'completed'.]

Keywords: fire patterns, forest classes, forest composition, forest history, forest pattern – Urewera forests, podocarp forest vegetation maps, Taupo Eruption, volcanic succession hypothesis

123. McKelvey, P. J. 1973b: The pattern of the Urewera forests. *Forest Research Institute Technical Paper 59*. Forest Research Institute, New Zealand Forest Service, Rotorua. 48 p.

This is a primary ecological account of the Urewera forest tract, based on data collected by the National Forest Survey of 1946–55, and further ecological data collected up to the mid-1960s. The area covered includes Urewera National Park and Whirinaki Forest. Boundaries of Whirinaki Forest are not marked on the accompanying colour map of forest class (NZFS Mapping Series 6, 1:250 000, Sheet 7: Urewera 1st ed. 1970). A historical outline refers to first human occupation in the region as early as the 11th or 12th century [probable dates altered recently], with some 3000 Tuhoe people present when Europeans reached the area in the 1840s. There is a good reference list with 46 items. The paper covers the composition and pattern of the forests by broad forest classes, described either as merging 'altitudinal-gradation forests', or more discretely defined volcanically modified forests. A map of forest classes shows the situation as it was in the 1950s. The main forest classes within the area of the present Whirinaki Conservation Park are the volcanically modified forests at lower altitude of podocarps (referred to as 'softwoods'), and rimu–matai–hardwoods (broadleaved species), usually with tawa, and unmodified higher-altitude beeches or rimu–beeches. Development of the forests is discussed. In the area of Whirinaki, much forest was apparently destroyed or severely modified by deposits of pumice and ash from the Taupo Eruption (revised date AD 200). This parallels the situation of the west Taupo forests [mentioned in Pureora bibliography, item 171]. Volcanic succession is suggested, with the softwood class representing a first stage of forest colonisation and the rimu–matai–hardwoods class a later stage. Evidence from podocarp diameters in these two classes, and ring counts of matai (Cameron 1962) indicated that the podocarps may be about 350 years older in the latter class. [Forest type L2 (McKelvey & Nicholls 1957) is younger than type M2, and there is still much controversy about succession after the Taupo Eruption.] The author considered (p. 23) that dense podocarp forests such as those in Whirinaki Forest may have resulted from Polynesian burning (Cameron 1960a, 1961). Several aerial photographs, with forest types marked as shown in the paper, show areas

within or near Whirinaki Forest (figs. 3, 5, 7, & 14). Human influence on the forests, for example burning, sawmilling, and the introduction of browsing animals and predators of bird life, are discussed. Crown fires have changed the composition and structure of some forests, often removing or damaging rimu and northern rata and encouraging prominence of hardwoods, often tawa. Successional stages after burning at the forest edges are suggested (McKelvey 1955). Liberation dates are given for the ubiquitous red deer and possums [both of which were liberated at Te Whaiti between 1917 and 1921].

Keywords: fire patterns, forest classes, forest composition, forest history, forest pattern – Urewera forests, podocarps, Taupo Eruption, vegetation maps, volcanic succession hypothesis

124. Mackenzie, R. M. J.; Gadgil, P. D. 1973: Dieback of tawa. *New Zealand Journal of Forestry 18*: 36–46.

Tawa health was monitored in four plots in unlogged and logged forest, one of them in Whirinaki Forest (Waione), over 2 years (1968–70), in relation to degree of canopy closure. Death of tawa foliage, buds, and shoots, in autumn and early winter, was greater under more open canopies and this was attributed to frost. Foliage wilting and branch death in late winter and spring was also greater under more open canopies, but its cause was not established. [Sapling and pole-sized tawa beneath a tall podocarp canopy also showed wilted foliage at Waione and in the old-growth forest of the Whirinaki Forest Sanctuary in the 1970s (Beveridge, A. E., pers. obs.).]

Die-back was generally greater in logged than unlogged plots. [Some west Taupo and Mamaku podocarp/tawa forests were heavily logged in the 1950s, with all podocarps removed. The residual tawa showed severe die-back soon after logging. But many appear to have recovered 40 years on, through production of epicormic growth in tree crowns (Beveridge, A. E., pers. obs.). See Knowles & Beveridge (1982).]

Keywords: tawa die-back

125. Millyn, G. E.; Nevin, D. C, 1978: Archaeological site survey, Whirinaki SF 58, Rotorua Conservancy. New Zealand Forest Service, Rotorua. 8 p. Site record forms, maps, sketches c. 100 p., 10 photographs.

A 6-week survey in 1978 located, described and mapped many archaeological sites, mainly in the Whirinaki River Catchment in Whirinaki Forest, but also in the leased block of Te Whaiti-Nui-a-Toi. Sites described include pa, graves, forest clearings, house sites (now covered in young plantations of exotic conifers) and tracks. Artefacts collected include totara pigeon-troughs, stone adzes and obsidian flakes. Some large totara with lower bark stripped from one side were located (one with a subsequent radial growth of 20 cm). Four types of threatened areas were identified, including those crushed, burnt and planted in 1977–78, and those to be cleared for planting in 1979. A number of sites had already been recognised and given some protection, however others had been damaged by bulldozers. Many clearings had secondary forest of kamahi and kanuka, occasionally with rimu regeneration (e.g. at 'Pigeon Camp'). Pig rooting had been extensive on many sites. Some forest clearings had probably

been cultivated. Details of Okarea Pa and Te Tapiri Pa are given. At Okarea Pa some upright totara palisade posts were still sound, possibly dating from construction about 1818. Potato pits were recorded at the pa site.

Keywords: archaeological survey (Whirinaki Forest), forest clearings, Maori occupation

126. Moorhouse, R.; Greene, T.; Dilks, P.; Powlesland, R.; Moran, L.; Taylor, G.; Jones, A.; Knegtmans, J.; Wills, D.; Pryde, M.; Fraser, I.; August, A.; August, C. 2003: Control of introduced mammalian predators improves kaka (*Nestor meridionalis*) breeding success: reversing the decline of a threatened New Zealand parrot. *Biological Conservation 110*: 33–44.

This study is concerned with the impact of introduced mammalian predators on kaka. Past work on the decline of kaka in mainland forests is outlined. Stoats are believed to be the main predators, although ferrets may kill fledglings on the ground. There is also evidence of possum predation on eggs, nestlings, and nesting females.

In this study, six mainland sites were chosen, and at each site a number of kaka adults and fledglings were radio-tagged, so that nesting success or failure could be followed and reasons for failure determined where possible. Three of the sites had on-going predator control, the other three did not. Results of nesting success at the three controlled sites were compared with those at the three unmanaged sites. Two of the six study sites were in central North Island podocarp forest; a 1100 ha site in the Waipapa Ecological Area (WEA), and a site in Whirinaki Forest. The WEA was one of the sites where predator control (possum) had taken place. Possum control was performed using several different toxins (including 1080 and Talon™). Bait stations placed on a grid system were used over a period of 8 years. Whirinaki was one of the unmanaged sites. There was no systematic predator control there during the research period, but recreational possum hunting occurred.

Data on failure at different stages of the nesting process are presented for all six study sites. At the WEA site there were 27 successful nests (87% of all the kaka nests found at WEA through the radio-tagging operation), with an average of 3.2 chicks fledged per nest. At the Whirinaki site there were 5 successful nests (38% of all kaka nests found at that site), with an average of 1 chick fledged per nest. The most common cause of nesting failure at Whirinaki and the other unmanaged sites elsewhere on the mainland was egg mortality, with predation of nesting females the next most common cause. At both the WEA and Whirinaki study sites all fledgling mortality occurred within 10 days of fledgling—the fledglings being susceptible to predators while spending much of their time on the ground.

The high nesting success in the WEA is considered anomalous (despite the systematic possum control). However, stoats had been found to be relatively rare on this site before predator control. It was concluded that 'Control of stoats and possums can potentially reverse the decline of the kaka on the main islands of New Zealand.' Stoats can be effectively controlled by secondary poisoning (e.g. eating a dead poisoned possum) and trapping. The ship rat (*Rattus rattus*) may also be a predator of kaka eggs and nestlings. While there are

no published records of possums preying on adult kaka, possums are known to be predators of other bird species. Competition with possums for food and nesting sites were considered to be a factor in the decline of kaka. [Good seed crops may be necessary for higher breeding intensity by kaka. See Powlesland et al. (2003).]

Keywords: kaka breeding, kaka predation, predator control – kaka

127. Morton, J. 1984: Whirinaki: a forest still at risk. *Forest and Bird 15(2)*: 22–27. Colour illustrations.

After tracing the broad history of logging New Zealand's indigenous forest, the author makes a strong plea for cessation of logging in Whirinaki Forest. [This wish was later granted by 'administrative fiat' in the same year. Continued employment of Minginui villagers in logging and milling exotic plantation species has not yet been realised, while recreation and tourism has developed slowly.] Some 350 km of roads had been constructed in Whirinaki Forest [many of these were built for selective logging and salvage of windthrown podocarps during the preceding 10 years]. The book *To save a forest: Whirinaki* (Morton et al. 1984) was published later the same year, and is given a fuller annotation.

Keywords: forest management policy – Whirinaki, logging cessation, logging history – indigenous forest

128. Morton, J.; Ogden, J.; Hughes, T.; MacDonald, I. 1984: To save a forest: Whirinaki. David Bateman Ltd, Auckland. 111 p. 59 colour photographs, forest profile diagrams.

This is a beautifully illustrated and well-written book, which cogently argues for the cessation of all logging in Whirinaki Forest, including extraction of logs from windfallen trees or from natural mortality of podocarps. The book, written mainly in popular style, must have been published only a few months before a government forestry caucus committee of a new government visited Whirinaki (5 October 1984) and proclaimed that all felling of trees should cease immediately in Whirinaki Forest. The previous government had made Whirinaki a forest park on 28 April 1984. The text is a polemic against the government forest policy prevailing at the time of the book's publication, and the activities of the NZFS, as set out in their 1981 management plan for Whirinaki Forest (Orchard et al. 1981). The authors recognised the NZFS was attempting to follow (revised) forest policy approved by Government in 1975, proscribing the total logging or clearing of indigenous state forest in the central North Island in most circumstances. The policy advocated substitution with controlled partial-logging, allowing perpetuation of the indigenous forest while wood production was to continue at a much reduced level.

Publication of this book followed nearly 10 years of public debate on the management of indigenous forests in New Zealand. The authors gave the example of the first operational partial-logging in the Mangawiri Basin, which started in 1975 and was later assessed as making a devastating impact on stability of the residual forest (Herbert 1979). The Okurapoto selection management trial was also criticised for being located in dense podocarp forest of the Tauranga Basin. [But it was intended to demonstrate that well-controlled and executed logging at low intensity need not severely damage the forest].

The two principal authors of the book are eminent scientists, and although they write with passion in their arguments and their descriptions of the forest, they mainly give fair summaries of experimental work in central North Island forest, and include hypotheses on podocarp regeneration cycles. Some apparent Forest Service arguments are set up for demolition. [No Forest Research scientist ever considered that 'the forest was dying and needed to be logged to provide regeneration and a healthier condition (pp. 57, 75). Research has shown that some of the podocarps are senescent and the forest structure changes in time according to cycles not yet fully understood at Whirinaki. Podocarps at Whirinaki regenerate abundantly through canopies of kanuka or kamahi developed after fire or on old Maori clearings, while seedlings occur commonly on disturbed ground.]

Apart from presenting a case for immediate cessation of logging, this book contains much of interest to the present-day reader, particularly on botanical and ecological matters. The colour photographs display many of the main features of the different forest types, with botanical identification. There are photographs of the forest interior and ground vegetation, including some of the mosses, ferns and lichens. There are eight aerial and ground shots of the Arahaki Lagoon and the surrounding kahikatea forest in the Oriuwaka Ecological Area. Some photograph captions have a political slant, but most are purely descriptive and instructive.

[The four photographs of a totara/matai stand in the Mangawiri Basin and its margins (photographs 44, 46, 48, and 49) illustrate earlier lack of understanding of totara die-back, prompting a decision to clear-fell in 1973 and convert what was a proposed sanctuary to Douglas fir and radiata pine. Investigation into totara die-back was started in the mid-1960s, and it has since become apparent that browsing by possums has contributed to widespread die-back of totara and Hall's totara in New Zealand. Many totara at the margins of Mangawiri Basin where boles are exposed to light, especially trees with crown die-back, subsequently produced long, healthy, epicormic shoots along their stems. When inspected in February 2004 these shoots had become dense and bushy, with possum browsing evident. See also Beveridge (1967).]

The photographs of matai stands (photographs 83–86) illustrate a forest type logged for totara from the 1940s, with podocarp regeneration in places [see Gamble (1979)]. Coloured maps are appended for vegetation types and management zones shown in the NZFS management plan of 1981. The question of 'values' is discussed in the last chapter. Whirinaki Forest had been 'saved' [from logging], but with closure of the Minginui Sawmill, after a short period of using exotic conifers, the impact on the local community had been considerable.

[The authors write on birds of the forest (p. 34) and comment that 'the forest is, with some exceptions, ominously quiet'. Studies at Pureora and in other central North Island forests have indicated the impact that predators such as possums, rats and stoats have on wildlife. In recent years DOC have initiated similar studies in Whirinaki Conservation Park. The Mangawiri Basin could be a prime target for restoration of a totara/matai forest by group planting of totara raised from cuttings. The source of the cuttings would be either the epicormic shoots of totara trees marginal to the previously cleared forest, or the seeds that are

now being produced by trees with improved crowns. Groups could be planted within canopy gaps of the Douglas fir stands after thinning at margins of the basin. Inspection in April 2004 showed that some totara are again producing seed and exhibit crown recovery after degrees of die-back in the1960s.]

Keywords: conservation issues, environmental values, forest description, forest ecology, forest types, management revision, Mangawiri Basin, podocarp regeneration, successional hypotheses

129. Moynihan, K. T. 1979: Native wildlife of Whirinaki Forest. *Fauna Survey Unit Report 17*. New Zealand Wildlife Service, Department of Internal Affairs, Wellington (unpublished report). 13 p.

A list is given of native and introduced birds recorded in Whirinaki Forest, with brief notes on the habitat, feeding preferences, and conservation status of some species. References are made to a 1971 reconnaissance survey by the Wildlife Service of birds in the indigenous forest of the Rotorua and Taupo districts (Crook et al. 1971), and 'the notes of St Paul' (St Paul 1977). St Paul (1977) observed numbers and movements of birds in Whirinaki over a period of 17 years from 1946, and commented on the large numbers of New Zealand pigeon, tui and bellbirds gathered seasonally to feed on fruit of podocarps [he also noted large flocks of starlings]. Among the threatened species listed by the author, kiwi are reported to occur occasionally, reference is made to a diminished population of blue duck in some parts in the east and south of the forest, and the New Zealand falcon is reported as rare. The optimum habitat for kaka and yellow-crowned parakeets is the dense podocarp forest. Kokako have never been recorded in Whirinaki Forest, though there was one sighting at Te Whaiti in 1942. Bats are present, with a colony reported in 1969. Evidence indicates that 'much of the dense podocarp/hardwood forest of Whirinaki should be rated as of high or outstanding wildlife value', based on the diversity of forest habitat, general abundance of native forest birds, and the presence of threatened species such as kaka and parakeets.

[The impact of selective logging on native wildlife had not been assessed in 1979, but the Wildlife Service was about to commence a 3-year study looking at the impact on bird populations in two study areas in Whirinaki. See Crawley (1981), Harrison & Saunders (1981), and Leathwick (1981).]

Keywords: bird population survey, blue duck, dense podocarp forest – forest-bird habitat, forest-bird distribution, kaka, parakeet – yellow-crowned

130. Moynihan, K.; Imboden, C.; Ogle, C. 1979: Bird survey in Whirinaki Forest. *Fauna Survey Unit Report 18.* New Zealand Wildlife Service, Department of Internal Affairs. Wellington (unpublished report). 7 p. Figures, tables.

This survey was carried out in September 1979, early in the season, in cold weather, owing to controversy over the future of Whirinaki Forest and imminent political decisions. Five-minute bird counts were made at a total of 176 stations over four sample areas covering different forest types: (i) Old Fort Road Block, Tauranga Basin (dense and medium-dense podocarp forest); (ii) headwaters of Waiatiu Stream (podocarp/hardwood forest); (iii) Pukeroa Block,

in the headwaters of Te Kohu Stream, the proposed Te Kohu Ecological Area (podocarp/beech forest); and (iv) Te Hoe Block, in the headwaters of Whirinaki River (silver beech forest with red beech).

The four sampled blocks and full extent of forest types are shown in figures. Data comparing bird populations are given in tables. The Old Fort Road Block ranked highest for abundance of kaka and parakeets, the two most threatened species (0.7 birds/station), also whiteheads and pied tits. It also rated highest of all the sample blocks for diversity and abundance of native bird species. Riflemen were more abundant in the higher-altitude beech forest where winter flocks of whiteheads were encountered and conditions seemed to favour some introduced species (mainly chaffinch). The low-altitude dense podocarp forests of Whirinaki were considered of outstanding value for native bird communities, and the Wildlife Service recommended a comprehensive conservation area should include as much as possible of the remaining podocarp-dominated forest in Whirinaki. The report notes that many stations in the Old Fort Road Block were in areas where some totara were extracted many years ago, and others were in areas recently logged in Forest Service selection-logging trials.

[A selection management trial in over 30 ha of dense podocarp forest was established in the Okurapoto Basin in 1979. It was set up by the Forest Research Institute and the Rotorua Conservancy (NZFS) at the request of the Forest Service, following a disastrous first operational partial-logging at the margin of the Mangawiri Basin in 1975 (Herbert 1979). Operational partial-logging by the Rotorua Conservancy also took place in other areas of the Old Fort Road Block. Removal of totara from fallen or sometimes felled trees was carried out over extensive areas from the 1920s and left few long-term canopy gaps. Reserves were established in podocarp/tawa forest by Old Fort Road, and in the virgin dense podocarp forest (including totara) of the Tauranga Basin Ecological Area (previously also known as the Tauranga Stream Ecological Area).]

Keywords: bird population survey, bird sampling in ecological area, dense podocarp forest – kaka and parakeet habitat, forest types – bird habitats, Tauranga Basin Ecological Area

131. Mulcock, T. 1987: Minginui. *Historical Review 35(1)*: 25–29.

An account of life in the early days of the milling settlement. The author became sole teacher at the mill school in 1933—the same year in which fire destroyed the mill. Written in 1987, the last year the NZFS administered Minginui Village and Whirinaki State Forest, the author writes of the promise of recreation and tourism in the forest. The account includes photographs of the village taken in 1933. [For a full account of Minginui Village history, see Hutton & Neumann (2001).]

Keywords: Minginui Village history

132. Native Forests Action Council. 1979a: Sections of submission on Whirinaki Forest. Native Forests Action Council Bulletin (incomplete). Native Forests Action Council, Nelson. Text 50 p. Appendices 8 p.

This incomplete submission by the NFAC is on NZFS proposals for the management of Whirinaki State Forest (NZFS 1979a). The brief proposals had

been written to conform to revised indigenous forest policy (NZFS 1977, 1978a). [Completion of the submission was requested urgently by the NZFS, so that, together with other submissions, it could be analysed before the full management plan was written, according (mainly) to the views and values of the NZFS (see Orchard et. al 1981).]

The NFAC presents a case for including the southern half of Whirinaki State Forest (as it then was) in the Urewera National Park. Completed sections include 'Geology and landforms', 'Climate', 'Vegetation', 'Wildlife', 'History of a long Maori occupation', and 'European contact from the time of a first mission station established near Te Whaiti in 1847'. Sections nearing completion, but omitted, were 'Scenery', 'Recreation', and 'National Park criteria'. [Sections omitted from this paper were included in a full report, with references, later the same year (i.e. NFAC 1979c). See also Field & Garrett (1979).]

Five appendices deal more directly with management proposals, and the possible effects on the Minginui community of inclusion of part of Whirinaki State Forest in Urewera National Park. One appendix gives descriptions and locations for 12 vegetation types. Each section is a review of what was known in 1979 of forest ecology and human impact that was relevant to Whirinaki Forest. The authors of each section are anonymous. The authors and dates of published papers that the submission refers to are given in the text, but there is no reference list.

The values of the NFAC are expressed to counter the proposals of the NZFS, and interpretation and argument are in favour of the addition of 30 000 ha of the upper Whirinaki Catchment to Urewera National Park. Some sections, such as 'Geology and Landforms', have obviously been written by well-informed scientists. Parts of the account were later included in the widely distributed book *To save a forest: Whirinaki* (Morton et al. 1984), which comments on the final management plan for Whirinaki, distributed by the NZFS (Orchard et al. 1981).

[From today's perspective, little was known in 1979 by any of the protagonists about the importance of predators and their impact on wildlife, or, indeed, about the wildlife itself. The NFAC submission makes little reference to changes in vegetation through browsing by deer and possums, nor does it mention invasive weeds, or the decline of northern rata and kamahi (a vital nurse for podocarp regeneration in long-term cycles). The account of Maori occupation of the Whirinaki Valley is interesting, but no sources are given (the works of Elsdon Best obviously provide some sources). Reference is made to the Great Fleet arrival in 1350. This event is discredited by academic historians (Howe 2003: The quest for origins. Penguin, Auckland. 235 p.). However, 1350 may be a reasonable approximation of the date of first occupation of the Bay of Plenty region. Several hundred years of Maori occupation in the Whirinaki district—with fires and clearing of forest for habitation, and shifting cultivation for fern root and potatoes (from about 1840)—have given the disturbance necessary for the slow process of recolonisation of such sites by podocarps (discussed briefly in the submission).]

Keywords: conservation issues, environmental issues, environmental values, forest description, forest ecology, forest types, human history, management proposals submission

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