Ecology, management and history of the forests of the Mamaku Plateau, New Zealand

An annotated bibliography

Department of Conservation
Te Papa Atawhai

Ecology, management and history of the forests of the Mamaku Plateau, New Zealand

An annotated bibliography

A.E. Beveridge, B.R. Christensen, M.C. Smale and D.O. Bergin

Published by
Publishing Team
Department of Conservation
PO Box 10420, The Terrace
Wellington 6143, New Zealand

Cover: Lake Rotohokahoka, Mokaihaha Ecological Area, Mamaku Plateau. *Photo: J. Kelly, Rotorua Lakes Area Office, Department of Conservation.*

Individual copies of this book are printed, and it is also available from the departmental website in pdf form. Titles are listed in our catalogue on the website, refer www.doc.govt.nz under *Publications*, then *Science & technical*.

ISBN 978-0-478-14573-1 (hardcopy)
ISBN 978-0-478-14574-8 (web PDF)

This text was prepared for publication by the Publishing Team; editing and layout by Amanda Todd. Publication was approved by the General Manager, Research and Development Group, Department of Conservation, Wellington, New Zealand.

In the interest of forest conservation, we support paperless electronic publishing. When printing, recycled paper is used wherever possible.

CONTENTS

Ecology, management and history of the forests of the Mamaku Plateau, New Zealand

An annotated bibliography

A.E. Beveridge[1], B.R. Christensen[2], M.C. Smale[3] and D.O. Bergin[4]

[1] 62b Panapa Drive, St Johns, Auckland 1072, New Zealand

[2] Bay of Plenty Conservancy, Department of Conservation, PO Box 1146, Rotorua 3040, New Zealand. Email: bchristensen@doc.govt.nz

[3] Landcare Research, Private Bag 3127, Hamilton 3240, New Zealand

[4] Ensis, Private Bag 3020, Rotorua 3046, New Zealand

ABSTRACT

The forests of the Mamaku (or Patetere) Plateau, North Island, New Zealand, have a history of numerous land uses, and now exist as key enclaves for indigenous biota within the Bay of Plenty. Conservation focus is moving from single-species protection to a more comprehensive management approach, targeting multiple pests at key sites. This annotated bibliography covers a timeframe from the late 19th century onwards. It includes research and survey work on the forests, flora and fauna, with some information on soils, geology and hydrology. It also covers the history of logging and conversion of logged indigenous forest to pine plantations on land leased to forestry companies. Pododcarp restoration trials following cutover operations are outlined. This is the third compilation of annotated bibliographic information on the ecology and management of indigenous forest of the central North Island Volcanic Plateau, following publications on the Pureora Forest Park and Whirinaki Conservation Park. The bibliography is an ongoing project and its authors welcome updates, corrections or details of relevant articles.

Keywords: bibliography, Mamaku Plateau, Patetere Plateau, ecology, forest history

Beveridge, A.E.; Christensen, B.R.; Smale, M.C.; Bergin, D.O. 2009: Ecology, management and history of the forests of the Mamaku Plateau, New Zealand. Department of Conservation, Wellington. 152 p.

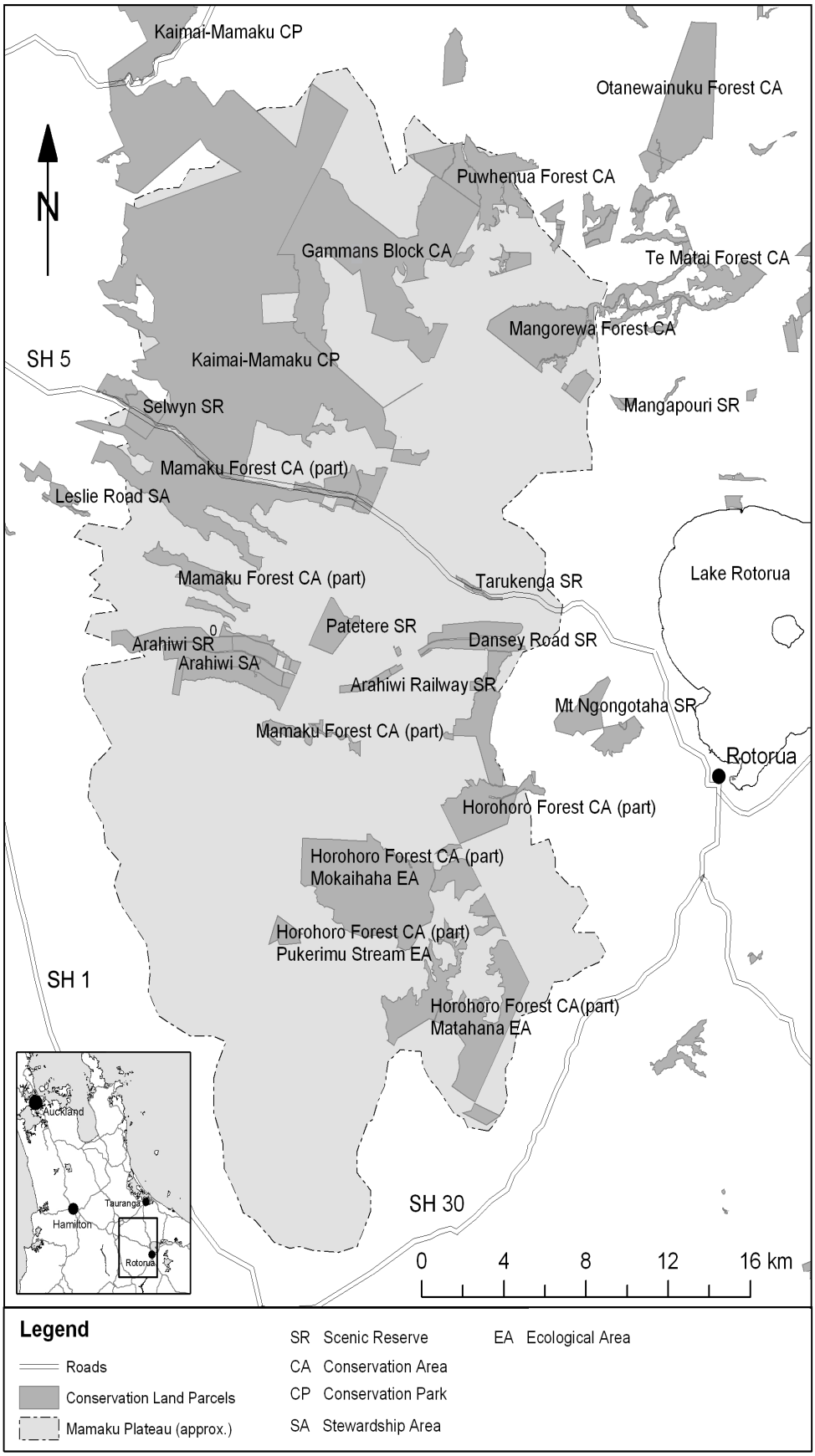
1. Introduction

The Mamaku (or Patetere) Plateau is approximately 1250 km^2 in size and lies immediately west and northwest of Rotorua (Fig. 1). The Plateau is crossed by State Highway 5 (SH5) and the Rotorua Branch railway (currently mothballed), linking Rotorua on the east side with Tirau at the western foot. The Plateau rises to about 500–600 m a.s.l. to the west of Lake Rotorua and to over 800 m on the Horohoro Bluffs in the south.

A feature of the Mamaku forests, whether old-growth or cutover, is that much of the indigenous shrub vegetation palatable to browsing animals has remained. This contrasts with the situation in Whirinaki Forest and most other central North Island forests, where palatable vegetation has been depleted by the relatively high red deer (*Cervus elaphus*) populations. In all these forests, however, ship rats (*Rattus rattus*), stoats (*Mustela erminea*) and possums (*Trichosurus vulpecula*) are ubiquitous as predators of birdlife and other indigenous wildlife, some species of which are rare or endangered. Most of the indigenous forest areas on the Plateau are surrounded by, or adjacent to, plantations of radiata pine (*Pinus radiata*) and Douglas fir (*Pseudotsuga menziesii*). If these exotic conifer plantations were left to grow to maturity, they would provide further protection to the indigenous biota.

Forest types, as mapped and described by John Nicholls, are based on features including climate, landforms, soils, volcanism and history of disturbance (Nicholls 1966, 1967a–c). The region covered by this bibliography extends from the southern part of the Kaimai Mamaku Forest Park, south of State Highway 29 (SH29), through to the northern part of the less-disturbed section of Mamaku Forest, which includes the surviving population of the endangered North Island kokako (*Callaeas cinerea wilsoni*) in the Opuiaki Ecological Area. Further south is Horohoro State Forest, which has another substantial population of kokako in the Mokaihaha Ecological Area. Most of the old-growth (virgin) forest in the region covered by this bibliography is now included in eight Ecological Areas. Coverage in this bibliography has its eastern boundary for the Plateau indicated by the Tauranga Direct Road. However, the eastern boundaries of the Mamaku Plateau are less well defined than on the other sides, and some reference has been made to studies of kokako in Rotoehu Forest and the privately-owned forest (now part of the DOC-managed area) in the Onaia catchment adjacent to the previous Kaharoa State Forest.

Figure 1. Location diagram and associated Department of Conservation (DOC) land parcels of the Mamaku Plateau.



1.1 LAND USE AND VEGETATION HISTORY

The Mamaku Plateau was once covered by many forest types in which podocarps, tawa (*Beilschmiedia tawa*), kamahi (*Weinmannia racemosa*) and northern rata (*Metrosideros robusta*) were prominent, although there were also enclaves of silver, red and hard beech forest (*Nothofagus menziesii*, *N. fusca* and *N. truncata*, respectively). Much of the original forest at lower altitude on the Plateau margins was destroyed by successive fires in pre-European and early European times. However, the high forest on the crest of the Plateau was left relatively intact, owing to the high rainfall (over 2000 mm/year) and cool climate making it less flammable.

Logging and settlement on the central Plateau was relatively late in starting. The Steele brothers began logging in 1888, mainly for rimu (*Dacrydium cupressinum*), and built the first sawmill. This was sited a few kilometres north of the site of the Mamaku settlement, which was established from 1894 on completion of the railway between Tirau and Rotorua. With the development of tramways for log extraction, more mills were built at Mamaku, logging became more intensive, and podocarps were also taken to mills north of the Plateau and in Rotorua. Tractor logging was introduced in the 1930s, causing more soil disturbance and compaction, while leaving a partial tawa canopy over substantial areas of the Plateau during the next 40 years.

Clearing of the forest for farming started with the establishment of the Mamaku settlement. However, farming was restricted and not generally successful until the 1930s, owing to cobalt deficiency in the relatively infertile soils derived from volcanic ash, prolific weed growth, and lack of surface water on the Plateau. Rainwater flows into sink holes, known as tomo, and percolates slowly through thick ignimbrite sheets. It then emerges as springs that feed the headwaters of some of the streams on the flanks of the Plateau, or near Lake Rotorua. Some streams on the western and northern flanks of the Plateau are deeply entrenched in gorges. A feature of the farm landscape is the number of ignimbrite outcrops, or tors, left by erosion of tephra and loess.

During the 1970s, rapid changes in land use occurred, with the large-scale clearing of reverting cutover indigenous forest. This followed a 1968 government decision to lease State Forests to a forestry company for utilisation of the residual tawa component and conversion to plantations of radiata pine. Site preparation was carried out by clear felling residual vegetation before burning or machine clearing. This conversion to pines on central and southern parts of the Plateau continued into the late 1980s, with clearing of cutover beech forest in the northeast of the Plateau.

At the same time, environmental organisations, some scientists and members of an increasingly environmentally aware public protested against the extent of clearing of the Mamaku indigenous cutover forests and the use of fire for site preparation. In the 1970s, the former New Zealand Wildlife Service (NZWS), through its Fauna Unit surveys, recommended the establishment of large reserves of less disturbed forest on the Plateau to sustain bird populations, with particular emphasis on kokako, which were present in two relatively large populations on the central and southern Mamaku Plateau,

with a few birds also surviving in smaller and fragmented forest patches, as in Dansey Scenic Reserve and the upper Waipari catchment.

The Kaimai Mamaku Forest Park was created in 1975 by the former New Zealand Forest Service (NZFS). Shortly after, NZFS also initiated the establishment of Ecological Areas as scientific reserves with representative examples of different forest types.

Concerns about the extent of clearing in the area were reflected in many comments made on a revised draft management plan for the Kaimai Mamaku Forest Park, which was released by NZFS for public comment in 1982. This management plan was never implemented and control passed to the Department of Conservation (DOC) when it was formed in 1987. The emphasis then changed to the protection of indigenous wildlife and flora, and some of the Ecological Areas were later enlarged by DOC to include parts of further conservation areas for greater protection of indigenous wildlife.

1.2 CURRENT FLORA AND FAUNA

Travellers coming along SH5 from the west pass through the Tukorehe Scenic Reserve (Fitzgerald's Glade), with its canopy of tawa and mangeao (*Litsea calicaris*). They then travel through old secondary forest of kanuka (*Kunzea ericoides*) / tanekaha (*Phyllocladus trichomanoides*), with glimpses of virgin forest in the Kaimai Mamaku Forest Park, before going through fringing podocarp/tawa forest with thin-crowned kamahi.

The forest of the Ecological Areas contains populations of the more common indigenous birds. However, the bush falcon[1] (*Falco novaeseelandiae*), North Island rifleman (*Acanthisitta chloris granti*) and yellow-crowned parakeet (*Cyanoramphus auriceps auriceps*), which were sometimes seen in Horohoro Forest in the 1960s or later, now seem to be rare or absent from the Plateau. There are also fewer North Island kaka (*Nestor meridionalis septentrionalis*).

The general bird populations of the old-growth forest and mainly tawa-dominant cutover forests of the Plateau are augmented by the informal retention of indigenous vegetation along some stream banks. The radiata pine populations also have populations of insectivorous indigenous birds, particularly North Island robins (*Petroica australis*), whiteheads (*Mohoua albicilla*) and tomtits (*Petroica macrocephala*). More permanent protection for these species and more widely distributed populations could be provided by retaining permanent strips of radiata pine in stream valleys and allowing them to grow to maturity to provide buffers around Ecological Areas. This would be of particular benefit in the Mokaihaha Ecological Area, where there are populations of kokako and surrounding radiata pine or Douglas fir. Examples of mature stands of these two exotic conifers are scarce in central North Island, although small stands once existed near Murupara; these were felled at an age of about 90 years, by which time diverse indigenous vegetation had developed and tui (*Prosthemadera*

[1] A falcon nest was found in the Opuiaki Ecological Area (see Hudson 2005).

novaeseelandiae) and bellbirds (*Anthornis melanura*) were present, as well as the species already mentioned[2].

Surveys of the kokako populations in the two substantial reserves where the birds continue to survive have been made over the past four decades. These have indicated that some 50 birds remain in each of the Mokaihaha Ecological Area of the southern Plateau and the Opuiaki Ecological Area of the central Plateau, and that the Opuiaki population may be increasing through intensive multi-pest species management by DOC. Measures to control predators have been carried out in both areas. Both possums and ship rats are abundant in central North Island forests and are known to be regular predators of birds, including kokako on occasions (Brown et al. 1993[3]). Ship rats are considered the most destructive predators of nesting birds (John Innes, Landcare Research, Hamilton, pers. comm.). They are also the most abundant predator in indigenous forests, with the ability to quickly reinvade areas where they have been substantially reduced by control measures (John Innes, pers. comm.). Mustelids are also predators of birds in most indigenous forests, with stoats (*Mustela erminea*) killing nesting birds, including kaka.

The kokako population of about 100 birds in the Mamaku forests has been the focus for predator control and surveys in the Mamaku region (especially in the Mokaihaha Ecological Area and Opuiaki Ecological Area), to locate the birds and follow the outcome of nesting. Comparable research has also been undertaken for four other substantial kokako populations in central North Island at Mapara, Pureora, Rotoehu and Kaharoa; see the Pureora bibliography (Beveridge et al. 2000) for details of the pioneering studies in Pureora Forest Park.

Possums may also pose an indirect threat to kokako and other fruit-eating birds, by diminishing the supply of flowers and fruits. One of the authors (AEB) has a vivid memory of tui and bellbirds feeding on nectar, and a pair of kokako feeding on the flower buds of a large kohekohe in May 1973 at the fringe of Kaharoa Forest, where the hardwoods were soon to be logged for pulpwood. It is unusual to see prolific flowering of kohekohe in semi-coastal forest in this region, as possums, which are ubiquitous in central North Island forests, eat both flowers and fruits. Kokako have persisted in a part of Rotoehu Forest where logging of podocarps was carried out prior to the 1960s, leaving tawa-dominant forest with palatable ground vegetation, which was eaten out by deer during the 1960s. At this time, kokako were observed eating supplejack (*Ripogonum scandens*) berries (Miro Road) (AEB, pers. obs.). As possums eat tawa fruits at two stages of their development and tawa leaves in some forests, these omnivores could threaten continued regeneration of tawa from seed and pose an indirect threat by diminishing the supply of fruits for all fruit-eating birds.

---

[2] Carter Holt Harvey Forests Ltd produced a handsome coloured poster entitled 'Plants and animals in plantation forests', which depicted 41 species and bore the signature of G.T. Cox 1991.

[3] Brown, K.; Innes, J.; Shorten, R. 1993: Evidence that possums prey on and scavenge birds' eggs, birds and mammals. *Notornis 40*: 169–177.

1.3 MANAGEMENT

In regions like the Mamaku Plateau, plantations of exotic conifers that are in close proximity to reserves of indigenous vegetation can serve as corridors for birds to reach these fragmented areas of indigenous vegetation. The canopy gaps in plantations and roadsides can quickly be occupied by a range of shrubs with fruits that attract indigenous birds. Such vegetation is more prolific when deer are scarce, as is the case on the northern part of the Plateau where a palatable understorey has been maintained. This section of the Plateau, with its relatively undisturbed canopies and understoreys, was regarded as a 'wilderness area' by NZFS and had few maintained tracks, and this situation has continued under the management of DOC. Tourism has never featured in the forests of the Mamaku Plateau. The retention of healthy indigenous bird populations is a major concern of DOC management.

In the late 1950s and early 1960s, regeneration surveys of tree species were undertaken in partially-logged forest of the central Plateau (Mamaku Forest) and south Mamaku (Horohoro Forest), mainly in regions where a partial tawa canopy had been retained. These surveys showed that whilst tawa was regenerating continually from seed and coppicing, and miro (*Prumnopitys ferruginea*) seedlings were common, other podocarp regeneration was sparse. The exception to this was two areas of some 500 hectares, which were maintained from about 1960 as indigenous forest experimental areas of the former Forest Research Institute (FRI) (now Scion), and thus had escaped the general clearance and conversion to radiata pine of tawa-dominant forest logged for podocarps prior to 1970. The reserve north of SH5 has had a good population of North Island robins and also fernbirds (*Bowdleria punctata*) in and near a wetland (AEB, pers obs to 1990s). Following attempts to sell these experimental areas in 2002, they were finally incorporated into conservation forests under management by DOC.

Both of these experimental areas contain examples of exceptionally good podocarp regeneration, which has developed since the last logging in the 1940s. They could therefore serve as education reserves (close to Rotorua and easily accessible) that demonstrate the ability of cutover forest to develop into podocarp forest over a long period of time. Similarly, in the reserve north of SH5, planted podocarps are emerging from dense regrowth or residual indigenous forest to constitute one of the largest and most successful examples of restorative podocarp planting in cutover indigenous forest within New Zealand.

Now that clearing of the indigenous forest on so much of the Mamaku Plateau is a *fait accompli*, the goodwill of the forestry companies managing pine plantations is essential to reserve existing indigenous vegetation or leave strips of pines or other planted conifers and buffers around Ecological Areas such as the Mokaihaha and Pukerimu Ecological Areas (now surrounded by plantations). The three former FRI experimental areas have small plantings of exotic species that could provide 'nurses' for indigenous vegetation or planted podocarps if carefully manipulated and finally removed. A fine example of the use of a lightening canopy of an exotic conifer to allow development of underplanted podocarps is an FRI sample plot in Kaingaroa Forest, which was established in 1961 on a harsh, frosty site with shelter

from declining overwood of *Pinus ponderosa*. When this site was visited by one of the authors (AEB) and Mike Wilcox in October 2006, the establishment of healthy totara and rimu was quite spectacular (see item 162 in Beveridge et al. 2004).

1.4 SCOPE OF THIS BIBLIOGRAPHY

The 249 papers in this bibliography comprise all the published and unpublished items relevant to the Mamaku Plateau and its fringes that could be located over a 23-month period (July 2005 to May 2007). The scope and format are comparable with bibliographies on Pureora Forest Park by Beveridge et al. (2000) and the Whirinaki Conservation Park by Beveridge et al. (2004). All three bibliographies are concerned with central North Island podocarp/tawa forests on soils derived from volcanic ash showers, and share some comparable aspects in the ecology of the forests and wildlife. The Mamaku Plateau, however, was affected by eruptions (containing free-draining pumice) from the Taupo Volcanic Centre only on its southern fringe in Horohoro Forest. On the central and northern parts of the Mamaku Plateau, tephra from the more recent Okataina Volcanic Centre have produced surface soils of low fertility, classed as allophanic soils (formerly yellow-brown loams), sticky in texture and easily compacted, as on logging tracks.

All annotated items in this bibliography have been read in full. For some of the more highly technical items on geology and hydrology we present only the abstracts or summaries of the authors, and in a few cases only the titles and keywords where they have not been sourced. A number of items on forest ecology, scientific values, forest types and recommendations for Ecological Areas are contained in Forest Research Institute files, which were transferred to Landcare Research, Hamilton, on the formation of Crown Research Institutes in 1992. These files have been catalogued and some Mamaku topics may have only titles and keywords in this bibliography. All annotations and comments are enclosed in square brackets [ ] and are by A.E. Beveridge (AEB), B.R. Christensen (BRC) or M.C. Smale (MCS). Many annotations refer to other articles within the bibliography, with the direction 'see name year'. Further explanations on some points are provided in footnotes. The keyword, author and title index at the back of the bibliography is a guide to events, activities, sites and publications. 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), Forest Research Institute (FRI), New Zealand Forest Service (NZFS), Department of Scientific and Industrial Research (DSIR).

2. Bibliography

Allen, D.J. 1983: Notes on the Kaimai-Mamaku Forest Park. New Zealand Forest Service, Tauranga (unpublished). 20 p.

[A collection of notes written for the 1984 'Summer Interpretation Programme' and edited for teachers and school groups staying at lodges within the Kaimai Mamaku Forest Park. There are six sections, each with references for wider reading. The notes give general information on history, Maori use of the forest, forest regeneration, kauri, forest fauna and the forest stream, and provide a useful background to the forest environment. There are few references to the Mamaku Plateau in the southern region of the Park where the Ngatuhoa Lodge is the only centre for visiting school parties. See Department of Conservation (1994a) for an education compendium, Department of Conservation (1996) for recreation priorities, and Department of Conservation (1997c) for a regional history—AEB.]

[It records that George Gamman built a mill at Mamaku in 1915 and logged rimu on an 18 000 acre block of the Plateau. It also records that between 1940 and 1960 the Frankham Bros logged podocarps and hardwood extensively in the Ngatuhoa area from the Tauranga side. See Jennings (1994) and Somervell (2004) in this bibliography for logging and milling by George Gamman—BRC.]

Keywords: forest environment, education, history, milling, logging, Kaimai Mamaku Forest Park, Mamaku Plateau, Ngatuhoa

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

[This article sets 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 Co-ordinating Committee' was formed to consider recommendations by FRI scientists. The scientific reserves were to be established as areas for scientific investigation and research, as well as for the protection of animal and plant species. See Nicholls (1978) for proposed Ecological Areas on the Mamaku Plateau—AEB.]

Keywords: Ecological Areas, scientific reserves

Anon. 1982: Species list from Kopurererua Stream. New Zealand Wildlife Service National Habitat Register, May 1982. Bay of Plenty Habitat sheets, Folder 2, records room, Rotorua Conservancy.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: Kopurererua Stream, species list

Anon. 1983a: Gazette notice for establishing Mangorewa Ecological Area. Unpublished note. Copy on Bay of Plenty Conservancy file PAA-04-02-12, Rotorua. 2 p.

[A copy of a gazette notice dated 11 May 1983 is attached, establishing the Mangorewa Ecological Area of 850 ha. This note describes topography and three forest types, with the Ohaupara and Mangorewa Rivers cutting into the easy terrain of the rhyolite plateau (see Druce & Ogle (1975) for plant list, and Clarkson (1981) for description of vegetation in the Mangorewa Scenic Reserve). In the Mangorewa catchment, rimu and red beech are dominant over tawa; other beeches are also present. Some pure kamahi stands provide evidence of earlier fires. The old-growth forest, undisturbed by logging, has high wildlife values; kokako, kiwi and blue duck have been recorded. A track from the Tauranga Direct Road leads along the Ohaupara River and then to a hut in beech forest. The road was started in 1869 as part of a central North Island military road and has historical associations. No author given, although probably written by J.L. Nicholls—AEB.]

Keywords: Mangorewa, beech forest, *Nothofagus* spp., Ecological Areas, forest track

Anon. 1983b: The inadequacy of the ecological reserves proposed for the Kaimai-Mamaku State Forest Park. Joint campaign on Native Forests, Nelson. 14 p. plus 3 references.

[This report (apparently authored by P.S. Grant, Nelson) presents detailed arguments for enlarging ecological reserves proposed by NZFS (New Zealand Forest Service 1982), with input from FRI forest ecologist John Nicholls and the Scientific Co-ordinating Committee. Four environmental groups comprise the Joint Campaign for Native Forests, which responds to comments by NZFS on its earlier submission on the draft management plan for the Forest Park (New Zealand Forest Service 1982).

The points raised by the Joint Campaign on botanical and wildlife matters have some historical interest, although discussion based around them became largely irrelevant as the draft management plan was never approved or implemented. The Conservation Act of 1987 established DOC, and tree felling and wood extraction from the Park was halted. On the Mamaku Plateau, some of the Ecological Reserves were enlarged, and both the Mokaihaha and Opuiaki Ecological Areas have become important old-growth forest areas for studies and measures to sustain kokako populations—AEB.]

Keywords: Ecological Reserves, Kaimai Mamaku State Forest Park, New Zealand Forest Service, forest management plan

Anon. 1983c: Overwhelming support to save the Kaimai-Mamaku. *Bush Telegraph 12*: 1–2. Wellington.

[A note on the submissions on the Kaimai Mamaku Forest Park management plan prepared by the NZFS, recording that most submissions were against any future logging, including the removal of dead or senescent trees. No trees had been felled on the Kaimai Range since 1973, when local residents started their 'protection campaign'. The management plan was never implemented. See New Zealand Forest Service (1983a, c, d) for information about submissions and their analysis—AEB.]

Keywords: conservation, management plan—submissions, logging—cessation, Kaimai Mamaku Forest Park

Anon. 1985: Vascular native plants of Pukerimu Stream Ecological Area; Southern Mamaku Plateau—500m asl. Forest Research Institute, Rotorua (unpublished). (File held at Landcare Research, Hamilton; File 31/9.) 6 p.

[This report has not been seen by the authors. A preliminary list of 147 vascular plant species was included in a report by Herbert (1975); see also Druce & Haydock (1978)—AEB.]

Keywords: Pukerimu Ecological Area, plant list

Anon. 1989: Conservation values of natural areas on Tasman Forestry freehold and leasehold land. Unpublished report for Tasman Forestry Ltd, Department of Conservation and Royal Forest & Bird Protection Society. 60 p. plus appendices and maps.

[While this report covers the nature conservation values of Tasman's indigenous forest land and lease holdings throughout New Zealand, the Mamaku Plateau region is of particular interest for this annotation, specifically the Gammans and Mangorewa-Kaharoa blocks (pp. 14–18). A small-scale map shows the boundaries of the Gammans area (5548 ha of Tasman freehold), and the Mangorewa-Kaharoa block (2250 ha of Tasman leasehold). Reserves (proposed or actual) total some 1450 ha, while a sale of 3500 ha of forest to DOC is noted. Descriptions of forest in the two blocks are given. In the Gammans Block, the forest has been logged three times, firstly for podocarps, then for tawa sawlogs, and finally for tawa pulpwood, leaving indigenous forest in gullies beside deeply entrenched streams. The Mangorewa-Kaharoa block with beech-podocarp forest is mainly committed to clearance, with a reserve around the wetland section. Other protected forest areas on the Mamaku Plateau are listed where they have soil and water values and provide wildlife corridors.

Kokako distribution within or near the Tasman block is roughly indicated. The intentions are to provide a continuous corridor of indigenous forest between the Kaimai Mamaku Forest Park and conservation land in Puwhenua and Mangorewa Forests, primarily for the protection of kokako; the rest of the blocks are to be converted to plantations (mainly radiata pine). There is a summary of the status of the North Island kokako and wildlife corridor

requirements, based on the report of Saunders (1983): 'the Mamaku population is regarded as the key population in New Zealand for the long term survival of the kokako'—AEB.]

Keywords: conservation values, Tasman Forestry reserves, kokako, *Callaeas cinerea*, kokako—survival, wildlife corridors

Armstrong, D.P. 1995: Effects of familiarity on the outcome of translocations, II. A test using New Zealand robins. *Biological Conservation 71*: 281–288.

[From the author's abstract:]

Research on bids has shown that familiarity between mates and neighbours leads to lower aggression and higher reproductive success. This study addresses the hypothesis that founder groups used for translocations will do better if made up of individuals that are familiar with one another. The study involved a translocation of a territorial forest bird, the North Island robin *Petroica australis longipes* to an offshore island.

[On p. 282, it is stated that 'Robins were taken from the Mamaku Plateau (38°2′–38°6′S, 175°57′–176°3′E), 4 km NW of Mamaku village, and 15 km NW of Rotorua, from or adjacent to pine plantations in order to avoid removing birds from areas of high conservation value'. The author performed a census of the source population, and notes that the robins tend to be quite shy initially. A personal comment is acknowledged to Kerry Brown that within the Mamaku area, juvenile robins fledge from October to December. The article also contains a location diagram of the North Island robin harvest sites on the Mamaku Plateau—BRC.]

Keywords: research, fauna, ecology, conservation management, translocations, toutouwai, North Island robin, *Petroica australis*

Armstrong, D.P.; Craig, J.L. 1991: Proposal to transfer North Island robins from Mamaku Plateau to Tiritiri Island. Centre for Conservation Biology, School of Biological Sciences, University of Auckland, Auckland (unpublished). 6 p.

[A proposal to transfer a total of 40 robins from the Mamaku Plateau (in pine forest) near Rotorua. Notes that Paul Jansen (then a DOC Bay of Plenty Conservancy staff member) had already used the Mamaku Plateau robin population as a source for an earlier transfer of birds supposedly to Tiritiri Matangi. This proposal outlines two objectives—BRC:]

1. to establish a permanent population of North Island robins on Tiritiri Island,
2. to experimentally test the effect of familiarity on the success of bird transfers.

Keywords: research, fauna, ecology, conservation management, translocations, toutouwai, North Island robin, *Petroica australis*

Armstrong, D.P.; Ewen, J.G. 2001: Assessing the value of follow-up translocations: a case study using New Zealand robins. *Biological Conservation 101*: 239–247.

[From the authors' abstract:]

Following a reintroduction, one or more additional translocations may be conducted to supplement the initial population. Such follow-up translocations are common, although the logic behind them is usually unclear. We used population viability analysis to assess the benefit of supplementing a population of New Zealand robins 14 months after reintroduction, at which time the population had 6 females and 22 males.

Our post hoc analysis predicted that the initial population had had a 100% chance of surviving for at least 30 years, hence the follow-up translocation was unnecessary. We further predicted that even if our initial parameter estimates had been correct, the follow-up translocation could have been delayed by up to 9 years without reducing the benefit derived. The best strategy would therefore have been to wait for additional data, and to reallocate the resources used for the follow-up translocation to research on the reintroduced population.

[The authors note that the source population was located on the Mamaku Plateau (38°2′–38°6′S, 175°57′–176°3′E), near Rotorua on the North Island, with an initial translocation of 44 robins occurring between 7 and 12 April 1992, and a second follow-up translocation of 14 robins occurring between 5 and 9 June 1993—BRC.]

Keywords: research, fauna, ecology, conservation management, translocations, toutouwai, North Island robin, *Petroica australis*

Armstrong, D.P.; Lovegrove, T.G.; Allen, D.G.; Craig, J.L. 1994: Composition of founder groups for bird translocations: does familiarity matter? Pp. 105–111 in Serena, M. (Ed.): Reintroduction biology of Australian and New Zealand fauna. Surrey Beatty & Sons, Chipping Norton.

[See Armstrong & Ewen (2001) above. This article notes the translocation of the founding population of North Island robin to Tiritiri Matangi from Mamaku Plateau—BRC.]

Keywords: research, fauna, ecology, conservation management, translocations, toutouwai, North Island robin, *Petroica australis*

Aston, B.C. 1924a: Bush-sickness investigation: five years' work at the Mamaku Demonstration Farm. *New Zealand Journal of Agriculture 28*: 215–238.

[This article describes experiments to improve the health of stock grazed on pasture (cleared of rimu-tawa forest) on the Mamaku Plateau—part of the extensive area of 'pumice land' where farming had not generally been found to be economic before the discovery of cobalt deficiency. Contains photographs of pasture, with standing dead tree spars—BRC.]

Keywords: iron-hunger 'bush-sickness', agriculture, farming, earth science, soils, Mamaku Demonstration Farm, conversion of indigenous forest

Aston, B.C. 1924b: A reconnaissance survey of pumice soils. *New Zealand Journal of Agriculture 29*: 333–338.

[An early account of the rhyolitic pumice soils producing Mamaku sandy silts with an extensive and uniform tawa-rimu forest on the Patetere (Mamaku) Plateau, and sandy loam with red beech and silver beech of the Mangorewa-Kaharoa Block. The botanical composition of these two forest types is given—BRC.]

Keywords: soils, rhyolitic pumice soils, vegetation, tawa, *Beilschmiedia tawa*, rimu, *Dacrydium cupressinum*, tawa-rimu forest, beech, *Nothofagus* spp., beech forest, Mamaku, Mamaku Plateau

Aston, B.C. 1925: Iron-hunger in ruminant stock: the season's work at Mamaku Demonstration Farm. *New Zealand Journal of Agriculture 30*: 175–186.

[This article describes the history of a group of milking cows with mammitis on the Mamaku Plateau—see Aston (1924a). Contains photographs of pasture, with standing dead spars—BRC.]

Keywords: iron-hunger 'bush-sickness', agriculture, farming, earth science, soils, Mamaku Demonstration Farm

Aston, B.C. 1930: Bush-sickness investigation: notes on some recent results. *New Zealand Journal of Agriculture 41*: 215–238.

[The author's précis in full:]

The area now known as the Mamaku Demonstration Farm was acquired in 1912 by purchase for the purpose of investigating the deficiency disease called "bush sickness", which was hindering the development of a very large area of country quite capable of growing healthy pasture although which would not grow healthy ruminants (cattle and sheep). This particular disease exists in varying degrees of severity on many areas in the North Island situated in various positions from sea-level to 2,000 ft.

The Mamaku Farm represents an area which may be roughly computed at 50,000 acres of country, originally densely forested, and remarkably uniform in vegetation, physical features, and history. Timber milling was the main industry of this area, situated about 1,760 ft. above sea-level, of almost flat land, intersected by a network of tramlines for getting out timber, and crossed by the Auckland-Rotorua Railway. On maps the area may be located as part of the Patetere Plateau, which has been referred to as the Mamaku Plateau. As might be expected, the winter conditions of this inland elevation are fairly severe, and must be counted an added condition antagonistic to the health of stock weakened by malnutrition.

Thus, although there may be areas more severely afflicted with bush sickness than Mamaku, the climatic conditions in these areas are generally milder, so that Mamaku may be accepted as a useful experimental area with easy means

of access by rail and road, and any method of treatment found successful would be applicable to a far wider area than that represented by the Mamaku Farm.

Keywords: iron-hunger 'bush-sickness', agriculture, farming, earth science, soils, Mamaku Demonstration Farm, conversion of indigenous forest

Barry, M.A. 1984: Kaimai–Mamaku Forest Park, a clear cut choice. *Soil and Water 20(30)*: 24–27.

[The author refers to the revised management plan for the Kaimai Mamaku Forest Park, published by New Zealand Forest Service (1982), and warns of the hazards of increased runoff and poorer water quality if native forest cover is reduced by logging and if some areas are converted to plantations of exotic species, involving greater soil disturbance.

The management plan was never implemented, and a different management policy was soon to be introduced in the Forest Park by DOC, from its inception in 1987. The conversion of large areas of native forest to pine plantations on the Mamaku Plateau outside the Forest Park has led to protests by environmental organisations and individuals concerned about destruction of native bird habitat and the impact of forest conversion on water resources (see Fleming 1969; Dell 1982a, b; McEwen 2005).

Small-scale interplanting of blackwood has been undertaken in the indigenous forest of the Kaimai Range – Mamaku Plateau, but if removal is undertaken, seedlings, sprouts and root suckers could be sprayed—AEB.]

Keywords: Kaimai Mamaku Forest Park, logging—impact, conversion of indigenous forest, blackwood, *Acacia melanoxylon*, eucalypts, water resources, erosion

Beadel, S.M. 1985: A vegetation survey and an assessment of the biological conservation values of the Otawa–Otanewainuku area, Western Bay of Plenty. Department of Lands and Survey, Hamilton (unpublished; reference 13/17/2). 57 p. Includes appendices, figures and maps.

[Biological conservation values were assessed during this survey, with the conclusion that most of the area surveyed could be included in a proposed Ecological Area with high conservation values. The land surveyed covered vegetation in many tenures, as shown in a plan indicating 21 land sections; these included the former State Forests of Otanewainuku and Oropi, three water reserves, the privately owned Dean's Block, and other areas with forest remnants or shrubland. Forty-nine vegetation types are mapped and described in appendices, and lists of indigenous and adventive plant species are given. Seven broad vegetation classes are recognised, with about 70% of the surveyed area being covered by three of the forest classes: rimu-tawa forest, tawa-kohekohe forest and tawa-kamahi/kauri forests. Kauri exists at its eastern limit (in Dean's Block and Oropi Forests). Many of the vegetation types have been affected by logging (mostly for rimu), burning and grazing.

A list of indigenous and introduced birds is given. A notable feature is the presence of kokako 'in limited numbers'. Some information included in this survey came from papers annotated within this bibliography, e.g. Saunders (1983) and Nicholls (1974b). The southern part of the survey region covers the northern part of the Mamaku Plateau with its sheet of Mamaku ignimbrite and soils 'derived from weathering of Kaharoa Ash'. See also Smale (1986)—AEB.]

Keywords: vegetation survey, Ecological Area—proposals, vegetation types, birds, kauri, *Agathis australis*, Otanewainuku Forest, Oropi Forest, Dean's Block

Bellingham, P.J.; Bellingham, M.R.; Cameron, E.K.; Courtney, S.P.; Druce, A.P.; Haydock, K.; Herbert, J.W.; Ogle, C.; Smale, M.C. 1985: Vascular flora of the Mamaku Plateau. Forest Research Institute, Rotorua (unpublished). Copy held on file 31/6 at Landcare Research, Hamilton; reference 13/17/2. 7 p.

[Authors' précis:]

A comprehensive species list for the Mamaku Plateau between Opuiaki Ecological Area in the north and Horohoro Bluff Maori Reserve in the south is presented, compiled from numerous visits by the authors between 1975 and 1985. It lists 346 taxa: 9 conifers (including a hybrid), 4 monocot trees (including a hybrid), 40 dicot trees (including a hybrid), 43 dicot shrubs (including hybrids), 2 monocot lianes, 10 dicot lianes, 7 psilopsids and lycopods, 85 ferns (including hybrids), 20 orchids, 14 grasses, 36 sedges, 10 composite herbs, 5 rushes, 12 other monocot herbs, and 49 other dicot herbs. It is worth noting that the list does not cover at least one area of the Plateau, Te Pu Mires (see Cashmore 2006), that may well support additional species, and that substantial areas of the Plateau have never received any sort of botanical attention.

Keywords: Mamaku Plateau, plant list

Bergin, D.O. 1991: Rehabilitation of the Gammons/Mangorewa-Kaharoa wildlife corridor, Mamaku Plateau. Contract Report FWE 91/60, prepared for Bay of Plenty Conservancy, Department of Conservation. Forest Research Institute, Rotorua. 18 p. plus photos and maps.

[Options are given for restoring high forest on 100 ha of recently cleared indigenous cutover forest of the Mangorewa wildlife corridor, linking populations of North Island kokako in forest of the Mamaku Plateau and Puwhenua Forest with the Mangorewa Ecological Area and Mangorewa Forest. The recommended method for providing pathways and roosting places for possible movements of North Island kokako is to plant small groups of close-planted radiata pine at intervals of up to 50 m. Radiata pine is able to suppress weed growth and, if tended, provide a suitable nurse for regeneration of native plants. Patches of native shrub hardwoods occur, particularly on mounds of slash and topsoil from earlier clearings. Extensive

planting of native trees is considered to be too expensive, although cluster planting (of podocarps) could be carried out along roadsides. Dense toetoe has invaded some sites heavily disturbed by logging and can persist for many years, excluding or reducing regeneration of native shrubs.

Sites heavily compacted by logging, such as skid sites, can be restored by machine cultivation, as has occurred at Whirinaki in areas marginal to high forest, and sown with manuka seed (AEB, pers. obs. 2006). In the logged corridor referred to in this paper, some small-scale planting of indigenous species has been undertaken by Forest & Bird volunteers (Paul Cashmore, DOC Bay of Plenty Conservancy, pers. comm.)—AEB.]

Keywords: Gammans Block, Mangorewa Forest, Kaharoa Forest, Mangorewa wildlife corridor, Puwhenua Forest, Mangorewa Ecological Area, conservation management, fauna, kokako, *Callaeas cinerea*, radiata pine, *Pinus radiata*, revegetation, rehabilitation, Forest & Bird

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

[From the authors' abstract:]

Variation in seedling growth and form between provenances of *Podocarpus totara* from 42 sites throughout New Zealand was investigated. Seedlings were grown for three years under uniform nursery conditions. There were significant differences between provenances in height growth in the first three years after sowing. Early growth was highly correlated with germination rate after sowing. In the third year, growth followed a different pattern and was negatively correlated with provenance latitude, i.e., provenances from southern latitudes grew more slowly than those from further north. This suggests that genetic factors correlated with mean summer temperature of the locality of seed source were beginning to predominate. Stem form and branch length also varied between provenances, although foliage colour and leaf size did not. Neither stem form nor branch length were related to any provenance site variable. Since provenance variation is appreciable, it is recommended that *P. totara* plantings for ecological purposes should be of seedlings raised from locally collected seed. However, for growing *P. totara* in plantations to produce special-purpose high value timber, considerable scope exists for an in-depth breeding study that will eventually lead to producing planting stock with both superior height growth and good tree form.

[One Mamaku provenance is listed among the 42 provenances. The Mamaku seed was collected from two bushy trees on farmland at an altitude of 270 m a.s.l. (lower slopes of the Plateau). During their third year in the nursery, Mamaku seedlings grew 48 cm, reaching a total height of 84 cm; these growth rates are in the mid-range for all provenances—AEB.]

Keywords: totara, *Podocarpus totara*, totara—provenance trial, totara—seed collection, totara—growth

Bergin, D.O.; Pardy, G.F.; Beveridge, A.E. 1988: Planting to restore or extend native forest remnants. *New Zealand Tree Grower 9*: 44–47. Includes photos.

[A concise account is given of the Mamaku planting trials established from 1959 to 1961, using 33 000 nursery-raised podocarp seedlings. Details of these trials are given in unpublished reports (Pardy 1983a–d) and a summary published account by Beveridge & Bergin (2000).

The trial site of reverting cutover forest had been logged c. 1905 and in the 1940s mainly for podocarps, leaving tawa as the dominant canopy tree. The concepts of large group planting of rimu and a later preferred method of smaller sized gaps with 3–5 tree clusters are illustrated and described. Dense regrowth and minimal releasing resulted in slow early growth of totara, kahikatea and rimu, although 25 years after planting faster-growing trees were 5–7 m tall and had a survival of 50% or more.

Extensive releasing was carried out at 23 years after planting, leading to faster growth of podocarps emerging from a shrub and small tree canopy. Perspectives are given on early trial results, and recent developments and guidelines for restoration of disturbed native forest are presented—AEB.]

Keywords: restoration planting, reverted cutover forest, planting trial, podocarp—survival and growth

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

[The author sampled areas on the central and south Mamaku Plateau for regeneration of podocarps. One area of over 100 ha on the central Mamaku Plateau had a good stocking of miro and rimu seedlings and saplings, some as a result of germination of seed on the ground at the time of logging. Rimu seedlings were found around stumps of felled rimu trees and on ground disturbed by hauler logging (p. 30). Germination of miro seed also occurs from logging disturbance (p. 31)—AEB.]

Keywords: podocarp—regeneration in logged forest

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.

[On pages 54–55 there is a summary account of podocarp enrichment planting over 50 ha of reverting cutover podocarp/tawa forests (trial no. 3). The trials to test the growth and survival of rimu, kahikatea, totara, matai and tanekaha were established by FRI from 1959 to 1961 on the crest of the Mamaku Plateau at 550 m a.s.l. This is the most recent of several short published accounts with illustrations giving results and assessment of methods. Most of the earlier accounts were by George Pardy, who has also written four detailed FRI Project Records (Nos 255-1–4; Pardy 1983a–d) on performance

of podocarps planted in large groups in hand-cleared plots, tractor-cleared plots and lanes. See also Pardy et al. (1999) in this bibliography. This is one of the largest plantings of podocarps in cutover indigenous forest, with 50% survival at 40 years after planting, and a density of 300 stems per ha.

These Mamaku trials have provided a useful background for developing guidelines for enrichment planting of reverting cutover indigenous forest, and they provide insights into the ecological characteristics of native conifers.

Of the species planted, tanekaha and totara are near their natural upper altitudinal limit (c. 600 m a.s.l.) on the Mamaku Plateau, in an area where Hall's totara occurs more frequently. Rimu has been assessed as the most successful species in terms of survival on a wide range of micro-sites, with the ability to remain as slow-growing or suppressed seedlings in competition with relatively short-lived pioneer shrub hardwoods such as wineberry or karamu, with some eventually emerging from the shrub canopy.

An overall assessment of growth and survival of the podocarps was last made in 1976, about 15 years after planting, results from which are reported in the four project records by G. Pardy (1983a–d). These accounts contain comments on the invasion of disturbed soil and canopy gaps by shrubs and other vegetation, with a dense growth of toetoe on compacted ground, indicating the worst sites for vigorous growth of podocarps.

Since 1976, some smaller assessments or inspections of the trials have been made, most recently in 2006 by AEB and Mike Wilcox. At 47 years since the earliest planting, dominant specimens of rimu, kahikatea and totara are emerging through gaps in the residual forest canopy on the most suitable micro-sites, reaching heights of 10–15 m and stem diameters of 15–25 cm.

Previous appraisals of the trials are given in two published items—Bergin et al. (1988) and Pardy & Bergin (1992). The latter article provides a good perspective on application of results of the Mamaku trials to larger-scale forest restoration projects, concluding that 'the cost of extensive native planting projects and the commitment to after-planting care is usually very high'. Large groups of podocarps as planted in the Mamaku trials would not be required where the objective is to return a depleted forest to high forest with podocarps dominant. Instead, the use of smaller groups or 'clusters' of 3–5 seedlings is recommended.

The trial area is now incorporated in the Patetere Scenic Reserve, and will retain its educational and demonstration values.

Natural regeneration of rimu and miro of all sizes up to small trees are at least locally prolific, as seen in recent visits (up to 2007) to more easily accessible areas, such as the hand-cut groups. There has been attrition of the residual tree canopy in places over the years, with dieback of kamahi crowns and windfall of tawa and tawari, increasing overhead light to some planted groups, although crushing others—AEB.]

Keywords: podocarp—enrichment trial, site preparation, podocarp—survival and growth, forest restoration

Beveridge, A.E.; Smale, M.C.; Christensen, B.R.; Steward, G.A. 2004: Ecology, management, and history of Whirinaki Conservation Park, New Zealand: an annotated bibliography. *DOC Science Internal Series 193*. Department of Conservation, Wellington. 139 p.

[Authors' abstract:]

This annotated bibliography lists 230 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.

[The old-growth forests of Whirinaki are generally lacking an understorey of palatable plants, and dieback of trees such as northern rata, totara and large kamahi is widespread; there has been a long history of high population numbers of deer and possums. This situation contrasts strongly with that of old-growth forest on the Mamaku Plateau, especially in the Opuiaki Ecological Area, where few deer have been reported in recent times and palatable understorey species have generally been retained. High possum populations have been recorded in the Mamaku Ecological Areas and no studies of possum diet in the Mamaku old-growth indigenous forest are known to the authors.

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[4]). The torching in high winds of scattered large northern rata, mainly dead although loaded with epiphytes, has been witnessed during land clearing adjacent to Horohoro Forest (a high rainfall area) where the rata were emergent from dense regrowth resulting from early logging of podocarps; this was also seen for emergent rata and rimu during a 'dry' electrical storm at Whirinaki (R. Collins (Minginui) District Ranger NZFS, pers. comm.)—AEB.]

Keywords: bibliography, Whirinaki—ecology, Whirinaki—history, Whirinaki—management, Whirinaki-Mamaku comparison, vegetation trend, possum—impact, *Trichosurus vulpecula*

[4] McKelvey, P.J. 1973: The pattern of the Urewera Forests. *Forest Research Institute Technical Paper 59*. Forest Research Institute, New Zealand Forest Service, Rotorua (unpublished). 48 p.

Beveridge, A.E.; Smale, M.C.; Holzapfel, A.S. 2000: Ecology and management of Pureora Forest Park: an annotated bibliography. *Conservancy Science Notes No. 282*. Department of Conservation, Wellington. 91 p.

[From the authors' introduction:]

This is not an exhaustive bibliography although the 277 papers comprise all the published and unpublished items relevant to the Park that could be located over a 12 month period.

The original terms of reference from the Department of Conservation stated that the bibliography should deal with flora and fauna values and pest management in the park. The scope has been broadened to encompass ecological values and management in the broadest sense, including descriptive material, research papers, forest history, management plans and the restoration of forest condition and wildlife following direct or indirect human impact (especially from the introduction of browsing animals and predators).

[There are few direct references to the Mamaku forests, although many annotations of papers that are relevant to them, e.g. surveys of kokako populations by Ian Crook (1971–78), kokako diet and behaviour, increase in the impact of browsing mammals, studies on small mammals and the impact of predators on birdlife, ecology of tawa (the main canopy tree of the Mamaku Plateau), and studies on the impact of poison operations on birdlife—AEB.]

Keywords: bibliography, Pureora—ecology, Pureora—management, kokako, *Callaeas cinerea*, browsing animals, predator control, tawa, *Beilschmiedia tawa*, tawa—ecology

Boyd, M.J. 1993: Conservation and management of New Zealand's indigenous forests: a selected bibliography, 1848–1990. M.J. Boyd, Auckland. 144 p.

[This bibliography contains 2230 items. In the index of listed keywords, 60 items are listed for Mamaku forests, of which a dozen are annotated in the current bibliography. The title of Marlene Boyd's bibliography is reflected by many items expressing opposition to any clearing or logging of indigenous forest and the use of fire to prepare cleared sites for conversion to plantations of exotic species.

The NZFS revisited its Indigenous Forest policy during the 1970s, the decade of strong protest against government policies on indigenous forest management. In 1968, the Government arranged a long-term lease of Crown land on the Mamaku Plateau, allowing private companies to clear tawa-dominant forest previously logged for podocarps, enabling conversion to pine plantations. Reserves for scientific purposes, termed 'Biological Areas' or 'Ecological Areas', were established in Mamaku forests during the 1970s, and these were expanded by DOC when it was given responsibility for management of indigenous forests and wildlife from 1987. Many of the controversies dealing with national or local issues of conservation and management of New Zealand's indigenous forest before 1990 are referred to in Marlene Boyd's bibliography—AEB.]

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

Broekhuizen, P.; Nicholls, J.L.; Smale, M.C. 1985: A provisional list of vascular plant species: Rapurapu track, Kauri spur, and Rapurapu Gorge, Kaimai-Mamaku SF Park. Contributed by the Rotorua Botanical Society. Unpublished report held on file at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua.

[This work lists 135 indigenous species and 15 adventive species in the Rapurapu catchment, North Mamaku. It is arranged by lifeform within four vegetation types related to topography. Kauri (which is towards the lower southern extent of its range), six podocarp species and 47 fern species, which represents a strongly diverse fern flora for the relative size of the area surveyed, are recorded in the Rapurapu catchment, northern Mamaku. See Smale (1985) for botany of the catchment, and Bellingham et al. (1985) for botany of the general central and southern Mamaku Plateau—AEB.]

Keywords: Rapurapu catchment, plant list, vegetation types, Rapurapu, kauri, *Agathis australis*, Kaimai Mamaku State Forest Park

Brown, K.P.; Moller, H.; Innes, J.; Alterio, N. 1996: Calibration of tunnel tracking rates to estimate relative abundance of ship rats (*Rattus rattus*) and mice (*Mus musculus*) in a New Zealand forest. *New Zealand Journal of Ecology 20*: 271–275.

[From the authors' abstract:]

Ship rat (*Rattus rattus*) and mouse (*Mus musculus*) density and habitat use were estimated by snap trapping and tracking tunnels at Kaharoa in central North Island, New Zealand. Eighty-one ship rats were caught in an effective trapping area of 12.4 ha. Extinction trapping gave an estimated density of 6.7 rats ha^{-1} (6.5–7.8 rats ha^{-1}, 95% confidence intervals). A linear relationship existed between ship rat trapping and tracking rates. Estimating the density of mice was impossible because trapping rates increased rather than decreased during the experiment. Comparisons of density from tracking and trapping rates of mice may be confounded by interference by rats, although this requires further investigation.

Keywords: ship rat, *Rattus rattus*, mouse, *Mus musculus*, Kaharoa

Buckingham, R.P.; Hudson, Q.; Shaw, W.B. 2000: Bird survey of the Opuiaki Ecological Area, Mamaku Plateau, central North Island, New Zealand. Contract report No. 328 by Wildland Consultants Ltd, Rotorua, for the Department of Conservation. Unpublished report held at Tauranga Area Office, Department of Conservation, Tauranga. 36 p. plus 44 references, 4 appendices and 15 maps of bird distribution.

[This report has significant findings for the remaining populations of North Island kokako and general birdlife in the Opuiaki Ecological Area and in the forests of the Mamaku Plateau. There is a useful reference list, which includes articles that discuss earlier bird surveys in Mamaku Forest since the 1970s, and papers on kokako and the role of introduced predators in the decline of threatened indigenous wildlife. The authors conclude that there

is a strong case for urgent predator control to assist the declining population of kokako in the Opuiaki Ecological Area. A total of 48 kokako, comprising 13 pairs and 22 singles, was found and their positions mapped, although no juveniles were found. Most kokako were found in the eastern half of the Ecological Area, near the headwaters of the Opuiaki and Waipapa Streams. There had been a dramatic reduction in kokako numbers in the part of the Ecological Area surveyed in 1994 (Wills 1997).

There is discussion about all bird species found during this survey, as well as bird species that were not recorded but had previously been observed on the Mamaku Plateau. There are 24 maps, most of which show the distribution of 19 bird species, both indigenous and introduced, recorded in the Opuiaki survey. It is stated that kakariki and rifleman appear to have disappeared from the Mamaku Plateau since the 1970s. Although North Island brown kiwi and blue duck were not recorded, it was believed that they could exist in very small numbers, as reports of their presence had been made in the previous 2 years. The most commonly recorded bird species were grey warblers, robins, tomtits and bellbirds, while kereru, tui, silvereyes and whiteheads were widely distributed. Kaka were encountered infrequently, supporting reports from previous studies that they are declining in numbers on the Mamaku Plateau, as in other forests of the North Island.

A concise account is given of the terrain and forest types of the survey area, which covered 5400 ha of predominantly unlogged lowland podocarp/tawa forest, encompassing the Opuiaki Ecological Area and unlogged forest east of Hiwiroa Trig, as shown in a coloured map of the vegetation. In the northeastern part of the survey area, there are basins with dense podocarp stands.

Sign of deer was found at only one locality, indicating that numbers were still very low, as found during a 1975 survey (Owen 1999). Possums were considered to be present at very high densities, as were rats (from reports in other North Island podocarp forests).

John Innes (Landcare Research) has shown compelling videos of ship rats attacking native birds on their nests at night, and considers that rats offer the greatest threat to birds in indigenous forest, as they are usually present in high numbers and their populations quickly recover from predator-control operations.

Rifleman were seen in the mid-1980s in forest in the middle reaches of Endeans' Road, in the Ngongotaha catchment (MCS, pers. obs.), and were also seen occasionally in Horohoro Forest in the 1960s (AEB, pers. obs.)—AEB.]

Keywords: bird survey, Opuiaki Ecological Area, kokako, *Callaeas cinerea*, kokako—population, kokako—population decline, predator control, Mamaku Plateau, Mamaku Forest, bird recovery, forest bird populations, management operations, forest ecology, possum, *Trichosurus vulpecula*, deer, *Cervus* spp., ship rat, *Rattus rattus*

Cameron, E. 2005: Northwest Mokaihaha Ecological Area, a botanical visit, 15 March 2005. Unpublished report held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua. 5 p.

[This report outlines a route followed through unlogged podocarp/tawa forest, where kokako have been studied and predator control work undertaken. A brief description of the vegetation is given. Pig and deer sign was frequent and it was presumed that deer had been responsible for removal of most of the palatable shrubs (if cattle had not been present). A list of 113 indigenous vascular plant species includes species recorded by other botanists. The mountain cabbage tree was a new addition to this list. This species commonly occurred on log extraction tracks to the southeast of the Mokaihaha Ecological Area in the 1960s and 1970s, probably from bird-distributed seed that was dormant in the soil germinating after soil disturbance (AEB, pers. obs.). See also the account of Stephens (2005), and Smale et al. (1997) on forest dynamics of a study area on the southwest side of the Mokaihaha Ecological Area—AEB.]

Keywords: Mokaihaha Ecological Area, species list, vegetation description

Cameron, R.J. 1959: Report on cutover survey, Mamaku S.F. No. 3. Forest Research Institute, Rotorua (unpublished). 2 p.

[The survey was conducted in the summer of 1958/59, using standard plot sheets and methods of the Ecological Forest Survey, with some revision to record stocking of tree species and their regeneration. A total of 51 1-acre plots were assessed on 10 000 acres (4000 ha) of forest that had been previously logged at various intensities on easy terrain of the central Mamaku (Patetere) Plateau, lying north and west of the Mamaku township. An appendix gives a summary of plot data.

The results of this work are of little relevance today, as most of the forest in the area was cleared and converted to pine plantations following a government decision in 1968 to lease the State Forest to private companies. There are, however, some interesting historical perspectives on land use. In 1959, Cameron considered that most of this forest in the Mamaku area was not much nearer to being converted to farmland than it was 30 years previously, 'after many farms were abandoned in the 1920s, the land lacking water and being cobalt deficient'. The possibility of converting the indigenous forest to pine plantations is not mentioned by Cameron, who writes that research into ways of managing indigenous forest and introducing silvicultural measures in central North Island was started at FRI in 1956.

The original rimu/tawa forest on the central Plateau was logged mainly for podocarps from 1904 until the 1940s, with tawa being used locally for firewood and fuel for bush haulers and locomotives. Post-war, tawa was often logged and the cutover forest was left in a devastated condition, with dead rata amongst scattered residual emergent podocarps.

Positive results of earlier FRI studies in Mamaku forests were obtained from extensive podocarp planting trials established from 1959 to 1961, north of SH3 (see Pardy et al. 1983a–d), and reservation of the two FRI experimental

areas (north and central), now in the Patetere Scenic Reserve (see Department of Conservation 2002). These two experimental areas, in which a partial tawa canopy was retained, have some of the best regeneration of tawa, miro and hinau in the area surveyed by Cameron—AEB.]

Keywords: Mamaku cutover forest, regeneration, logging—history, tawa—forest, *Beilschmiedia tawa*

Carryer, S.J. 1980: Report on the hydrogeology of the Mamaku Plateau. Hauraki Catchment Board and Regional Water Board (unpublished). 4 p. plus map.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: water resources, hydrology, hydrogeology, geology, Mamaku Ignimbrite

Cashmore, P. 2005: Northern Mamaku Lagoons. *Rotorua Botanical Society 45*: 27–36.

[An account of a group of botanists visiting the lagoons with fringing wetlands, shrublands and patches of high forest or forest disturbed by logging that lie between Galaxy Road and the Tauranga Direct Road. The visit was made on 6 November 2006. The author writes that this is an old and significant wetland complex that is presently 'little modified despite logging and clearing of most of the adjacent forest habitats over the last decade'. Grey willow has started to invade and requires control. Despite deer tracks in manuka shrubland, a patch of high forest on a hill had abundant raukawa and kanono in the understorey and appeared to have been little modified by browsing ungulates, as in forest over much of the Mamaku Plateau. Surviving beech forest contained red beech, silver beech and hard beech, with an abundance of tree orchids. Other accounts of visits to this wetland complex include Shaw & Milligan (1998), Cashmore (2006) and an unseen unpublished account by Wallace (1994). Graeme Jane and John Hobbs have also produced a 4-page list of vascular plants entitled 'Northern Mamaku Lagoon Species List'—AEB.]

Keywords: lagoons, wetland, beech forest, *Nothofagus* spp., species list

Cashmore, P. 2006: Te Pu (Roy Rd) wetlands field trip. *Rotorua Botanical Society 47*: 9–20.

[A botanical visit on 7 May 2006 to three wetland/mire complexes, fringed in places by kahikatea forest or shrubland around open-water lagoons. The wetland complexes are said to be very old, and occur in the Mangorewa Forest Conservation Area. Deep tomo were found draining the wetlands through the ignimbrite bedrock. Grey willow was an occasional invader of the wetlands. A plant list entitled 'Vascular flora of the Te Pu (Roy Rd) wetlands, Northern Mamaku Plateau', produced by five members of the Rotorua Botanical Society, is printed on pp. 13–20 of this issue. Grid references are given for the three wetlands and vascular plants are listed under lifeform, totalling 189 indigenous taxa and 59 adventive taxa. See also Cashmore (2005) on northern Mamaku lagoons, which includes a list of vascular plants—AEB.]

Keywords: Te Pu (Roy Rd) wetlands, wetland, Mangorewa Forest Conservation Area, species list

Cashmore, P.; Ecroyd, C. 2000: Notes on the flora of the Forest Research 'Central' Experimental Block, Mamaku Plateau. *Rotorua Botanical Society 34*: 26–28.

[This account of a botanical excursion concludes with the observation 'that the area was in good condition and representative of the logged forest on the Mamaku Plateau'.

The 278-ha block was bought from FRI with Nature Heritage funds in 2003 and is now included in the Patetere Conservation Area managed by DOC (see Department of Conservation 2002). This block was made an FRI experimental area c. 1960, as it contained the best podocarp regeneration found in a 4000-ha area of cutover tawa forest surveyed by Cameron in 1959 (Cameron 1959). This central block was logged up to the 1940s by hauler to a tramway on Cecil Road. Steward & Klomp (1988) refer to FRI experimental work in this block from the 1960s to 1984. The interplanting of exotic species in tawa-dominant forest (Moberly 1984) is in the northern experimental area, north of SH5.

During the 1970s, a forestry company pressed for the reduction of FRI experimental areas so they could be converted to pine plantations. On the western edge of the 'central' block, a site preparation fire (termed an overburn) penetrated a reserve holding tawa-dominant forest, consuming humus, and killing tawa and all standing vegetation; hence the marginal planting of Australian blackwood, which was later subject to decline attributed to psyllid insects. The authors note that the understorey of palatable species indicates an absence of deer and good recovery from past disturbance from logging of podocarps and some cattle grazing in parts of the block in the early 1970s. South of the area visited is a block where NZ Forest Products Ltd removed tawa for pulpwood, but the remnant vegetation was retained—AEB.]

Keywords: botany, cutover indigenous forest, experimental areas

Cashmore, P.; Griffiths, R.; Smale, S. 2002: Assessment of conservation values of Baxter Property, Onaia Stream–Kaharoa. Nature Heritage Fund application to the Bay of Plenty Conservancy: purchase of regenerating forest, private land located adjacent to the Onaia Ecological Area. Unpublished report. 6 p. plus photos.

[Features of the vegetation, birdlife and landscape pattern of the Baxter Property, Onaia Stream, Kaharoa, are described. This 32-ha area consists of forest either side of the deeply incised Onaia Stream. There are dense regenerating tanekaha stands on some of the gorge sides, as well as patches of rewarewa emergent over tanekaha; Hall's totara, matai and kahikatea grow beside the Onaia Stream over a sub-canopy of tawari-kamahi and hinau. There is a good diversity of indigenous birds and kokako present in the adjacent Onaia Ecological Area. King fern is present in some gullies of the Onaia Stream downstream from the purchase area. See Shaw (1991) for descriptions of the Conservation Area.

The main management goal for an enlarged Onaia Conservation Area is to increase the kokako population's capability to be sustainable. This objective

should be aided by the local community and by 'promoting protection of contiguous forest on private lands'—AEB.]

Keywords: fauna, flora, Nature Heritage Fund, Kaharoa Conservation Area, Onaia Stream, Onaia Ecological Area

Cashmore, P.; Richardson, C.; Smale, S. 2002: Assessment of conservation values of Florey Property, Onaia Stream – Kaharoa. Nature Heritage Fund application, Bay of Plenty Conservancy: purchase of regenerating forest, extension to the Onaia Ecological Area. Unpublished report. 8 p. plus photos.

[Features of the vegetation, birdlife and landscape pattern of the Florey Property, Onaia Stream, Kaharoa, are described. This 70-ha area is adjacent to the recently acquired Baxter Block to the north. These two blocks provide a forest corridor to the upper tributaries of the Onaia Stream, joining the Onaia Ecological Area with its population of kokako.

The rimu/tawari/kamahi forest beside the deeply incised Onaia Stream was not logged and contains mature rimu, tanekaha and kahikatea. Ridges and gully sides of southeast aspect have dense regenerating tanekaha stands, while central ridges have scattered rewarewa emerging from tanekaha and manuka. There is a good diversity of indigenous birds in the consolidated Kaharoa Conservation Area, including kokako and several threatened species. Reference is made to the Kaharoa Kokako Trust—AEB.]

Keywords: fauna, flora, Nature Heritage Fund, Kaharoa Conservation Area, Onaia Stream, Onaia Ecological Area

Cashmore, P.; Willans, M.; Owen, K. n.d.: Assessment of conservation values of Geyser Farm Property, Onaia Stream – Kaharoa. Nature Heritage Fund application, Bay of Plenty Conservancy: purchase of tawa-dominated forest, Geyser Farm Ltd, Mamaku (unpublished). 8 p. plus photos.

[Features of the vegetation, birdlife and landscape pattern of the Geyser Farm Property are described. This 38-ha area is well fenced from an adjoining pine plantation on its northern boundary and from farmland on its western boundary. The importance of conserving this block is given in the context of providing a corridor for birdlife linking the much larger forest tract of the Horohoro Conservation Area to the headwaters of the Umurua Stream on the southern side.

The block lies at the eastern edge of the Mamaku Plateau and the flatter parts have tawa-dominant forest previously logged for podocarps. The southern boundary of the block is the deeply incised gully of the Umurua Stream, and vegetation of the gully sides 'appears to be largely unmodified, consisting of predominantly tawa-tawari with toatoa, Hall's totara and miro common'. A map and aerial photo are referred to, but these were not attached to the copy seen—AEB.]

Keywords: fauna, flora, Nature Heritage Fund, Umurua Stream, Horohoro Conservation Area

Choudhry, S.; Bardsley, W.E.; Morad, M. 1997: Rainfall-runoff modelling of the Opuiaki River, New Zealand, using GIS. In: 24th Hydrology and Water Resources Symposium, Auckland.

[From the authors' abstract:]

A rainfall-runoff model has been developed using GIS, and applied to the study area. Results show that the GIS-based model gives good inflow prediction, when compared with the actual inflow data and empirical model prediction. ARC/INFO's GRID function is a powerful tool for modelling purposes, although it has limited use in handling time series data. Finally, the limitations of ARC/INFO GIS, and new developments in spatial hydrologic modelling using object - oriented programming, are discussed.

Keywords: rainfall—runoff, Opuiaki River, hydrology

Christensen, B.R. (Ed.) 2002a: Monitoring, survey & inventory in the Rotorua Lakes Area, Bay of Plenty Conservancy. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished).

[An updated and expanded biodiversity information inventory (providing electronic access to inventory data, GIS data manipulation and analysis tools) for the Rotorua Lakes Area, Bay of Plenty Conservancy (see Hunt 2001)—BRC.]

Keywords: biodiversity, inventory, conservation, Mamaku Forest, Leslie Road Stewardship Area, Arahiwi Scenic Reserve, Arahiwi Stewardship Area, Tukorehe Scenic Reserve, Takapuhurihuri Stream Marginal Strip, Horohoro Forest, Mangorewa Forest, Mangorewa Ecological Area, Arahiwi Access Stewardship Area, Mamaku Scenic Reserve, Arahiwi Railway Scenic Reserve, Mamaku Stewardship Area, Tarukenga Scenic Reserve, Dansey Road Scenic Reserve, Mangorewa Conservation Area, Mangapouri Scenic Reserve, Mangapouri Stream Marginal Strip, Ngongotaha Stream Marginal Strip, Umurua Stream Marginal Strip, Mt Ngongotaha Scenic Reserve, Utuhina Stream Marginal Strip, Tihiotonga Stewardship Area, Otamaroa Stream Marginal Strip, Umurua Scenic Reserve, Pukerimu Stream Ecological Area, Pokaitu Stream Marginal Strip, Taahungatara Stream Marginal Strip

Christensen, B.R. 2002b: Northern Mamaku (Opuiaki) Restoration Programme: Project Plan 2002–2008. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished).

[Author's précis:]

The Opuiaki Ecological Area is representative of the land forms, soils and unlogged forests of the dissected old rhyolite dome and lava flow complex forming the southern end of the Kaimai Range and abutting the North West 'corner' of the Mamaku ignimbrite plateau. The area contains a complex type of dense podocarp forest occurring on the few large valley floors and adjacent slopes, which is not known to occur anywhere outside this southern quarter of the Kaimai Mamaku Forest Park. It is a mosaic of tanekaha and toatoa over kamahi, tawari and *Quintinia*, and rimu and Hall's totara over

kamahi and maire. Beadel (1995) has stated that this area has outstanding botanical values.

Possum numbers are moderately high (23% RTC, 2000) and it is apparent that they are having significant impacts on forest diversity and canopy health. Possum control is needed to ensure that major canopy components of this forest are not lost and that native fauna habitat does not become degraded. Browsing ungulates (goats and deer) are not present, and thus the forest understorey is intact with most palatable vegetation present.

The Opuiaki Ecological Area holds the last known, and potentially manageable, population of kokako in the Kaimai/Mamaku Ranges and uplands (excluding the Mokaihaha Ecological Area). Over the past two decades unmanaged kokako populations have declined dramatically, and are now effectively extinct from the Coromandel and much of the Kaimai Ranges. A fauna survey of the Opuiaki Ecological Area the summer of 1999/2000 in this area revealed that known kokako numbers have declined by at least 50% since 1994. Further delays in initiating pest control will result in further decline of kokako numbers, exacerbating the likely 'gender imbalance' (increasing the duration of control effort required to achieve a positive response). Other species in danger of local extinction are red mistletoe, blue duck, falcon, North Island (NI) kaka, NI brown kiwi, with kakariki and rifleman now thought to be locally extinct. By not managing the pest animal populations, the extinction of native species including kokako in the northern Mamaku is likely.

[An operational plan, including targets and measures for the conservation management operations at Opuiaki Ecological Area—BRC.]

Keywords: biodiversity, conservation, Opuiaki Ecological Area

Clarkson, B.D. 1981: Mangorewa Scenic Reserve: main habitats and features. Botany Division, Department of Scientific and Industrial Research, Rotorua (unpublished). 5 p.

[Three vegetation types are briefly described and their location (between the Mangorewa Stream and the Tauranga Direct Road) is indicated in a sketch plan. The major vegetation type is red beech-tawa/tawari forest with other tree species, including silver beech, rimu, rata, hard beech and kamahi. The second type is manuka-kamahi shrub forest at the southern end of the reserve, which is an early successional type resulting from forest clearance; and the third type is river bank vegetation of herbs and ferns on the banks of the Mangorewa Stream, including the ferns *Lindsaea viridis* and *Hymenophyllum atrovirens*.

The reserve is contiguous with the Mangorewa Ecological Area and could be incorporated into it, together with any land that can be added to the reserve (see gazette notice, Anon. 1983a), as the area has high botanical and scenic value. A species list is given for the scenic reserve; see also species list by Druce & Ogle (1975) and Druce (1978)—AEB.]

Keywords: Mangorewa Scenic Reserve, vegetation types, red beech, *Nothofagus fusca*, red beech forest, species list

Clarkson, B.D. 1985a: Botanical survey of Tukorehe Scenic Reserve. Botany Division, Department of Scientific and Industrial Research, Rotorua (unpublished). (Copy held on Department of Conservation Old File RSC–048.) 5 p. plus sketch plan.

[Tukorehe Scenic Reserve, also known as Fitzgerald Glade, is bisected by SH5, with marginal trees overarching the road and giving a high scenic value. This paper, which includes a list of plant species, has not been sighted, although vegetation types are described in a management plan (see Clarkson 1985b)—AEB.]

Keywords: Tukorehe Scenic Reserve, botany, species list

Clarkson, B.D. 1985b: Tukorehe Scenic Reserve: Management Plan. Department of Lands and Survey, Rotorua (unpublished). 5 p. plus sketch plan.

[Tukorehe Scenic Reserve (also known as Fitzgerald Glade) is a 46-ha reserve of high scenic value, which is bisected by SH5. Indigenous vegetation marginal to the road has been carefully protected by the Ministry of Works and Development. Most of the emergent podocarps were removed by logging, leaving a few rimu. The forest is described as 'typical Waikato cutover native forest'. The main vegetation types on the plateau top are tawa–mangeao–pukatea–rewarewa and a successional type of kamahi–rewarewa/wheki forest. Pukatea/mahoe and fuschia dominate in deeply incised gullies. Small pockets of cleared forest and invasive weeds, such as *Tradescantia* and ivy, indicate the need for restorative planting and weed control. A boundary fence should remain stock-proof. There is a memorial stone to Tukorehe, whose canoe brought ancestral Polynesians to New Zealand—AEB.]

Keywords: Tukorehe Scenic Reserve, vegetation types, reserve management plan

Clarkson, B.D. 1987: Botanical survey of Mt Ngongotaha Scenic Reserve & protected private land. Botany Division, Department of Scientific and Industrial research, Rotorua (unpublished). (Copy held on Department of Conservation File PAR – 4-3-24.) 5 p. plus sketch plan.

[A full plant list of both indigenous and adventive species is attached to this report, which describes five main habitats and their features:

1. Kamahi forest: This developed as a dense young forest on summit and surrounds after earlier burning.

2a. (Rimu)–(rata)/tawa-kamahi forest: Virgin forest on the southwestern side.

2b. (Rimu)–(rata)/tawa-rewarewa forest: Virgin forest on the southwestern side.

3a. (Rata)/tawa-rewarewa forest: 'Occurs in the northern quarter below 2a of which it is a logged variant' (p. 1).

3b. (Rata)/tawa-rewarewa forest: 'Covers most of the western side of the reserve. A logged variant of 2b' (p. 1).

4. Kamahi-rewarewa forest: In two pockets, probably resulting from burning in around the 1830s.

5. Sweet vernal-cocksfoot grassland: A narrow strip along the headwaters of the Ngongotaha Stream.

Conclusions and recommendations follow in full—BRC:]

This forest-covered mountain reserve is a very significant landscape feature of Rotorua city providing a scenic backdrop and a scenic drive and lookout over the lake and surrounding district. A significant proportion of the forest is virgin and such forest is very scarce in the district. The remainder is secondary after logging or burning. [Some change in forest vegetation with increasing altitude is apparent (AEB, pers. obs.)]. The forest capping the mountain is marginally montane in character with species present such as, broadleaf [*Griselinia littoralis*], toro [*Myrsine salicina*], and the ferns *Blechnum nigrum* and *Phymatosorus novae-zelandiae*. Cattle and goat browsing damage were both noted during my earlier visits however goat numbers have since been substantially reduced by New Zealand Forest Service hunters and cattle trespass is apparently infrequent. In order to maintain the integrity of the reserve forests it would be highly desirable to incorporate all the forest remaining on the mountain in reserve either by acqisition [*sic*], lease or covenant. Clearance or logging of forest in the privately owned enclaves would have a detrimental 'edge effect' on the reserve.

Keywords: Mt Ngongotaha Scenic Reserve, botany, species list

Clarkson, B.D. 1999: Vascular plant species list: wetland and adjoining forest in Forest Research experimental area A, Mamaku. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 3 p.

[List of 95 indigenous species and 8 adventive species arranged by life forms, with some contributions made by members of the Rotorua Botanical Society.

The 25 ha of wetland forms part of the 250 ha of the former northern FRI experimental area, which is now included in the Patetere Scenic Reserve purchased with Nature Heritage funds and managed by DOC (see Department of Conservation 2002).

The species list annotated here is part of a report on a proposed rezoning of FRI experimental area A, Mamaku Plateau, written by M.C. Smale et al. in 1999, and includes notes on the main ecological features of the area and a brief account of the vegetation types of wetland and forest. A more detailed description of the wetlands is contained in a further note on 'Forest Research Covenant, Mamaku wetlands, Management statement (05/08/386), and Management statement (3/12/0/1), part B, descriptive'—MCS.]

Keywords: wetland, plant list

Clarkson, B.D.; Clarkson, B.R. 1992: Lake Rotohokahoka vascular species list, May 1992. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 2 p.

[List of 148 indigenous species and 6 adventive species, arranged in alphabetical order. *Pittosporum kirkii* is a noteworthy record—AEB.]

Keywords: Lake Rotohokahoka, plant list

Clarkson, B.D.; Smale, M.C.; Ecroyd, C.E. (Comps) 1991: Botany of Rotorua. Forest Research Institute, Rotorua. 132p.

[An account of both native and introduced plants and plant communities in the Rotorua district, which extends westward to include part of the Mamaku Plateau where the headwaters of streams flowing into Lake Rotorua arise, mainly as springs. The 18 chapters, lavishly illustrated with colour photos, are written by professional scientists, and include accounts of native forest, exotic forest and mires, with reference to their features and composition on the Mamaku Plateau. Each chapter has a list of references and there is an index to the common and scientific names of all plants mentioned in the text.

Introductory sections describe the volcanism, soils and climate of the district, as well as the history of the vegetation. Figures show the location of the Taupo, Rotorua and Okataina Volcanic Centres, and the distribution of topsoil-forming tephra of the district. Mamaku Ignimbrite erupted from the caldera of the Rotorua basin about 140 000 years ago and formed the Mamaku Plateau. The rhyolitic dome of Mt Ngongotaha rose as a lava flow from the Rotorua caldera.

The topsoils of the Mamaku Plateau were formed from a long succession of ash showers, which also buried many soils. Soils derived from Taupo pumice, erupted about 1850 years ago from Lake Taupo, formed on the southern part of the Mamaku Plateau, while Kaharoa Ash reached the northeastern part. Soils derived from the older Rotorua and Mamaku Ash occupy the central part of the Plateau—AEB.]

Keywords: botany, Rotorua, volcanicity, soils, geology, vegetation, naturalised vegetation, indigenous forest, mires, Te Pu mire, Mamaku Plateau, threatened species—plants, fungi, traditional use of plants, *Dactylanthus taylorii*

Clout, M.N. 1977: Aspects of the ecology of possums in pine plantations. *Proceedings of the New Zealand Ecological Society 24*: 128–129.

[From the author's précis:]

One of the two study sites was cutover tawa/kamahi forest on the Mamaku Plateau, adjacent to a 12 year old plantation of Radiata pine. Mark-recapture estimated the possum population density was 2–3/ha in both indigenous forest and pines. The cutover site with many logs, dead trees and abundant ground vegetation had more possums per area than 12 and 23 year-old pine plantations.

Keywords: ecology, possum, *Trichosurus vulpecula*, mammals, forestry, radiata pine, *Pinus radiata*, cutover indigenous forest

Collins, D. 1977: Horohoro-Utuhina. A proposal for a regional park. Native Forest Action Council, Rotorua Branch, Rotorua. 9 p. plus 4 appendices and map.

[A case is presented for a regional park over an area of indigenous forest that is shown on a map as extending to a block of virgin forest in the northwestern part of Horohoro Forest and that includes protection forest and other forest in the catchments of streams flowing into Lake Rotorua. The concept and values of a regional park are discussed, and there are appendices on vegetation, birdlife and stream fauna within the forest tracts in the proposed park.

Virgin forest in the northwest of the present Horohoro Conservation Forest is now in the Mokaihaha Ecological Area, fringed on the south by forest that was partially logged in the late 1970s, on the east by older cutover with a tawa canopy, and on the west and north by exotic forest. A high proportion of cutover indigenous forest in the lower catchments of the Utuhina and other streams flowing into Lake Rotorua has been logged on leased or Maori-owned land since 1977 and converted to pine plantations—AEB.]

Keywords: Horohoro Forest, Utuhina catchment, regional park proposal, bird corridor

Crook, I.G. 1975: An assessment of Horohoro State Forest (SF31 Rotorua Conservancy) as a habitat for native vertebrate life. *Fauna Survey Unit Report No. 4*. New Zealand Wildlife Service, Wellington. 9 p.

[A primary wildlife survey in 1970 and a more intensive survey in September 1974 showed that the unlogged part of Horohoro Forest was of outstanding wildlife interest, with a good population of kokako, a moderate number of kaka, and a high density of North Island robins. In general, the forest had bird populations that were rich in numbers, although poor in diversity of species. It was recommended that the existing small Biological Reserve be extended to include all the unlogged forest in this block. Tables and figures show the distribution of kokako, kaka and robins at 5-minute bird count stations 500 m apart: 0.9 kokako per station, 0.2 kaka and 1.6 robins, amongst 11 bird species. No parakeets were recorded (refer to Marsh & Blake 1997; Owen 1999).

The author refers to an ecotone between two major forest types in the proposed reserve, with rimu/tawa forest typical of the Mamaku Plateau and soils derived from old ash showers in the northern part, and some dense podocarp forest to the south on a layer of Taupo Pumice. Changes in soils and associated forest types are discussed by Herbert (1975) in his account of Pukerimu Forest in the southwest corner of Horohoro Forest. Populations of kokako and other birds may be influenced by forest type and also altitude, with fewer kokako above 600 m a.s.l. The author considers that the kokako population on a larger block of unlogged forest may be well fitted to long-term survival in such a habitat (now the Mokaihaha Ecological Area of 1445 ha). See later surveys by Marsh & Blake (1997)—AEB.]

Keywords: Horohoro Forest, wildlife habitat—native vertebrates

Crook, I.G. 1978: Proposals for conservation areas for native birds in the Mamaku-Rotorua area. *Fauna Survey Unit Report No. 9*. New Zealand Wildlife Service, Wellington. 9 p. plus maps and references.

[The author, after some 8 years of studying New Zealand's indigenous birdlife with the Fauna Survey Unit, deals in this paper with the decline of the North Island kokako and its current distribution in favoured habits, and speculates on factors that may be causing this decline in some areas. In Horohoro Forest, the bird recording stations noted 0.85 kokako/station in 1970, and a drop to 0.31 kokako/station in 1977. The area of Horohoro Forest surveyed was 1500 ha. Logging on the periphery only stopped in 1977, by which time it had caused the destruction of dense podocarp forest as well as podocarp/tawa forest. The general questions raised by Crook were:

1. Are areas too small to support viable populations of kokako?
2. Is decline caused by destruction of the most favoured habitat?
3. Have there been habitat changes other than logging, such as damage by browsing animals?
4. Has there been a harmful impact from 1080 poisoning for possum control?

Crook concludes that observations on habitat selection and requirements of kokako were 'tantalisingly incomplete' at the time of his report, although his recommendations include reservation of as large an area of indigenous forest as possible in the northwestern part of Horohoro Forest, including the proposed Mokaihaha Ecological Area and partially-logged forest on its southern boundary.

This is now the established Mokaihaha Ecological Area. His recommendations of a substantial reserve in Mamaku State Forest north of Rotorua-Hamilton have been realised with the establishment of the Opuiaki Ecological Area. Both the Horohoro and Mokaihaha Ecological Areas have substantial Conservation Areas adjacent to them—see Marsh & Blake (1997) and Owen (1999) for later surveys of kokako in these two Ecological Areas. Both are on easy terrain, and have had only minor disturbance to the old-growth forest and low numbers of deer (at least until recently)—criteria that suit kokako according to Crook. Very few deer have been recorded in or near the Opuiaki Ecological Area to the present time (2006), although red deer have been increasing in the Mokaihaha Ecological Area over recent decades, despite there being few signs in the 1960s—AEB.][5]

Keywords: conservation proposals, kokako, *Callaeas cinerea*, kokako—habitat, kokako—population decline, Mamaku Plateau, Horohoro Forest

[5] *Alseuosmia* shrubs are very common in forest west of Galaxy Road and in the Opuiaki Ecological Area. As *Alseuosmia* are highly palatable to deer, the abundance of these shrubs indicates scarcity of deer. Possums, which are both browsers and bird predators, are now ubiquitious in Mamaku forests. See Williams & Leathwick (1994) for vegetation unaffected by browsing in this area—MCS.

Crook, I.G.; Merton, D.V.; Moran, L.R. 1971: Distribution and habitats of native bird species in indigenous State Forests of the Rotorua and Taupo Districts. *Fauna Survey Unit Report No. 1a.* New Zealand Wildlife Service, Wellington. 7 p. plus appendices and bird distribution maps.

[This report is mainly concerned with the distribution, habitats, behaviour and food items of the kokako, although kaka and parakeets are also referred to and are included in some distributions maps of the three threatened species in central North Island forests. The earlier use of tape-recorded song and distress calls of kokako to determine their abundance is described. Mamaku Forest (State Forest 3), north of the Hamilton–Rotorua Highway (SH5), is one of the six main areas surveyed for distribution and abundance of kokako. Tawa-dominant forest, as found in north Mamaku, provides suitable habitat for kokako, and understorey plants are important food sources, particularly *Coprosma grandifolia*.

The article includes a list of food plants of kokako in relation to those browsed and preferred by ungulates and possums; however, this is incomplete, as it lacks any indication of leaves and fruits favoured by possums. No parakeets were found in the Mamaku survey. Proposals for reserves to maintain bird populations are given, which were mainly acted on in due course—AEB.]

Keywords: bird survey, kokako, *Callaeas cinerea*, kokako—habitat, kokako—behaviour, kokako—research, kokako—reserves

Dale, R.W.; James, I.L. 1977: Forest and environment in the Kaimai ranges. *Technical Paper No. 65.* Forest Research Institute, New Zealand Forest Service, Rotorua. 34 p. plus photos.

[The region covered by this paper lies to the north of that covered by this Mamaku bibliography, with the Matamata–Tauranga road (SH29) being the common boundary. The Whakamarama Plateau to the north of SH29 is, however, an extension of the Mamaku Plateau, with tawa-dominant forest. Possums were liberated on the Whakamarama Plateau in 1946, although it is stated that the red deer [in some southern areas] probably resulted from a northward colonisation from the Mamaku Plateau (p. 5) and that deer numbers were greatest on the Whakamarama Plateau, where goats were also common (p. 12). Mortality of emergent northern rata was common in the Kaimai Ranges and 'may have been caused by possums'.

In the 1960s, dieback or death of large rata was evident in cutover indigenous forest on the Mamaku Plateau (AEB, pers. obs.). Possums were suspected of causing browsing damage in an old cohort of rata in the Horohoro Forest at the southern end of the Mamaku Plateau, where removal of podocarp forest by logging left rata crowns more exposed; other emergent, although mainly dead, rata with epiphyte loads near the northern boundary of Horohoro Forest were killed by crown fires, resulting from 'torching' by brands blown from adjacent land-clearing operations. See Somervell (2004) for comment on earlier death of rata—AEB.]

Keywords: tawa-dominant forest, *Beilschmiedia tawa*, Mamaku Plateau, Whakamarama Plateau, northern rata—mortality, *Metrosideros robusta,* possum, *Trichosurus vulpecula*, possum—liberation, red deer, *Cervus elaphus*

Daniel, M.J.; Williams, G.R. 1984: A survey of the distribution, seasonal activity and roost sites of New Zealand bats. *New Zealand Journal of Ecology* 7: 9–25.

[From the authors' abstract:]

The lesser short-tailed bat (*Mystacina t. tuberculata*) has been found in 18 locations in indigenous forest in North Island since 1961, mainly in Northland kauri forest (including Little Barrier Island), on the volcanic plateau (including Tongariro National Park), Urewera National Park and in Tararuas Range.

The long-tailed bat (*Chalinolobus tuberculatus*) is widely distributed in a variety of indigenous and man-made habitats in both North and South Islands and is the only common species of bat in New Zealand.

[Mamaku Plateau is one of the 18 indigenous forests mentioned as bat habitat in the North Island. The authors state that the New Zealand bats roost mainly in hollow trees under loose bark and in cover, including 'pumice cover'. Tomo (sink holes) are a feature of the Mamaku Plateau—AEB.]

Keywords: bats, lesser short-tailed bat, *Mystacina tuberculata tuberculata*

Dawson, D.G.; Gaze, P.D. 1983: Ecology Division submission on Kaimai–Mamaku State Forest Park draft management plan revision 1982–1992. Ecology Division, Department of Scientific and Industrial Research, Lower Hutt (unpublished).

[This submission was made to NZFS (see New Zealand Forest Service 1983a–c)—AEB.]

Keywords: Kaimai Mamaku State Forest Park, indigenous forest, forest management

de Lacy, H. 1987: Successful farming: exploiting natural health: bush-bound deer units puts emphasis on profitability. *New Zealand Journal of Agriculture 152*: 24–25.

[This 240-ha deer farm, named Ngapahu, is bounded by old-growth rimu-tawa forest of the Kaimai Mamaku Forest Park and SH5. The development policy of the current owner is outlined and involves intensive deer fencing to produce a carrying capacity of 1200 deer and comparable numbers of goats. Early problems in farm development from the 1920s included cobalt deficiency and reversion of pasture to fern in the high-rainfall climate. In the 1970s, up to 600 feral goats were used for weed control.

The owner (in 1987) is reported to have plans to export high-quality water from a spring on the property, producing a flow of 3 million litres of water per day. Goats were used as a (land) 'development tool' as well as for weed and scrub control. The stocking of goats on land before fencing was common farming practice in the early 1980s—BRC.]

Keywords: agriculture, farming, mammals, deer, *Cervus* spp., goat, *Capra hircus*

Dell, P.M. 1982a: The effect of afforestation on the water resource of the Mamaku Plateau Region. Unpublished MSc thesis, University of Waikato, Hamilton. 178 p. plus appendices.

[From the author's abstract:]

In assessing the water resources of the Mamaku Plateau region, the area exhibits high, constant base flows with much of the water discharging in the north western part of the study area. Water balance studies showed groundwater recharge to approximately equal old groundwater discharge. Although none of the individual catchments were watertight the entire study area gave a reasonable balance. The use of environmental isotopes allowed an estimate to be made of the water storage volume of the system. Tritium analysis showed the mean residence time of the old groundwater to be in the order of 50–100 years. This implies a minimum of 16km^3 of water stored in ignimbrites, using a base flow of 10m^3 s^{-1}.

Due to the region's geology, the high groundwater recharge rates, and the interception similarities there should be no major variations in the water yield when converting from native to exotics. The region's geological character causes over 80% of the base flow to be discharged in the north-western quadrant of the study area.

A sediment study highlighted one particular catchment as being a major sediment producer. Earthworks and roading when not properly managed were pinpointed as major causes of increased sediment loads. The two major sources of sediment were found to be earthworks and associated roading and bank erosion, however surface wash was of importance in parts of a steep catchment.

Once the earthworks had ceased and roading became stable, the afforested catchments' sediment yields decreased and in certain catchments approached pre-development levels.

[The study area of the western part of the Mamaku Plateau included catchments of streams that rise near Galaxy Road on the eastern side of the area and flow in entrenched valleys to the northwest and into the Waihou River. The Takapuhurihuri and Oraka Streams rise in the southeast of the study area, while the catchments of the Kuhatahi and Waipari Streams lie in the northern part, adjacent to SH5. These northern catchments were easily accessible from Galaxy Road and residual indigenous forest contained some resident kokako in the mid-1970s. Concern was expressed by conservationists about forest clearance here and erosion and sedimentation of streams through roadworks (see McEwen 2005).

A map in Dell's thesis indicates 'closed catchments' covering 1355 ha in the middle reaches of these two catchments. The higher parts of the central Plateau rise to 600 m and have numerous sinkholes or 'tomo'. A table shows the change in vegetation between 1970 and 1982: 'native forest and bush' was reduced from 18 530 ha to 7800 ha, while 'production forest' was increased from 2050 ha to 13 000 ha. This was the main period for conversion of cutover tawa forest (previously logged mainly for podocarps) to plantations of exotic species (mainly radiata pine)—AEB.]

Keywords: water resources, hydrology, afforestation—impact, ignimbrite—water storage, ground water flow, sedimentation, erosion

Dell, P.M. 1982b: The water resource of the Mamaku Plateau region. New Zealand Hydrological Society Annual Symposium, 23–26 November 1982. University of Auckland, Auckland. 13 p.

[From the author's abstract:]

The ignimbrites of the Mamaku Plateau Region at the head of the Thames Valley as a constant low flow water source for the Thames Valley is realised. Water balance studies have shown major variations in runoff and loss to groundwater to occur between adjacent catchments with low flow specific discharges ranging from 0.71 $s^{-1}km^{-2}$ up to 1321 $s^{-1}km^{-2}$. The large specific discharges are supplied by numerous springs which emerge in the lower part of the north-western catchment. Although the water balance shows the inputs to approximately equal outputs, the use of environmental isotopes allowed an indication of the water storage volume of the system to be calculated. Tritium analysis showed the age spectrum of the water to be in the order of 50–100 years which implies a minimum of 16km^3 of water being stored in the ignimbrites, using a spring base flow of 10m s^{-1}.

[See Dell (1982a) for main conclusions from his thesis—AEB.]

Keywords: water resources, hydrology, ignimbrite—water storage, ground water flow

Dell, P.M.; Cameron, L.A.; Carter, D.A. 1980: Mamaku Plateau investigation: second interim report. Hauraki Catchment Board and Regional Water Board (unpublished). 19 p. plus maps and appendices.

[This work has not been reviewed by the authors of this bibliography—BRC.]

Keywords: water resources, hydrology, forestry—erosion, forestry—sedimentation of catchment

Department of Conservation 1994a: An education compendium for Kaimai-Mamaku Forest Park. Bay of Plenty Conservancy, Department of Conservation, Rotorua. Unpaginated (90 p.).

[Compiled from a wide range of resources, this compendium is essentially a teachers' guide, suggesting activities for younger children and providing background information that should encourage appreciation of and respect for the forest environment. Although the material is said to be related specifically to the park, some applies mainly to the northern part of the park (as in the sections on mining, tracks, geology and outdoor education facilities, i.e. camps and lodges). However, much material can apply to any indigenous forest, whether virgin or logged and reverted. There are 15 numbered sections, including those on medicinal plants, streams and rivers, invertebrates, trees and plants (including forest structure and animal life), birds, and introduced pests.

Some personal experience has been obtained in taking school groups to Mamaku forests (AEB, pers. obs.). On visiting Horohoro Forest east of Lake Rotohokahoka (now in Mokaihaha Ecological Area), secondary school students from Reporoa farms (some unused to forest environments), while

sitting beneath a tawa canopy at lunch time, expressed delight in the beauty and variety of ferns, mosses, lichens and fungi, even though this was reverted residual forest years after logging of the podocarps. See McArthur (2003) for a list of Mamaku plant species, including many ferns—AEB.]

Keywords: education, environmental education, forest environment

Department of Conservation 1994b: Kaimai-Mamaku Forest Park day walks. Department of Conservation, Tauranga.

[This single folding sheet with location maps has only two walks that are described and located within the southern section of the park between State Highways 5 and 29. The Woods Mill track in Mamaku Forest, starting from SH5, leads to an old tramway and the old mill site, and then to the Waiomou Stream. The Rapurapu kauri grove track leads to three mature kauri and nearby kauri regeneration (near the southern limit of kauri). A brief account of the park is given. See Broekhuizen et al. (1985) for a list of plants in the Rapurapu area—AEB.]

Keywords: Kaimai Mamaku Forest Park, recreation, walking tracks, kauri, *Agathis australis*, kauri grove

Department of Conservation 1996: Recreation priorities for Kaimai-Mamaku Forest Park. Department of Conservation, Rotorua. 9 p. plus map.

[This report refers to the vision, principles and future priorities for recreation management in the Kaimai Mamaku Forest Park. Part of the Mamaku Plateau falls into the southern sub-region of the Park, south of SH29. The section on the vision for the Park states that 'the southern zone between State Highways 29 and 5 will continue to be a minimal development area, with only three existing short tracks maintained to provide access into the area. No campsites or other accommodation will be provided by the Department in this zone'. Development of further access tracks, campsites, etc. will be largely confined to the northern region of the Park.

The southern zone of the Park contains the Opuiaki Ecological Area and adjacent virgin podocarp/tawa forest where DOC has undertaken measures to sustain the kokako population—AEB.]

Keywords: recreation, Kaimai Mamaku Forest Park, wilderness area

Department of Conservation 1997a: Conservation Management Strategy Volume I for Bay of Plenty Conservancy 1997–2007. Department of Conservation, Rotorua. 273 p.

[Volume I deals with the conservation issues over the whole Bay of Plenty Conservancy and makes specific mention of the Mamaku Plateau in some sections—see below. It notes a conservation milestone in the 1960s of protecting the Kaimai Range and parts of the Mamaku Plateau. Initially, a government direction was given in the 1960s to clear partially-logged podocarp/tawa forest on the Mamaku Plateau. 'Later similar proposals for part of the Kaimai Range led to local and national objections which were successful in protecting this area' (p. 9).

A section of the Otanewainuku – Te Aroha Management Area deals with the Mamaku Plateau (pp. 54–55, see below), where measures have been taken to implement a kokako recovery plan, with the provision for control of predators and browsing animals—see Rasch (1989). A vegetation 'corridor' has been identified that joins two areas of forest with kokako (see Bergin 1991)—AEB.]

Mamaku Plateau – Manawahe [pp. 54–55]

1. The survival of kokako populations in Rotoehu, Kaharoa, and Mamaku Forests is threatened by predation and competition for food.
2. The discontinuous nature of the forested areas creates fragmented habitats for indigenous species, lowering population stability and overall ecosystem quality.
3. The spread of wallabies into this area poses a risk to natural resources.
4. The demand for upgrading facilities can conflict with the demand for remote experience areas.
5. Provide for remote recreation activities.

South Mamaku [p. 77]

1. Animals and invasive weeds threaten gazetted ecological areas.
2. The endangered plant *Dactylanthus taylorii* (wood rose) is:
   • Threatened by possum browsing; and
   • Pollinated by short-tailed bats.
3. Little is known about short tailed bats and their ecology.
4. Enforcement of legislation is inadequate to prevent rubbish dumping and taking of timber and ponga.
5. Remote recreation areas do not meet user needs.
6. Some land with indigenous forest remnants have little or no legal protection.

Keywords: conservation management, Mamaku Plateau—Manawahe, south Mamaku, forest corridor

Department of Conservation 1997b: Conservation Management Strategy Volume II for Bay of Plenty Conservancy 1997–2007. Department of Conservation, Rotorua. 99 p. plus topographic maps and tables.

[Volume II is a compendium of tabulated items and maps, enabling one to find the name, location, status, area and ecological district of all land in the Bay of Plenty Conservancy administered by the Department of Conservation. The region covered by this bibliography—substantially the forests of the central Mamaku Plateau and its flanks—is covered mainly by maps U15 and U16 (Ngongotaha and Rotorua) in the Ecological Districts of Otanewainuku and Rotorua, with the western fall in Tokoroa District. DOC-administered land parcels on the Mamaku Plateau area for Rotorua Lakes and Tauranga districts are listed separately—AEB.]

Keywords: conservation management, Mamaku Plateau—Manawahe, south Mamaku

Department of Conservation 1997c: Tracks through time: moments in history of the Kaimai-Mamaku Forest Park. Department of Conservation, Rotorua. 16 p. plus illustrations.

[This account outlines the history of the region, mainly with reference to the Kaimai Range, and traces the exploitation of the rimu/tawa forests of the Mamaku Plateau, the development of farming, and the use of water resources from streams rising from the flanks of the Plateau. The forest of the Mangapapa, Ngatuhoa and Opuiaki catchments provided refuge for Maori people, from early human habitation (near the coast) to the disturbances of the 1860s. Milling of rimu in Tauranga was said to start in 1912, with some timber being removed from Mamaku forests.

The milling of rimu from forests on the central Plateau near the future Mamaku township had started in 1888 (Jennings 1994). Wood's Mill, near the Waiomou Stream, operated from 1934, before being moved to Mamaku township. A later logging firm was Frankham's, operating past Ngatuhoa Lodge until logging (in old-growth forest) ceased in the 1970s.

The erosion and landslides observed in the Kaimai Ranges from the 1960s (Jane & Green 1983) did not occur on the Mamaku Plateau (Nicholls 1963), where damage by goats had not been a problem, although possums and over-wintering of cattle had caused damage in the whole region. The causes of erosion in the Kaimai Range is still debated, although a 1980 report—not referenced—is said to point to droughts causing soil cracking and leading to landslides during storms. For a full discussion, see Jane & Green (1983).

The rise of the conservation movement from the 1960s led to strong opposition to the large-scale conversion of tawa-dominant cutover forest to radiata pine plantations on the Mamaku Plateau in the 1970s, and proposals were made for a National Park or 'National Reserve status'—see New Zealand Forest Service (1983a, c, d). Conversion of cutover indigenous forest proceeded, although fuller protection to the Forest Park was provided by the Conservation Act 1987.

The Tauranga Joint Generation Committee was given the right to construct hydro-electric power stations from the waters of the Mangapapa and other rivers in the upper Wairoa catchment on the northern flanks of the Mamaku Plateau, with the first station built in 1972. See Stokes (1983) for the impact of changing land use on the Ngamanawa people—AEB.]

Keywords: Kaimai Mamaku Forest Park—history, historical notes, forest exploitation, conservation values

Department of Conservation 2000: Kaimai-Mamaku Forest Park Map: interim revision of coloured topographic map, 1:63 000 scale. Department of Conservation, Tauranga.

[The original edition was published by NZFS in 1983. Tracks for suggested day and overnight walks are shown. In Mamaku Forest, on the central Mamaku Plateau, the track from SH5 past the old Woods Mill site leads to the Waiomou Falls, and the Hiwiroa Road leads towards Hiwiroa, the highest point on the central Plateau at 696 m. A track heading south from SH29 leads to the Rapurapu kauri grove. Broad vegetation types are depicted—AEB.]

Keywords: Kaimai Mamaku Forest Park, recreation, walking tracks

Department of Conservation 2002: Proposed purchase of forest research areas. Native forest and wetland Mamaku Plateau—Rotorua District. Project summary. Nature Heritage application. Department of Conservation, Rotorua (unpublished). Project summary: 8 p. Report: 16 p. plus aerial colour photos. Valuation report: 17 p.

[The bound document has several sections, starting with an application to the Nature Heritage Fund for purchase of two areas of land owned by Forest Research Ltd on the Mamaku Plateau. This application is followed by a project summary by the Bay of Plenty Conservancy entitled 'Proposed purchase of native forest and wetland Mamaku Plateau—Rotorua District'. This summary contains administrative details for purchase of two FRI experimental blocks (the northern and central blocks), and attaches a Government Valuation assessment. Background information includes a brief account of the history of the two blocks and earlier discussion with Forest Research Ltd. The conservation values and the ecological significance of the two blocks are discussed in the conservancy report attached. This report is entitled 'Conservation and research values of two Mamaku Plateau Forest Research Limited Experiment Blocks, by Paul Cashmore, Keith Owen, George Pardy, all of Department of Conservation, Rotorua'. It updates the previous report by Pardy et al. (1999) on the three Mamaku FRI experimental blocks, which is annotated separately. Reference to the southern block in Horohoro Forest has been excluded. Several colour photos of vegetation have been included in this report, and a photo of wetland in the north block is shown on the title page of the full document. Plans and aerial photos of the two blocks are enclosed, as in the 1999 report.

As a result of this application and report, and with strong support from the Rotorua community and conservationists, these two experimental blocks were purchased by the Nature Heritage Fund in November 2002, to be managed by DOC as part of the Patetere Scenic Reserve. It is understood that the southern experimental block in Horohoro Forest, contiguous with the Mokaihaha and Matahana Ecological Reserves, is held by the Crown for possible land exchange in Maori settlements (see Steward 1986b)—AEB.]

Keywords: Nature Heritage Fund, forest conservation, forest ecology, Mamaku Plateau—experimental blocks

Department of Conservation 2004: Mokaihaha kokako survey, September 2004. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). Map.

[A single map sheet shows the location of 50 kokako (22 pairs and 6 singles) found during this survey. No report is attached. Most kokako were found in the northwestern section of the Mokaihaha Ecological Area. See Marsh & Blake (1997) for an earlier survey, during which 18 pairs of kokako were found, along with 13 singles and 1 juvenile.

The survey mentioned here followed 3 years of ground baiting (2001–2003) to control possums and rats, both of which are predators of birds. See Wilke (2002) for the post-control survey (2001), which found that nine kokako chicks were fledged from nine nests. See also Ebert (2002)—AEB.]

Keywords: kokako, *Callaeas cinerea*, kokako—survey, kokako—population, Mokaihaha Ecological Area, Horohoro Conservation Area

Department of Lands and Survey 1975: Kaimai-Mamaku Region: proposals for a National Park. Department of Lands and Survey, Hamilton. 37 p. plus coloured maps and photos.

[This report discusses the legal bases, concepts and objectives for Forest Parks and National Parks, and concludes that the Kaimai-Mamaku region is worthy of National Park status. A map shows the boundaries of the proposed National Park with the different land tenures within the region, including Unallocated Crown Land, Crown Leases, Scenic Reserves, State Forest, Maori Land and Freehold Land. Tenure is disregarded in the account of attributes of the region, which includes authoritative summaries of geology, topography, climate, soils, botany, forest types and fauna, and an outline of the major features of interest. These features are all in the northern part of the region in the Kaimai Range, and the area to the south of SH29 is referred to as the southern sub-region 'where the Kaimai Range proper merges into the Mamaku Plateau near the southern extremity of the region'. Historic associations and recreational values are also included. The introduction refers to the 1972 proposals of NZFS for management of all the State Forest land in the Kaimai-Mamaku region, some areas being zoned for partial or complete logging of indigenous forest, and establishment of exotic forest plantations following lease of land zoned for conversion. Local objections to logging conversion, in particular, were presented by the Kaimai Settlers' Committee, which made submissions to the National Parks Authority for the establishment of a national park in the Kaimai-Mamaku region as the best means of permanently preserving the native forest.

The Kaimai Mamaku Forest Park was created in 1975 and the native forest has been protected through management by DOC since 1987. Scientific reserves, in the form of Ecological Areas, were made under management of NZFS, although conservation forests have been extended—AEB.]

Keywords: Kaimai Mamaku Ranges, National Park Proposal

Department of Survey and Land Information 1995: Kaimai-Mamaku Map. New Zealand Department of Survey and Land Information, Wellington.

[Map of the Kaimai Mamaku Forest Park—AEB.]

Keywords: Kaimai Mamaku Forest Park

Druce, A.P. 1972: Indigenous vascular plants of Horohoro Bluff, southern Mamaku range, 1500–27550ft. Botany Division, Department of Scientific and Industrial Research. Unpublished report held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua. 2 p.

[This list of plant species is based on a 1961 visit (grid reference N85 605 885) and has since been revised on ten occasions to 1990. A total of 82 species is recorded. No description of site or vegetation is given, although previous disturbance and succession from fire in places may be indicated by the presence of lycopods and heathland plants in the plant list from undisturbed forest near the crest of the southern Plateau in Mokaihaha Ecological Area (Cameron 2005)—AEB.]

Keywords: plant list, Horohoro Bluffs

Druce, A.P. 1978: Species list for Mangorewa and Ohaupara Streams (1200–1500ft asl.). Botany Division, Department of Scientific and Industrial Research (unpublished).

[Refer to Druce & Ogle (1975)—AEB.]

Keywords: Mangorewa Stream, Ohaupara Stream, species list

Druce, A.P.; Haydock, K. 1978 (revised 1982): Indigenous vascular plants of southern Mamaku Plateau, including Pokai, Pukerimu and Endean's Block Reserves, 370–840m. Botany Division, Department of Scientific and Industrial Research (unpublished). (Copy held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua.) 6p.

[Plant species list. Grid references: N 76 456-94; N 76 49-96; N 76 49-03. Revised with additions to 1982. See also New Zealand Forest Service (1978) for Pukerimu, and Herbert (1975)—AEB.]

Keywords: plant list, Pukerimu Forest, Endean's Block—Ngongotaha, southern Mamaku Plateau

Druce, A.P.; Ogle, C. 1975: Indigenous vascular plants in vicinity of Mangorewa and Ohaupara Streams, N.N.E of Rotorua, 1200–1700ft. Botany Division, Department of Scientific and Industrial Research. Unpublished report held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua. 4 p.

[A list of plant species, revised on 11 occasions to 1991 with additions by other botanists, including B. Clarkson (1984: *Rotorua Botanical Society Newsletter 3*: 13–14). Species list only, including beech forest and wetlands. Conifers include rimu, totara, tanekaha and Hall's totara—grid reference N67 64-25. Beeches include red, silver and hard beech, and hybrids—*Nothofagus fusca* × *N. truncata* and *N. fusca* × *N. solandri*. See also Clarkson (1981) for species list and vegetation types in Mangorewa Scenic Reserve—AEB.]

Keywords: Mangorewa Stream, Ohaupara Stream, species list

Ducre, W.; Ducre, K. 2001: *Dactylanthus* monitoring survey, Mamaku Plateau. Unpublished report held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua (Old file KO4-7).

[This survey was carried out from 17 March 2001 to 1 April 2001 in three localities—Dansey Road Scenic Reserve, Horohoro Forest and Arahiwi Reserve. Results are summarised and the report has two locality plans. Gut samples from poisoned possums were examined for signs of dactylanthus (from staining), although all were negative. It was noted that 'the Mamaku area has been intensively fur-hunted for the last five years'. Methods are outlined. Cyanide paste lines were used with poor results. Feratox bait stations were used, pre-fed with Ferafeed paste. A total of 66 possums were killed with gut examinations of 17—AEB.]

Keywords: *Dactylanthus taylorii*—monitoring, possum—gut examinations, *Trichosurus vulpecula*

Dugdale, J.S. 1994: Hepialidae (Insecta: Lepidoptera). *Fauna of New Zealand 30.* Landcare Research, Auckland.

[This article describes the 27 species of Hepialidae in New Zealand, all of which are endemic. The puriri moth (also called the ghost moth *Aenetus virescens*) is our largest moth species (females can exceed 140 mm wingspan). It is found only in the North Island, where damage by its larvae to beech trees has curtailed their use for timber and veneer.

The puriri moth is common and widespread in central North Island indigenous forests, including those on the Mamaku Plateau, where a number of shrubs (particularly wineberry and putaputaweta) are hosts to the larvae. The adult moths emerge in summer and large numbers that have been attracted to street lights in Pureora Forest Village have been observed being hawked by moreporks (AEB, pers. obs.).

During early settlement at Mamaku village, the mummified caterpillars of porina with the elongate fruiting body of the parasitic fungus *Cordyceps* attached were sold to tourists as 'vegetable caterpillars'—AEB.]

Keywords: biodiversity, moths, 'ghost moths', 'swift moths', puriri moths, ecology, vegetable caterpillar, fungi, *Cordyceps* spp., porina

Ebert, B. 2002: Report on the 2001/2002 kokako breeding season in the Mokaihaha Ecological Area. Rotorua Lakes Area Office, Department of Conservation, Rotorua (unpublished). 9 p. plus coloured maps and appendices.

[This article reports on the kokako that were monitored over the 2001/2002 breeding season in 848 ha of unlogged rimu/tawa forest in the northwestern part of Mokaihaha Ecological Area. A predator control area was defined where baits containing 1080 were placed at stations on 8 October 2001, following pre-feeding with non-toxic baits; for details of this operation, see Wilke (2002). This control programme was successful in removing most of the possum and ship rat populations. Bait stations were cleared by 1 November 2001 and a pre-breeding walk-through survey was carried out from 12 to 23 November to make a census of the kokako population within the predator control area. A total of 20 adult kokako were found during the census, with a further pair found later. Locations of the kokako are shown on a map in appendix 1, with six single birds and eight pairs located; it also includes the location of five nests. No juvenile birds were found. The results of observations on breeding are given in a table headed 'Kokako nest monitoring summary'. Nine chicks were fledged from the eight pairs of adults observed and all were found to be with their parents in February 2002, 1–5 weeks after leaving the nest. Thus, this breeding season was considered successful, with benefits from the predator control programme undertaken a month before nesting started in mid-November. Recommendations include discussions to consider control of stoats and feral cats in the Mokaihaha Ecological Area, as well as removal of (white-backed) magpies *Gymnorhina hypoleuca* and (southern) black-backed gulls *Larus doiminicanus* (which nest in the forest). The author notes that 'stoat tracks have been seen on mud throughout the Mokaihaha' (p. 7). See Marsh & Blake (1997) for a kokako survey in 2136 ha of the whole Mokaihaha Ecological Area and adjacent conservation area—AEB.]

Keywords: kokako, *Callaeas cinerea*, kokako—breeding, magpie, *Gymnorhina hypoleuca*, black-backed gull, *Larus dominicanus*, Mokaihaha Ecological Area

Ecroyd, C.E. 1996: The ecology of *Dactylanthus taylorii* and threats to its survival. *New Zealand Journal of Ecology 20(1)*: 81–100.

[From the author's abstract:]

Dactylanthus taylorii, a root parasite in the family Balanophoraceae, is New Zealand's only fully parasitic flowering plant. It grows attached to the roots of a wide range of hardwood trees and shrubs, often in fire-induced secondary forest on the margin of podocarp-hardwood forest.

[This comprehensive account of the root parasite *Dactylanthus taylorii*, a threatened species, refers to 37 study sites in the North Island. Dactylanthus occurs on the southern Mamaku Plateau, where there is one major study site[6].

[6] A detailed description of Dactylanthus is given by Ecroyd (1993): 'In search of the Wood Rose'—*Forest & Bird 267*: 24–28. Annotations for both papers are given in the Pureora bibliography (Beveridge et al. 2000), as items 73 and 74.

See also Ducre & Ducre (2001) for results of possum monitoring in three localities where dactylanthus occurs on the southern Mamaku Plateau; possums browse and destroy dactylanthus inflorescences—AEB.]

Keywords: *Dactylanthus taylorii*—ecology, possum—impact, *Trichosurus vulpecula*, conservation

Edmonds, A.S. 1982: Indigenous forests of the central North Island. In: Symposium: fauna of the central North Island Volcanic Region. *New Zealand Entomologist* 7: 271–276.

[From the author's abstract:]

Since the Cretaceous era the effects of climatic change and intermittent vulcanism have dictated a shifting pattern for New Zealand's forests so that in any one place the mix of species comprising the forest has continually changed. The arrival of Man heralded a reduction in indigenous forest area from an estimated 18.8 million ha to the present 6.2 million ha, about 33 % of the original forest estate. A discontinuous fringe of 3 types of indigenous forest now encircles the central volcanic plateau in the North Island. Podocarp forests, which were originally very extensive, are now almost entirely restricted to the eastern fall of the Hauhungaroa Range, West Taupo, and to the Whirinaki basin, adjacent to Urewera National Park. Podocarp/hardwood forests are more extensive in the same 2 localities as well as on the Mamaku Plateau.

In the North Island only 56 000 ha of unlogged podocarp/hardwood forest, including dense podocarp forest, remains. This type of forest is now so limited in extent nationally and of such conservation importance that it should be logged no further.

[This article is a broad account of indigenous forest types, including historical aspects, the reduction of forest caused by the impact of humans and the continuation of logging at the time of writing. Of the three forest types referred to by the author, areas of dense podocarps still remain on the Mamaku Plateau in the Ecological Areas of Pukerimu, Mokaihaha and Opuiaki, as well as in some other Conservation Areas and Scenic Reserves, such as Arahiwi. Podocarp/hardwood forests were once extensive on the Mamaku Plateau, although after earlier removal of most of the podocarps by logging, some 12 000 ha with residual tawa were logged (mainly for pulpwood) and converted to plantations of radiata pine from 1970. With the exception of some small enclaves, beech forest on the Mamaku was confined to Mangorewa Forest in the Ecological Areas (old growth forest) and an area to the west of these areas that had been logged first for podocarps and large red beech (for post splitting), and later mainly cleared for radiata pine plantations. Edmonds makes a plea for cessation of logging in indigenous forest. This first occurred in North Island forests managed by NZFS in 1984, although clearing of Crown-owned leasehold forest continued in logged beech forest in the Mangorewa catchment until 1987—AEB.]

Keywords: forest management—human impact, podocarp forest, podocarp/tawa forest, beech forest, *Nothofagus* spp., Mamaku Plateau—forests, beech forest—clear felling, logging—cessation, conservation

Faville, M.J.; Holzapfel, A.S.; Gemmill, C.E.C. 2000: Genetic diversity of *Dactylanthus taylorii* in New Zealand. *Science & Research Internal Report 173*. Department of Conservation, Wellington. 19 p.

[From the authors' abstract:]

The populations [of the endangered parasitic plant woodrose *Dactylanthus taylorii*—AEB] at Little Barrier Island, Pirongia, Mamaku, and Waitaanga Forest were identified as being the most genetically distinct at the national level, and it is recommended that these are targeted for management. Overall, genetic groupings did not reflect conservancy boundaries. For this reason it is also recommended that conservancy management decisions regarding the allocation of resources to populations, or withdrawal thereof, should take into account the genetic status of those populations at the national level.

[The authors note that the known Mamaku population is near the southern edge of the Mamaku Plateau in the Pukerimu Ecological Area—AEB.]

Keywords: conservation, botany, *Dactylanthus taylorii*, Pukerimu Ecological Area

Fitzgerald, A. 1977: Number and weight of faecal pellets produced by opossums. *Proceedings of the New Zealand Ecological Society 24*: 76–78.

[The diet of possums in Orongorongo Forest was studied from 1969 to 1973 by identifying plant remains in faeces (the plant species that comprise a high proportion of possum diet are also common in the Mamaku Forest; AEB, pers. obs.). In the Orongorongo Valley, 60% of the leaf diet was taken from two tree species, northern rata (*Metrosideros robusta*) and kamahi (*Weinmannia racemosa*), both of which were eaten in all months and were defoliated and killed. Supplejack and *Metrosideros fulgens* contributed to a further 15% of possum diet and were eaten seasonally.

On the southern Mamaku Plateau (Horohoro Forest), the role of the possum in contributing to dieback and death of emergent northern rata that remain after logging podocarps has been controversial; trees were reported to start dying back from the 1920s (Somervell 2004). There have been studies of the defoliation of northern rata in Whirinaki Forest, where large old trees have died or suffered severe crown dieback attributed to possum browsing. See Whirinaki bibliography (Beveridge et al. 2004), items 92–95. In Tihoi forest, West Taupo, old northern rata in a roadside enclave were observed to have progressive crown dieback from the 1970s, about a decade after arrival of possums in the area. Dieback or crown decline of kamahi has been widely reported on the Mamaku Plateau, as well as in a number of central North Island forests[7]—AEB.]

Keywords: possum, *Trichosurus vulpecula*, possum—diet, dieback—rata/kamahi

---

[7] The role of possums in the crown decline and mortality of kamahi is still not clear, as other factors such as drought, insect damage and senescence of other tree species also contribute. See Hosking (1986) for hard beech decline.

Fleet, L.K. (Comp. and printer) n.d.: Saint Joseph's Catholic Church Mamaku 1907–2003. L. K. Fleet, Rotorua. 10 p. plus photos.

[This pamphlet gives a brief history of Saint Joseph's, the first church to be built in the early settlement. It was built in 1907 from rimu milled in the Mamaku District. The church was damaged by high winds in 1986, but was restored before closure in 2003 and removal to Cambridge 2 years later. See Jennings (1994) for an account of the first 100 years of the Mamaku township; Somervell (2004) for a history of logging and sawmilling in the Mamaku district; and the Native Forest Action Council (1976) and Collins (1977) for a proposal to restore a bush tramway and some historical background—AEB.]

Keywords: Mamaku church—history

Fleming, C.A. 1969: Mammon on the Mamaku. Guest editorial. *New Zealand Listener: Journal of the National Broadcasting Service 62*: 1570.

[A guest editorial that pleas for reservation of New Zealand's bush in the face of increasing pressure to extend logging and conversion to pine plantations. Forest on the Mamaku Plateau, particularly near the main highway from Auckland to Rotorua (SH5), remained the most accessible in the North Island to see native birds—robin, rifleman, whitehead, tui, bellbird, native pigeon, parakeet (kakariki), kaka, and the rare kokako. The author notes that 37 000 acres (15 000 ha) of the Mamaku forests were destined for conversion into pine plantations. Charles Fleming had visited Mamaku Forest to see native birds from boyhood, and in 1932 first heard and later sighted a kokako in tawa forest.

As an outstanding scientist and conservationist, Fleming's views were respected and influential. See his biography entitled 'Charles Fleming, environmental patriot', written by his daughter, Mary McEwen (McEwen 2005), for many references to Mamaku and Horohoro Forests—AEB.]

Keywords: forestry, conversion of indigenous forest, conservation, toutouwai, North Island robin, *Petroica australis*, rifleman, *Acanthisitta chloris*, whitehead, *Mohoua albicilla*, tui, *Prosthemadera novaeseelandiae*, bellbird, *Anthornis melanura*, kereru, New Zealand pigeon, *Hemiphaga novaeseelandiae*, kakariki, *Cyanoramphus* sp., kaka, *Nestor meridionalis*, kokako, *Callaeas cinerea*

Forest Research Institute 1976: Armillaria root rot. *What's New in Forest Research 36*. Forest Research Institute, Rotorua. 4 p.

[Armillaria root rot in New Zealand is caused by two fungi, *Armillaria limonea* and *A. novae-zelandiae*, which attack seedlings of radiata pine planted on sites recently cleared of indigenous forest. On such sites in central North Island where tawa recently grew (at Pureora), up to 35% of pine seedlings have been killed within 5 years of planting. Deaths have occurred in patches that increase in size with time, as infected trees are liable to windthrow.

In one Mamaku trial, 62% of radiata pine aged 10 years that had been thinned to final stocking had been infected in the root collar area (shown by resin

exudation and 'boot-lace' rhizomorphs of the Armillaria fungi, which had spread from host tree stumps, such as those of tawa).

In another assessment in a pine plantation established after clearing of logged indigenous forest in the high-rainfall area of Horohoro Forest on the southern Mamaku Plateau, 50% of pine seedlings had been killed by Armillaria root rot within 5 years of planting (Forest Research Institute Annual Report, c. 1966). A colour photo (in the leaflet) shows that the open areas in 5-year-old pine plantations were typical of plantations on the Mamaku Plateau where tawa was the dominant canopy tree in forests previously logged for podocarps and then later cleared. The gaps in the pine plantation were rapidly filled with indigenous shrubs, a diverse food source for native birds—AEB.]

Keywords: Armillaria root rot—radiata pine, radiata pine, *Pinus radiata*, fungi, tawa—disease host, *Beilschmiedia tawa*, pine mortality, Mamaku Plateau

Forest Research Institute 1981: Establishing nursery-raised native trees. *What's New in Forest Research 86*. Forest Research Institute, Rotorua. 4 p.

[Large numbers of native trees have been raised in the FRI nursery as well-conditioned bare-rooted stock. Seedlings were produced from seed or wildings gathered in central North Island forest and were planted out in these forests to supplement natural regeneration. Extensive trial plantings were established on the Mamaku Plateau from 1960 and results have been recorded in several papers in this bibliography.

Early growth of group-planted rimu and totara on a reverted cutover forest site is illustrated in this leaflet, as well as a newer concept of close planting small clusters of rimu seedlings on freshly disturbed ground of selected microsites. No full assessments of these Mamaku trials have been made for the past 20–30 years—AEB.]

Keywords: podocarp—planting trial

Forest Research Institute 1991: Native meets exotic – kokako and pine forest. *What's New in Forest Research 209*. Forest Research Institute, Rotorua. 4 p.

[From the author's précis:]

Fast-growing pines planted as "corridors" between isolated native forest blocks could prove a life-saver to some populations of the North Island kokako (*Callaeas cinerea wilsoni*) – one of New Zealand's endangered bird species.

[This article notes the presence of kokako within a 50-year-old *Pinus alliottii* stand (with an understorey of indigenous shrubs) adjacent to native tawa-dominant forest (Pongakawa Ecological Area and Rotoehu Forest) in 1986. Some kokako were observed feeding on invertebrates in the pine canopy. It notes that two pine forest corridors are proposed for the wider Bay of Plenty, at Rotoehu and Mamaku Plateau (Gammans Block)—BRC].

Keywords: kokako, *Callaeas cinerea*, Pongakawa Ecological Area, Rotoehu Forest, Gammans Block

Fransen, P.J.B. 1982: Geology of the western Mamaku Plateau and variations in the Mamaku ignimbrite. Unpublished MSc thesis in Earth Sciences, University of Waikato, Hamilton. 209 p. plus appendices and maps.

[From the author's abstract:]

The Mamaku Ignimbrite covers a surface area of nearly 4300 km^2 on the Mamaku Plateau.

Repeated and extended intervals of erosion followed the emplacement of the ignimbrites. Detritus from the eroding sheets was removed by rivers flowing into the Hauraki Depression. Construction of the Mamaku Plateau has largely taken place since the eruption of the Whakamaru Ignimbrite, *c*.300, 000 years ago, and terminated with the eruption of the Mamaku Ignimbrite, *c*.140, 000 years ago. Excavation of the long deep valleys in the plateau occurred mainly in the latter 42,000 years.

Keywords: geology, Mamaku Plateau, Mamaku Ignimbrite

Fuller, R.A. 1932: To Maungapohatu by bike. *Historical Review: Bay of Plenty Journal of History 28*: 44–45.

[From the author's abstract:]

This account traces a bicycle trip made by Nora Copsey from Stratford, through the Mamaku Ranges and the Maungapohatu Track, to Gisborne in 1932.

Keywords: history, travel, recreation, bicycling

Gammon, G.A. 1910: A trip through dense bush. *Auckland Weekly News*. Compiled by L.K. Fleet. Mamaku Photographic Gallery, Mamaku. 14 p.

[An account of a reconnaissance trip through the Mamaku bush by G.A. Gamman[8] and party in 1910. Starting from a Mamaku sawmill, the party travelled for 21 miles through virgin forest from Steele's logging area and tramway northwards over easy terrain to tributaries of the Omanawa River and the Mangapapa River (where clean drinking water was first obtained). The first part of the journey along old survey lines was over wet, marshy ground through forest with large rimu and red beech, as well as rata and tawa. Further north, on drier ground, red beech disappeared and the forest was alive with birds. An obstacle to line cutting was a 'network of supplejack'. By tributaries of the Omanawa, 'wild cattle and pigs were plentiful'. On northward slopes, the forest was called magnificent, with 'grey duck, teal, "mountain duck", kaka and pigeon abounding near one campsite'. On emerging from the forest towards Tauranga through fernland, there was little land development observed, although a start had been made with dairy farming. The farming, logging and sawmilling ventures of George Gamman, including a reference to Gamman's Tramway, are outlined in Somervell (2004) under G.A. Gamman & Co. Ltd and Gammans Ltd. See also Jennings (1994), which includes an aerial photo of the sawmill site of G.A. Gamman and Co. Ltd, 1927–1964—AEB.]

Keywords: history, travel

---

[8] Note: in subsequent references his name is spelled 'Gamman'.

Gilchrist, A. 2000: A baseline study of *Paryphanta busbyi* in the Kaimai–Mamaku Ranges region. Tauranga Area Office, Department of Conservation, Tauranga (unpublished). 22 p. plus coloured map and 18 references.

[This report appears to refer to the same study as that reported on by O'Connell (1999). It reviews previous work on the kauri snail, outlines the background to the survey area and describes the study methods. Rats were confirmed as the only predator identified in the survey area. The main habitat of the snails consisted of dense mamaku (black tree ferns *Cyathea medullaris*) close to the river—BRC.]

Keywords: kauri snail, *Paryphanta busbyi*, snails, Kaimai Mamaku Forest Park

Giribet, G. 2000: Catalogue of the cyphophthalmi of the world (Arachnida, Opiliones). Revista Ibérica de Aracnologia, Zaragoza.

[A catalogue of collected specimens of *Rakaia media media* by Ray Forster, who described this species in the type locality of Mamaku Bush, Bay of Plenty, in 1948—BRC.]

Keywords: collections, Arachnida, ecology

Grange, L.I. 1929: A classification of soils of Rotorua County. *New Zealand Journal of Science and Technology 11*: 219–228.

[The soil series described are based on geological origin, unlike the classification of Aston (1924b) for the pumice soils of Rotorua. The geology of the county is discussed. 'Hard, porous rhyolitic tuffs form the Patetere Plateau' (p. 220), the eastern part of which is shown on an outline map of Rotorua County. Pumice from the Rotorua Ash, which originated in or near Lake Tikitapu, was blown towards Mamaku and was succeeded by Mamaku rhyolite pumice, which covers the whole county. The later Kaharoa shower extends to the Mangorewa catchment. Each soil-forming shower made a separate series. The Mamaku series is derived from Mamaku Ash and consists of coarse sand or sandy silt—AEB.]

Keywords: Rotorua Ash, Mamaku Ash, soil classification

Grange, L.I. 1931: Volcanic-ash showers: a geological reconnaissance of volcanic-ash showers of the central part of the North Island. *New Zealand Journal of Science and Technology 12*: 228–240.

[From the author's abstract:]

Volcanic-ash showers from vents in the Rotorua District reaching the Patetere Plateau are rhyolitic and are described from the oldest to latest as Rotorua, Mamaku, and Kaharoa showers.

[Shaw et al. (1990) note that 'this is the first major paper on the volcanic ash showers of the central North Island'—AEB.]

Keywords: ash showers, geology, volcanicity, Rotorua Ash shower, Mamaku Ash shower, Kaharoa Ash shower

Griffiths, C.D.; Harris, R.W. 1972: Waihou valley scheme: Mountain zone report. Hauraki Catchment Board and Regional Water Board, Auckland (unpublished). 8 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: water resources, hydrology, Waihou Valley scheme, erosion

Griggs, K. 2006: As the crow flies. *New Zealand Listener, 3 June 2006*: 32–33.

[This article contains a brief account of a kokako population increasing from 3 pairs to 21 pairs on some 200 ha of bush on the Manawahe farm of John MacIntosh over a period of 10 years. This result was achieved by fencing and predator control, with the assistance of volunteers from the Manawahe Kokako Trust and aided by a grant from the Biodiversity Condition and Advice Fund. John MacIntosh comments on considerable improvement of the bush protected by stock-proof fencing, and the thriving of native birds. Refer also to the Baxter property adjacent to the Onaia Ecological Area with its kokako population (see Cashmore et al. 2002)—AEB.]

Keywords: Manawahe Kokako Trust, kokako, *Callaeas cinerea*

Grimmett, R.F.R. 1929: Chemical control of ragwort: experimental work at Mamaku. *New Zealand Journal of Agriculture 39*: 382–384.

[Growth of weeds such as ragwort and thistle and reversion to bracken were amongst several reasons for the early restrictions and development of farming in the high-rainfall climate of the Mamaku Plateau—AEB.]

Keywords: ragwort, *Senecio jacobaea*, weed control, agriculture, farming, Mamaku Demonstration Farm

Grouden, V.J. 1993: Kaimai-Mamaku Forest Park historic resources inventory. *Bay of Plenty Conservancy Technical Support Series 19*. Department of Conservation, Rotorua. 96 p.

[A summary on p. 95 notes that the survey has revealed 'a wealth of historic material within the northern part of the Kaimai-Mamaku Forest Park' and that the information needs to be implemented in terms of practical recreation and conservation management as a long-term project. The figures comprise both historic and recent photos, sketches and scale drawings of sites and artefacts from former sawmilling, logging and mining operations. Features described and illustrated include camp and mill sites, tramways, and logging machinery. Interpretation is offered or suggested for recreational interest and conservation significance. The Mamaku Plateau region is not included, although the northern Kaimai survey offers information that will be useful in covering historic milling and logging operations in the southern part of the Park. For comparable milling and logging operations in indigenous forest of the Mamaku Plateau, including accounts of the people involved, see Jennings (1994), Department of Conservation (1997c) and Somervell (2004)—AEB.]

Keywords: Kaimai Mamaku Forest Park, archaeology, historical resources, inventory, logging—indigenous forests, sawmilling

Harris, R.W. 1976: Commercial forestry operations—Mamaku range: Waihou River catchment part 'Mountain Zone' Waihou Valley scheme. Hauraki Catchment Board and Regional Water Board, Auckland (unpublished). 21 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: water resources, forestry—erosion, soil investigation, erosion—forestry: roading and earthworks

Harris, R.W. 1979a: Preservation of the quality and availability of the waters from the Coromandel-Kaimai-Mamaku Ranges. Hauraki Catchment Board and Regional Water Board, Auckland (unpublished). 16 p.

[The main thrust of this paper is that extensive clearing of upland native forest for farming and conversion to exotic conifers after site preparation by burning could result in further deterioration of the water resources for the rapidly increasing populations in the lowlands. Two sections of the report are headed 'The Mamaku Range as a source of high quality spring and underground water' and 'The role of the native forest in preserving water quality and evening out stream flow'. In the Mamaku section, it is stated that 'The underground aquifers in the Mamaku Range, and the resultant spring flow represent at least half of the available dry weather stream flow in the Thames valley. These, or similar aquifers also constitute an important water resource in the Western Bay of Plenty area, including Rotorua city water supply'.

Much remains to be learnt about the mechanics of these aquifers and the mode of recharge.

The author considers that forest conversion operations must damage the existent high-quality stream flow. At the time this report was written, clearing of cutover native forest of the Mamaku Plateau and burning to prepare the land for establishment of exotic forests was in full swing, with several thousand hectares converted to exotic plantations—ultimately amounting to some 15 000 ha. Concerns were expressed at this time about the use of fire for land clearing and about sediment washed into entrenched streams from road works and logging operations (AEB, pers. obs.).

Burning was later abandoned for clearing sites destined to be planted with exotic conifers. Recommendations include preservation of the remaining native forests, measures to control siltwash from existing roads and investigations into factors that could affect the underground aquifers of the Mamaku Plateau. For investigations into water resources of the western Mamaku Plateau, see Dell (1982a, b)—AEB.]

Keywords: water quality and availability, water resources, Kaimai Mamaku Forest Park, land use changes, clearing of indigenous forest, conversion of indigenous forest

Harris, R.W. 1979b: Waihou valley scheme: Mountain zone, Mamaku Plateau—N.Z. Forest Products Operation. Hauraki Catchment Board and Regional Water Board, Auckland (unpublished). 2 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: water resources, forestry—erosion

Harris, R.W.; Hansen, P.V. 1979: Forestry operations—Mamaku range: Report No. 2—Erosion and water quality assessment. Hauraki Catchment Board and Regional Water Board, Auckland (unpublished). 20 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: water resources, forestry—erosion, vegetation, soil investigation, erosion—forestry: roading and earthworks

Healy, J. 1963: Geology of the Rotorua District. Vulcanicity and vegetation in the Rotorua District: a symposium. *Proceedings of the New Zealand Ecological Society10*: 53–58.

[The author's introduction in full:]

The Rotorua district is 3500 square miles in area, extending north from Maroa and Murupara to the Bay of Plenty coast between Matata and Tauranga. The Taupo Volcanic Zone, which lies as a belt north-east from Ruapehu to White Island, passes through the centre of the area. In this account the rocks have been divided into a number of groups on a lithologic basis, and their distribution and approximate age range are shown in figure 1. These groups do not include Late Quaternary volcanic ash, which mantles the entire area superficially and in places is more than 40 ft thick.

Keywords: geology, Taupo Volcanic Zone, volcanicity, Mamaku Ignimbrite, pumice flows, volcanic ash, Patetere Plateau

Healy, J.; Schofield, J.C.; Thompson, B.N. 1974 (reprinted 1975): Geological map of New Zealand. Sheet 5, Rotorua. Scale 1:250 000. Geological Survey Division, New Zealand Department of Scientific and Industrial Research.

[Geological map of Rotorua area, including Mamaku Plateau—BRC.]

Keywords: geology, geological map

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*. 87 p. plus maps.

[The locality map of the study area indicates that soil-forming members of the volcanic ash beds described reached the Mamaku Plateau; these ash showers included Mamaku Ash, Rotorua Ash and Kaharoa Ash. Eruptive sources are given and pocket maps show isopachs (stratigraphic rock thickness contours)—BRC.]

Keywords: volcanic ash, geology, soils

Herbert, J.H. 1975: The forest and shrubland associations in the proposed Pukerimu Biological Reserve. *Indigenous Silviculture Report No 14*. Forest Research Institute, Rotorua (unpublished). 14 p. plus maps.

[This report analyses the vegetation in the Pukerimu Reserve (now an Ecological Area) in the southwest corner of the Mamaku Plateau and Horohoro State Forest. The proposed reserve is 72 ha in extent at an altitude of c. 500 m a.s.l. and is now surrounded by pine plantations. About half the study area surveyed in 1973 is virgin forest, dominated by rimu with other podocarps, in which five high forest associations are recognised. In the rest of the area, three seral type associations and five scrub associations are recognised.

This fine typing is obtained by the use of a numerical (computer-based) technique, applied to data from non-area plots in the field survey, and the 13 associations are easily recognised in the field. Soils, topography and climate are briefly described; Taupo pumice (15–30 cm in depth) and Waimihia lapilli make up the top 40 cm of the soil profile and lie over older ash showers and ignimbrite. The history of the vegetation is outlined, with information provided by John Nicholls. The Pukerimu Forest appears to lie in the transition zone between complete forest destruction (as a result of the Taupo eruption) and the unaffected forests to the north. Mature tawa and tawari are scarce at Pukerimu, although prominent in the rimu-tawa forest, which is characteristic of the forests of the central and northern Mamaku Plateau. It is suggested that the Pukerimu area was affected but not devastated by volcanic ash and lapilli erupted from the East Taupo region. In comparison with the more northern forests, the Pukerimu forests are characterised by the virtual absence of rata and a greater density of podocarps. Fires destroyed the forest around Pukerimu from Maori times until recently.

A species list, arranged by life form and totalling 147 vascular species, is provided in a table, which gives the frequency of species occurring in each association. Detailed accounts are given of the 13 plant associations within broad community classes: Class 1 is high forest with podocarps dominant; Class 2 contains seral association of kamahi poles with podocarp regeneration or podocarp ecotones; and Class 3 has scrub associations. Possible developmental sequences following the destruction of existing vegetation are shown diagrammatically.

The same numerical typing technique was applied in Rotohokahoka Biological Reserve (now included in an extended Mokaihaha Ecological Area). This survey area contains 'the more typical mixed podocarp-hardwood forest of the plateau', a forest class representing a basically rimu-tawa-kamahi community with many minor variations, so that communities were not recognisable in the field in the Rotohokahoka Reserve—AEB.]

Keywords: Pukerimu Biological Reserve, Mamaku Plateau, Horohoro Forest, vegetation survey, vegetation

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

[This catalogue lists titles by authors, and a dozen items relevant to the Mamaku Plateau (mainly on planting podocarps) are annotated in this bibliography; these articles include division and project records and an occasional file note by John Nicholls recording proposals for Ecological Areas and reserves on the Mamaku Plateau from 1968 to 1985. The file notes collated in FRI file 31/6 with extensions are now held by Landcare Research in Hamilton—AEB.]

Keywords: Mamaku Plateau, planting trial, Ecological Area—proposals, podocarp—phenology, forest ecology

Hill, R.; Tonkin, P.; Almond, P. 1998: The origin, character and distribution of pumiceous Taupo deposits in an upland environment, Mamaku Plateau. Geological Society of New Zealand and New Zealand Geophysical Society, joint annual conference, 30 November – 3 December 1998. 176 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: Mamaku Plateau, geology, Taupo Volcanic Zone, Taupo Pumice, volcanicity

Hill, R.; Tonkin, P.; Almond, P. 1999: A revised soil stratigraphic interpretation of the geomorphology and Late Quaternary erosion history of the southern Mamaku Plateau. Geological Society of New Zealand annual conference 1999, 29 November – 1 December, Massey University, Palmerston North. 179 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: soils, geology, erosion, loess, tephra, Taupo Volcanic Zone, volcanicity

Hill, R.; Tonkin, P.; Almond, P. 2000: A soil-stratigraphic interpretation of the Late Quaternary geomorphology and erosion history of the southern Mamaku Plateau, central North Island. Geomorphology Wanaka 2000: 9th Australia New Zealand Geomorphology Group (ANZGG) Conference. 106 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: soils, geology, erosion, loess, tephra, Taupo Volcanic Zone, volcanicity

Hoare, R.A. 1982: Nitrogen and phosphorus in the Ngongotaha Stream. *New Zealand Journal of Marine and Freshwater Research 16*: 339–349.

[From the author's abstract:]

This paper gives the data and methods used to calculate the nitrogen and phosphorus loads of the Ngongotaha Stream, near Rotorua, New Zealand. The variations in concentration with time and with flow rate are given in some detail, as examples of what may happen in other streams of the central volcanic plateau, and a novel way to define a flow-concentration curve is described.

Keywords: Ngongotaha Stream, nitrogen, phosphorus, floods, water quality

Hobbs, J.E. 2004: A note on the mistletoe *Ileostylus micranthus* in the Kaharoa Area. *Rotorua Botanical Society 43*: 31–33.

[This note records recent findings of the mistletoe *Ileostylus micranthus* in a number of localities along with the identity of host plants, including both indigenous and introduced trees and shrubs. Dense infestations of tawa were found at two localities on farmland. The largest population has been enclosed by a fence and the enclosure planted with native species. Tawa has been recorded as a host tree near Kaharoa and Mamaku. This mistletoe was common by shores of the Rotorua Lakes in the 1960s (AEB, pers. obs.)—AEB.]

Keywords: mistletoe, *Ileostylus micranthus*, Kaharoa

Hosking, G.P. 1986: Beech death. *What's New in Forest Research No. 140*. Forest Research Institute, Rotorua. 4 p. Includes illustrations.

[Following a broad survey of beech death in North Island forests, a concise account is given of hard beech decline on the Mamaku Plateau (see annotation for Hosking & Hutcheson 1986). Colour photos show severe tree decline in a Mamaku hard beech stand, and insects that contribute to defoliation.

A perspective is given of 'a three factor concept of stand deterioration'—predisposing factors (such as stress by age or sites), inciting factors (such as drought or wind) and contributing factors (such as insect or fungal attack) leading to stand decline. The Mamaku hard beech decline fits this concept of stand deterioration, with soil water loss a predisposing factor, drought an inciting factor, and insect and fungal attack contributing factors. This concept might be considered for the dieback or decline of large kamahi and emergent rata on the Mamaku Plateau, with possum defoliation being a contributing factor (AEB, pers. obs.)—AEB.]

Keywords: hard beech, *Nothofagus truncata*, hard beech—decline, Mamaku Plateau, drought, defoliation, insect and fungal attack

Hosking, G.P.; Hutcheson, J.A. 1986: Hard beech (*Nothofagus truncata*) decline on the Mamaku Plateau, North Island, New Zealand. *New Zealand Journal of Botany 24*: 263–269.

[From the authors' abstract:]

An investigation into the decline of hard beech on the Mamaku Plateau showed tree death to be due to a loss of new foliage over successive seasons. Severely affected trees shed more than 30% of newly flushed foliage as a result of attack by the leaf-mining weevil *Neomycta pulicaris* with further losses from attack by the tineid moth *Heliostibes vibratrix*. Growth and climatic data suggest decline was initiated by drought, with worst affected stands on sites with lowest soil moisture retention capability.

[Four study sites are shown in a location plan. Site one is described as a healthy site of pure hard beech on a terrace site above the Umurua Stream (in Umurua Scenic Reserve). The other three sites, in which beech showed different degrees of decline, were each near Capricorn Road, Leslie Road and Tunnel Road, where some strips or valleys of cutover indigenous forest were retained while the rest of the easier terrain was cleared, burned and converted to plantations of radiata pine in the 1970s. Possum browsing was not a factor in hard beech decline; faecal analysis showed only kamahi, tawa and rata in their diet—AEB.]

Keywords: botany, hard beech, *Nothofagus truncata*, hard beech—decline, drought, defoliation, leaf miner, forest decline

Hudson, J. 2005: Opuiaki kokako survey, March 2005. Ecosystem restorations. Unpublished report for Tauranga Area Office, Department of Conservation, Tauranga.

[This 15-day survey was the fifth to include the Opuiaki Ecological Area. A total number of 31 kokako were located, and territories and nests were mapped. The recorded kokako population consisted of six pairs, four chicks, 14 singles and one 'sub adult'. The results from four previous surveys of different forest areas on the Mamaku Plateau are outlined by Crook et al. (1971), Crook (1975), Wills (1997) and Buckingham et al. (2000). The author concludes that 'the 2004 and 2005 kokako surveys have shown that the population at Opuiaki still remains extremely vulnerable to extinction'. Pest control measures using 1080 poison in cereal pellets at bait stations, which were first used at Opuiaki in the spring of 2003, were successful in reducing rat and possum populations in the Waipapa/Opuiaki catchments. Recommendations are made to continue animal control for several seasons and to either monitor nesting attempts by the known six breeding pairs or to undertake a post-breeding survey to ascertain population trends. A falcon's nest was found and increased kaka activity was recorded. North Island robins were abundant and few whiteheads were detected—AEB.]

Keywords: kokako, *Callaeas cinerea*, kokako—survey, kokako—breeding, pest control—possum and rat, falcon, *Falco novaeseelandiae*, kaka, *Nestor meridionalis*, toutouwai, North Island robin, *Petroica australis*, whitehead, *Mohoua albicilla*, Opuiaki Ecological Area

Hunt, K. 2001: Survey and monitoring in the Rotorua Lakes Area, Bay of Plenty Conservancy: Volume II Appendices (draft). Bay of plenty Conservancy, Department of Conservation, Rotorua (unpublished).

[This is a compilation of biodiversity information on land parcels administered by DOC within the Rotorua Lakes Area. It includes botanical and fauna conservation rank (measures for conservation management prioritisation), flora and fauna lists, information on threatened species, references to vegetation maps, and threats to protected areas, including introduced pest plant and animal species. While Volume II was completed in draft form, Volume I (the summary) of this set was not completed by 2001, although it is now in draft form. Volume II provides the inventory on each land parcel, excluding topographic maps. The land parcels administered by DOC in the Mamaku Plateau area (c. 2005) include those listed as keywords below (refer to Fig. 1 for key land parcels)—BRC.]

Keywords: biodiversity, inventory, conservation, Mamaku Forest, Leslie Road Stewardship Area, Arahiwi Scenic Reserve, Arahiwi Stewardship Area, Tukorehe Scenic Reserve, Takapuhurihuri Stream Marginal Strip, Horohoro Forest, Mangorewa Forest, Mangorewa Ecological Area, Arahiwi Access Stewardship Area, Mamaku Scenic Reserve, Arahiwi Railway Scenic Reserve, Mamaku Stewardship Area, Tarukenga Scenic Reserve, Dansey Road Scenic Reserve, Mangorewa Conservation Area, Mangapouri Scenic Reserve, Mangapouri Stream Marginal Strip, Ngongotaha Stream Marginal Strip, Umurua Stream Marginal Strip, Mt Ngongotaha Scenic Reserve, Utuhina Stream Marginal Strip, Tihiotonga Stewardship Area, Otamaroa Stream Marginal Strip, Umurua Scenic Reserve, Pukerimu Stream Ecological Area, Pokaitu Stream Marginal Strip, Taahungatara Stream Marginal Strip

Jane, G.T. 1979: Forests and animals of the Rotorua Lakes and Mamaku Regions. New Zealand Forest Service, Rotorua (unpublished). 38 p. plus maps and photos.

[Two of the four regions surveyed for animal sign and forest composition comprised 'Mamaku and Horohoro regions' as shown on maps, including eastward extensions from the former State Forests on the Mamaku Plateau. A brief general description of the regions summarises information from NZFS working plans.

Only isolated red deer were found to occur on the Mamaku Plateau, although possums were prevalent, particularly in disturbed and seral forest. Liberation years are noted as 'probably about 1920 at Ngongotaha and Arahiwi'—see Pracy (1974), who believed that there had been widespread unauthorised liberations in New Zealand. Tawa forest predominates in the wetter areas such as the crest of the Mamaku Plateau where tawari is often associated.

The Horohoro region includes residual indigenous forest south of SH5 on the Mamaku Plateau, and includes some of Horohoro State Forest, some scenic reserves, Mt Ngongotaha, and some areas of private forest along the rim of the Rotorua Basin, extending southeast towards SH30. There may have been some colonisation by red deer from the south, as deer pellet frequencies in the southeast are mapped as 5–10%, but less than 5% elsewhere. Possum

pellet frequencies are also mapped as 5–10% in the southeast extension and part of the headwater of the Ngongotaha Stream, although less than 5% in the virgin forest of Mokaihaha and on Mt Ngongotaha. There was a small goat population on Mt Ngongotaha.

The Mamaku region surveyed includes most of the northern part of the Plateau in State Forest and some private land towards the Kaimai foothills. Deer numbers were generally low and possum numbers highest in recently logged forest. No other browsing animals are recorded on maps, except in two small enclaves, where a low presence of cattle sign was found in the headwaters of the Waiwhakarewarewa and Waipapa Streams.

Summaries of forest types are given in tables for the two regions. The author concludes that erosion risk was slight over the four regions surveyed, and forest depletion was usually light (although kamahi crowns may have declined). There is no reference to indigenous wildlife—AEB.]

Keywords: browsing animals—survey, Mamaku Plateau, Horohoro, forest composition, possum, *Trichosurus vulpecula*, red deer, *Cervus elaphus*, forest ecology, cattle, *Bos taurus*

Jane, G.T.; Green, T.G.A. 1983: Episodic forest mortality in the Kaimai Ranges, North Island, New Zealand. *New Zealand Journal of Botany 21*: 21–31.

[Authors' précis:]

Investigations of the upland vegetation of the Kaimai Ranges have revealed widespread mortality affecting a wide range of species and forest types. The mortality is not caused by browsing by introduced mammals, although they can be shown to have slowed recent forest recovery. Dendro-chronological data define 2 mortality episodes closely linked with severe droughts which occurred in 1914 and 1946. Continued ill-thrift in the surviving vegetation and slow growth in the seral forests is the result of complex causes which include changes in soil water table, increased exposure of residual trees, low nutrient status of the soils, and attacks by pathogens. On steeper slopes the mortality appears to have contributed to a period of increased erosion, and for this reason further study of the return frequency of the periods of mortality may enable the frequency of the erosion episodes to be determined. The association of drought with the primary causes of the mortality suggests that it may be an under-rated ecological factor in these temperate evergreen forests.

[The study region lies to the north of the Mamaku Plateau with steeper slopes and different soils. For drought-related decline of hard beech on the Mamaku Plateau, see Hosking (1986), which includes a comment on the continuing decline of large rata and kamahi in Mamaku forest as well as other central North Island forests—AEB.]

Keywords: research, dendrochronology, drought, erosion, browsing animals, beech forest, *Nothofagus* spp., forest decline

Jennings, S. (Ed.) 1994: Mamaku: 100 years. Mamaku Centennial Committee, Rotorua. 82 p.

[An anecdotal and well-illustrated account of Mamaku township from the arrival of the first settlers in 1894, when the railway to Rotorua was opened and the first sawmill was built on the site of the present township. Logging of the rimu/tawa forest on the central Mamaku Plateau was started in 1888 by the Steele brothers. An outline is given of the development of logging methods, from the hauling of logs by bullocks to the use of steam haulers and construction of tramways.

Sir Charles Fleming visited the Mamaku Forest from boyhood in the 1930s to see the birdlife, and heard the notes of the kokako for the first time. He also found molluscs on the old hauler tracks and observed that extraction of logs by hauler caused less damage to the forest than the later use of tractors (see McEwen 2005).

Tawa was used as fuel for the steam-driven haulers and logging trams, although little wood was extracted before its use for pulpwood in the 1970s, following which clearfelling, burning and conversion to radiata pine plantations occurred. Thus, the cutover forest that Fleming saw often had an almost closed canopy of tawa, and an understorey and ground vegetation unaffected by browsing of deer, while there were fewer or no possums in the 1930s to damage canopy trees or shrubs—AEB.]

Keywords: logging—history, sawmilling, Mamaku townships, podocarp/tawa forest, kokako, *Callaeas cinerea*, conversion of indigenous forest

Jerram, J.V. 1974: Man's inhumanity to nature. *Forest & Bird 194*: 9–10.

[This article protests at the extensive conversion of logged indigenous forest to radiata pine plantations on the Mamaku Plateau, with clearing and burning viewed from Leslie Road. Tawa that remained after early removal of podocarps was being logged for pulpwood with the Crown land leased to NZ Forest Products Ltd, disposing of trees that could have sustained part of our requirements for flooring, panelling and furniture for many years. Felling and erosion had resulted in mud debris in an adjacent stream (in the catchment of the Waipari). This scene is contrasted with the Tukorehe Scenic Reserve (also known as Fitzgerald Glade) by the Tirau-Rotorua highway—AEB.]

Keywords: clearing of indigenous forest, Mamaku Plateau, conversion of indigenous forest, radiata pine, *Pinus radiata*, conservation, Leslie Road, Fitzgerald Glade, Tukorehe Scenic Reserve, tawa—logging, *Beilschmiedia tawa*.

Kennedy, N.M. 1987: Late Quaternary loess deposition (c. 200,000 yrs bp–c. 15,000 yrs BP) on the Mamaku Plateau North Island, New Zealand. In Eden, D.N.; Furket, R.J. (Eds): Loess: its distribution, geology and soils: Proceedings of an International Symposium on Loess, New Zealand, 14–21 February 1987.

[The Mamaku Plateau, which is 1250 km^2 in area and at an elevation of 150–650 m a.s.l., is largely composed of welded and partly welded Mamaku Ignimbrite, which erupted c. 140 000 years BP (before present) from the location of Lake Rotorua. The Ignimbrite is capped by tephra and loess, except for loess-free parts of the Plateau where eroded hills or tors occur above an elevation of about 450 m a.s.l. The loess, which is up to 7 m thick, was derived from rhyolitic tephra during periods of cold climate. Palaeosols formed during warm periods. Various layers of loess are interbedded with tephra and palaeosols—BRC.]

Keywords: geology, loess, Mamaku Plateau—tephra, Mamaku Ignimbrite—tephra

Kimber, R.W.L.; Kennedy, N.M.; Milnes, A.R. 1994: Amino acid racemization dating of a 140 000 year old tephra-loess-palaeosol sequence on the Mamaku Plateau near Rotorua, New Zealand. *Australian Journal of Earth Sciences 41*: 19–26.

[The study material was obtained from a drill-core section of interbedded loess and predominantly rhyolitic tephra deposits, with associated buried palaeosols, from Tapapa on the Mamaku Plateau. 'The ages determined largely agree with previous estimates from tephrachronology. This technique may form a basis for dating of airfall deposits and palaeosols beyond the range of the radiocarbon method' (p. 19)—BRC.]

Keywords: earth science, geology, geological dating, tephra-loess-palaeosol sequence, Mamaku Plateau

King, C.M.; Innes, J.G.; Flux, M.; Kimberley, M.O. 1996a: Population biology of small mammals in Pureora Forest Park 2. The feral house mouse (*Mus musculus*). *New Zealand Journal of Ecology 20*: 253–269.

[From the authors' abstract:]

Over five years from November 1982 to November 1987, we examined 395 mice collected from unlogged and logged native forest and from exotic forest at Pureora Forest Park, in the central North Island of New Zealand.

[See also King et al. (1996b) below on the distribution and abundance of small mammals. These articles are likely to be relevant to other central North Island indigenous forests, such as those of the Mamaku Plateau (AEB, pers. obs.)—AEB.]

Keywords: mammals, rodents, mouse, *Mus musculus*, mustelids, cat, *Felis catus*, hedgehog, *Erinaceus europaeus*, forestry, logging, conservation, kokako, *Callaeas cinerea*

King, C.M.; Innes, J.G.; Flux, M.; Kimberley, M.O.; Leathwick, J.R.; Williams, D.S. 1996b: Distribution and abundance of small mammals in relation to habitat in Pureora Forest Park. *New Zealand Journal of Ecology 20*: 215–240.

[From the authors' abstract:]

Populations of ship rats (*Rattus rattus*), Norway rats (*R. norvegicus*), feral house mice (*Mus musculus*), stoats (*Mustela erminea*), weasels (*M. nivalis*), and ferrets (*M. furo*) were sampled with killtraps every three months from November 1982 to November 1987 in logged and unlogged native forest and in exotic plantations of various ages at Pureora Forest Park, central North Island. Mice (n=522 collected) were fewest in unlogged native forest, more abundant in road edge cutover forest, and most abundant in a young (5–10 year old) plantation. Traps catching most mice were set in dense ground cover under a low, sparse canopy. Ship rats (n=1793) were absent from the young plantation, present although not abundant in older exotic forest, and abundant in all native forest regardless of logging history. Traps set on warmer, steeper sites caught most ship rats, and those set in early successional habitats caught fewest. There was a marked reciprocal relationship between the distributions of ship rats and of mice: the proportion of mice in the total catch of rodents decreased significantly at the least disturbed forest sites (P<0.001). Most (81%) Norway rats (n=43) were caught in a single trap in unlogged native forest on the bank of a stream. Stoats (n=57) were most abundant in the older exotic plantations; weasels (n=16) in the young plantation and along road edges in native forest; and ferrets (n=11) in unlogged native forest. Hedgehogs (n=290) were common in unlogged native forest far from any roads and also in older exotic forest. Our data suggest that selective logging and conversion to exotics have different effects on each of the six species we monitored. We hypothesise that (1) selective logging is likely to stimulate temporary increases in the numbers of mice and weasels, although not rats or stoats, and (2) after conversion to exotic forest, mice and occasionally weasels will be abundant at first although will gradually be replaced by ship rats and stoats as the forest matures.

[Notes a personal communication from G.W. Hedderwick: 'It was well known to plantation foresters in the central North Island and the Mamaku Plateau that mice were likely to be abundant for a few years in cleared patches of any forest type, but they would disappear after the canopy closed' (p. 233). By this, it is assumed that the authors mean that mice are still present although become substantially less conspicuous—BRC.]

[The summary is likely to be relevant to other central North Island indigenous forests, such as those of the Mamaku Plateau. See also King et al. (1996a) above on the feral house mouse. From personal experience with site preparation trials in Horohoro Forest in the mid-1960s, there appear to be some comparable situations between this forest and study areas at Pureora (AEB, pers. obs.). After clearing and burning cutover indigenous forest at Horohoro, there was an irruption of field crickets, followed by large numbers of mice (shown by trapping). In contrast, these phenomena were not

observed after 2 years with the planting of radiata pine and weed succession from grasses and 'fireweeds' through to canopy closure (see Knowles 1970). Rabbits and hares became common on new roadsides and grassy clearings, and ferrets were occasionally seen on open, burned sites. Possums were the main browsers of newly planted Douglas fir (shown by stomach contents of poisoned possums)—AEB.]

Keywords: mammals, rodents, mouse, *Mus musculus*, mustelids, cat, *Felis catus*, hedgehog, *Erinaceus europaeus,* forestry, logging, conservation, kokako, *Callaeas cinerea*

King, D.R. 1983: Tarukenga Scenic Reserve: main habitats and features, species list. Department of Scientific and Industrial Research, Rotorua (unpublished). 4 p. plus sketch plan.

[Tarukenga Scenic Reserve is an unfenced area of heavily logged, reverting cutover forest marginal to SH5. Roadside margins have been disturbed by public works, resulting in areas of bracken, grasses and adventive weeds. Considerable damage has been caused by stock trespass, with further disturbance by removal of tree ferns and dumping of rubbish. The matrix of the reserve consists of varying densities of residual tawa with three forest types, which are described as tawa, tawa/kamahi and kamahi. Restoration planting with local indigenous shrubs and trees is suggested for road margins. The species list is arranged alphabetically, and includes 97 indigenous species and 15 adventive species—AEB.]

Keywords: Tarukenga Scenic Reserve, cutover indigenous forest, restoration planting, species list, vegetation types

King, D.R. 1984a: Botanical survey of Dansey Road Scenic Reserve: main habitats and features. Department of Scientific and Industrial Research, Rotorua (unpublished). (Copy held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua; Old File RSC-003.) 6 p.

[This article records the plant species and general vegetation types found within the Dansey Road Scenic Reserve. A sketch plan shows the location of the reserve, which consists of narrow strips of disturbed forest beside the Rotorua-Morrinsville Railway and is flanked by Dansey Road along its eastern margins. The locations of seven vegetation types described in the text are indicated in the plan. The major type is described as virgin rimu/tawa-kamahi forest with dense tree ferns, scattered hinau and miro. Other types consist of small areas subjected to some form of past disturbance: tawa-rewarewa-kamahi forest with scattered emergent rimu left by past milling with some mangeao and hinau; tawa-rewarewa-tawari forest on a ridge top with tanekaha and toatoa along a gully fringe; four other types, which are described as shrubland, grassland, kale herb field and shrub fernland, mainly along roadside or railway; and mahoe/wheki-pate forest in steep-sided gullies. Kiekie occurs locally on top of a railway embankment.

A species list is attached for native and adventive species. Part of the reserve at its western end is leased to farmers and used for grazing and cropping.

Winter grazing by cattle of forest adjacent to farmland on the Mamaku Plateau has been a common practice in the past. This reserve provides a scenic corridor for the railway and Dansey Road, although domestic rubbish has accumulated along the Dansey Road margin, another common practice in the district—AEB.]

Keywords: botany, Dansey Road Scenic Reserve, vegetation types, species list, rimu/tawa-kamahi forest

King, D.R. 1984b: Botanical survey of Mangapouri Scenic Reserve: main habitats and features. Department of Scientific and Industrial Research, Rotorua (unpublished). (Copy held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua; Old File RSC-003.) 6 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: botany, Mangapouri Scenic Reserve—botanical survey, species list

King, D.R. 1984c: Umurua Scenic Reserve: main habitats and features, species list. Department of Scientific and Industrial Research, Rotorua (unpublished). 2 p. plus sketch plan.

[This 12-ha reserve is unfenced and has a surround of comparable cutover forest on steep ridges and valleys. The main habitats and features are two forest types of tawa-rewarewa with kamahi and tawheowheo in the canopy, and tanekaha with toatoa and tawari on ridges. A moss field is associated with a waterfall in the Umurua Stream. Stock trespass has occurred, although is considered to be limited. Species are listed in alphabetical order—AEB.]

Keywords: Umurua Scenic Reserve, species list

Knowles, B. 1970: The autecology of bracken. *Indigenous Silvicultural Report No. 5*. Forest Research Institute, Rotorua (unpublished). Part 1. A literature review and discussion. 22 p. plus 158 references. Part 2. A preliminary investigation into regeneration from spores. 23 p.

[A field study of bracken regeneration after burning off slash from clearing of indigenous cutover forest was carried out on two sites in FRI experimental areas on the central and southern parts of the Mamaku Plateau (Mamaku and Horohoro forests) over a 19-month period. It was found that bracken spores were dispersed to burnt sites from patches of established bracken in small clearings nearby, and germinated in abundance to produce the small, flattened prothalli (3 mm across) that bear sex organs and spore-bearing plants, ultimately producing the rhizomes that spread mature bracken plants and survive fires. Germination of bracken spores occurs rarely overseas, where spread is generally by vegetative means. The development of the bracken

prothallus and spore-bearing plant is described from field and laboratory studies, and it is shown that the establishment of the adult bracken plant is dependent on a large number of interacting variables, the most significant of which are frost, adequate rainfall, features of macro- and micro-topography, and competition from *Marchantia* (a liverwort) and other weeds. At the central Mamaku site, possums appeared to be responsible for browsing of the tips of tender, new bracken fronds, especially those from the new, spreading rhizomes. Rabbits and hares were absent from this site, although they were present at the Horohoro site.

Weed growth and succession is described on both sites from June 1968, several months after the burns. By the following summer, a dense herbaceous weed cover (mainly composites) had developed, firstly with Scotch thistle (*Cirsium vulgare*) or *Senecio sylvaticus* dominant, and then Australian fireweed (*Erechtites atkinsoniae*) and fleabane (*Erigeron* spp.), both up to 2 m tall. In the second summer, Yorkshire fog (*Holcus lanatus*) was dominant on flat areas and ragwort was widespread, as well as toetoe (*Cortaderia fulvida*) on the Horohoro site, where it became abundant in the third year. The indigenous shrubs wineberry, fuchsia, pate and narrow-leaved mahoe (*Melicytus lanceolatus*) were killed by frost on bare, open ground, although survived and developed in the more sheltered microclimate around stumps and in slash heaps.

Bracken started to appear in the first year after burning, was up to about 15 cm high in patches around stumps and in slash heaps during the second year, and extended from these colonising centres to occupy 10–20% of the site in the fourth year.

This account of bracken has been extensively quoted in a recent general review (McGlone et al. 2005[9]) and could be a useful reference if supervised burning is carried out on selected sites to induce bracken and thus provide early succession for the development of indigenous vegetation in some forest restoration schemes—AEB.]

Keywords: bracken autecology, succession after fire, forest restoration

Knowles, B.; Beveridge, A.E. 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.

[From the authors' abstract:]

Morphological and anatomical descriptions of *Beilschmiedia tawa* are given together with information relevant to its ecology, a distribution map based on its presence or absence in grid squares, and bibliographic references to other information. *B. tawa* is one of the main canopy-forming trees in the lowland and low hill forests of the North Island and is also one of the main merchantable hardwoods. It has a good capacity to regenerate in shade or small canopy gaps, although is sensitive to exposure, tending to deteriorate in intensively logged forests.

---

[9] McGlone, M.S.; Wilmshurst, J.M.; Leach, H.M. 2005: An ecological and historical review of bracken (*Pteridium esculentum*) in New Zealand, and its cultural significance. *New Zealand Journal of Ecology 29(2)*: 165–184.

[This general account of tawa has a number of references to its regeneration, growth rates, seed production, vegetative reproduction, habitat preference and ecology on the Mamaku Plateau, where it was a dominant canopy species in the original forest and has retained dominance on its preferred sites since the logging of podocarps. In partially-logged forest, there are groups of tawa of all sizes in residual forest patches, usually on higher ground, and tawa regenerates both from seed and the coppice growth of crushed or fallen stems.

This article contains a brief reference to small trials to assess tawa seedfall and germination on the Mamaku Plateau and in other central North Island forests indicate that seed crops are annual, although subject to considerable fluctuations in abundance and germination success. Flowers produced in spring take 18 months to produce ripe fruits, which fall in March on the Plateau. In the summer before seedfall, the half-developed fruits in Horohoro Forest have been observed to be opened (presumably by possums) with extraction of the soft kernels (AEB, pers. obs.). In forests such as those on the Mamaku Plateau, where there is a wide range of plants preferred by possums, tawa seeds from fallen mature tawa fruits are not eaten by possums as they are at Whirinaki. Ship rats do not eat tawa seed in the forest or in caged trials (Beveridge 1964[10]).

In Mamaku forests partially logged for podocarps, immature fruits on exposed tawa crowns have been observed to drop prematurely in mid-summer (AEB, pers. obs.) owing to withering of pedicels. Tawa regeneration does not occur frequently in large canopy gaps or on the compacted soil of log extraction tracks; instead, it occurs in small canopy gaps. Although seedlings persist in shaded conditions, they are slow to gain height (see Pardy & Steward (1989) for growth in a Mamaku trial). The main tree species associated with tawa in partially-logged forest on the Mamaku Plateau are kamahi, tawari and hinau.

Annotations for this paper have previously been made for aspects of tawa ecology relevant to Pureora and Whirinaki forests—item 151 in the Pureora bibliography (Beveridge et al. 2000) and item 104 in the Whirinaki bibliography (Beveridge et al. 2004). See Smale (1981) for growth rates and mortality of tawa in Mamaku transects—AEB.]

Keywords: tawa—ecology, *Beilschmiedia tawa*, regeneration, seed production

Land Information New Zealand 2000a: Topographic Map 260-U15, Ngongotaha. 1:50 000. Land Information New Zealand.

[This map includes the eastern part of Opuiaki Ecological Area and the location of an ecological transect by the Waiwhakarewarewa Stream. Possible indigenous forest corridors for movement of birds eastward from Opuiaki Ecological Area to the upper catchments of the Mangapapa and Mangorewa Rivers are apparent. See Bergin (1991) for rehabilitation of one such corridor—the Mangorewa-Kaharoa corridor—AEB.]

Keywords: Opuiaki Ecological Area, bird corridor, topographic map, indigenous forest—corridor, Ngongotaha

---

[10] Beveridge, A.E. 1964: Dispersal and destruction of seed in central North Island podocarp forests. *Proceedings of the New Zealand Ecological Society 11*: 48–55.

Land Information New Zealand 2000b: Topographic Map 260-U16, Rotorua. 1:50 000. Land Information New Zealand.

[This map shows how Mokaihaha Ecological Area is surrounded by exotic conifer plantations (mainly radiata pine and Douglas fir), leaving a narrow corridor of indigenous forest east of South Road to the headwaters of the Utuhina and Ngongotaha Streams. Radiata pine has been established in parts of the catchments of these streams and others flowing into Lake Rotorua. The headwaters of most of the streams over the rest of the former Horohoro State Forest to the southern Mamaku Plateau are covered with first or second rotations of exotic forest, with a close network of forest roads—AEB.]

Keywords: topographic map, exotic conifer plantations, stream headwaters, forest corridor, conversion of indigenous forest

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

[A dozen items that make direct reference to Mamaku forests or the Kaimai Mamaku Forest Park are listed by Leamy & Hayward (1986) and are annotated in this bibliography. There are also other items that refer to tawa, the dominant tree species of the Mamaku Plateau, or deal with principles or policies that have relevance for forest conservation, although these are not annotated here. Most of the items in the latter category are those dealing with the concepts of ecological reserves and include the reservation of New Zealand's indigenous State Forests for scientific reasons (item 1015—Bassett, and item 1356—Thomson & Nicholls); scientific reserves in State Forests (item 1016—Bassett & Miers); biological reserves and forest sanctuaries (item 1022—Forest Research Institute); and the concept of ecological districts (item 1258—Nicholls). See annotation for Nicholls (1978) for Ecological Area proposals for Mamaku Forest—AEB.]

Keywords: bibliography, indigenous forestry, reserve proposals, tawa, *Beilschmiedia tawa*, New Zealand Forest Service

Leathwick, J.R.; Hay, J.R.; Fitzgerald, A.E. 1983: The influence of browsing by introduced mammals on the decline of North Island kokako (*Callaeas cinerea*). *New Zealand Journal of Ecology 6*: 55–70.

[From the authors' abstract:]

The diet of the North Island kokako (*Callaeas cinerea wilsoni*) was studied in three central North Island habitats, Pureora, Mapara, and Rotoehu, for three years. Possum (*Trichosurus vulpecula*) diet was less intensively studied for part of the same time in Pureora and Mapara. A literature review was made of the diet of possum, red deer (*Cervus elaphus*), and feral goat (*Capra hircus*). There is considerable overlap between the diets of kokako and the three mammalian browsers; leaves and/or fruit of some species are eaten by all four, e.g. mahoe (*Melicytus ramiflorus*), fivefinger (*Pseudopanax arboreus*), lawyer (*Rubus cissoides*), pigeonwood (*Hedycarya arborea*), and raurekau (*Coprosma australis*). Possums, red deer, and goats have

reduced the abundance of preferred kokako food plants in much of the remaining kokako habitat. The present distribution of kokako suggests that their decline has been caused not only by forest clearance and introduced predators, although also by impoverishment of habitat resulting from the introduction of browsing mammals.

[The authors note that within the Bay of Plenty's forests, kokako are still widespread and plentiful, forests are less modified by browsing mammals than in other parts of the North Island, and deer have been sighted on the edges of the Mamaku Plateau from early times. Kokako are still surviving in pockets of the Mamaku Plateau, chiefly Mokaihaha, Kaharoa, Rotoehu, Onaia and Opuiaki Ecological Areas, as well as a few birds within Mamaku Forest itself—BRC.]

[On the central Mamaku Plateau there were few deer from the 1960s to 1980s and an understorey of palatable plants has been maintained in some old-growth forests—AEB.]

Keywords: mammals, deer, *Cervus* spp., possum, *Trichosurus vulpecula*, possum—diet, goat, *Capra hircus*, vegetation, kokako, *Callaeas cinerea*, kokako—diet

Llewellyn, M. 1985: Wild animal distribution in the Rotorua Lakes & Mamaku Regions: 1983–84 animal survey results. New Zealand Forest Service, Rotorua (unpublished). 17 p. with illustrations, plus folded maps and appendices.

[Five survey regions were covered, two of these being Mamaku North and Horohoro, both on the Mamaku Plateau. The presence/absence method of faecal pellet counting on transects was used. The distribution of red deer, cattle and goats is shown on maps. This annotation refers only to the Mamaku Plateau forests, where red deer populations were assessed as low or very low in tracts of virgin podocarp/tawa forest, despite the presence of palatable understorey vegetation.

Possums were recorded as occurring everywhere in relatively low numbers, although pellet counts could have been affected by periods of high rainfall, which would have made it difficult to assess pellet decay rates. Trends in animal populations were assessed by comparing results of the 1983/84 survey with a previous survey on the same transect in 1978/79. The Mamaku North survey region extended east to the Mangorewa Gorge. While the western part is mainly virgin podocarp-tawa forest, intersected by gullies and gorges, the eastern part has exotic plantations and cutover forest dominated by tawa, and in some places tawa-beech associations. Average pellet frequency of red deer was a low 0.6% in 1984, as for the previous survey. A small population of wild cattle was found mainly around the Hiwiroa trig and in the Opuiaki River catchment. Low populations of goats have been culled in the Opuiaki catchment and near the Ngatuhoa Lodge. The Horohoro survey region is comparable to that of Mamaku North, with low numbers of red deer in virgin forest and extensive areas of exotic forest. The road through these plantations has given good access for hunters of pigs and deer and possum

trappers. Deer pellet frequency was 3.7%, comparable with the previous survey. There were some 'small and discrete mobs of goats' in Horohoro, although a population on Mt Ngongotaha was thought to have been recently destroyed—AEB.]

Keywords: wild animals, red deer, *Cervus elaphus*, sambar deer, *Cervus unicolor,* fallow deer, *Dama dama*, possum, *Trichosurus vulpecula*, dama wallaby, *Macropus eugenii*, pig, *Sus scrofa*, goat, *Capra hircus*, wild cattle, *Bos taurus*, Rotorua Lakes, Mamaku North, Horohoro

Logan, P.C.; Harris, L.H. 1967: Introduction and establishment of red deer in NZ. *Information Services No. 55.* New Zealand Forest Service, Wellington. 36 p. plus illustrated maps.

[This article records the liberations of red deer within the Rotorua Lakes District between 1905 and 1922. Some of the Lake Okareka herd were thought to have spread along the eastern shore of Lake Rotorua. See Jane (1979) for the suggestion of some colonisation of southern Mamaku Plateau from the south, noting that only isolated red deer were then found to occur on the Mamaku Plateau. Red deer were not observed during frequent visits by AEB to three FRI experimental areas in the Horohoro and Mamaku State Forests during the 1960s, although deer sign was increasingly observed in the 1970s, with occasional sightings of animals on farmland at forest margins. More recent evidence is that red deer populations have increased in Horohoro Forest, causing obvious damage in the Mokaihaha Ecological Area, which is surrounded by exotic forest plantations (see Marsh & Blake 1997), whilst deer appear to still be absent or scarce in the Opuiaki Ecological Area (see Owen 1999)—AEB.]

Keywords: red deer, *Cervus elaphus*, red deer—liberation, Horohoro Forest, Mamaku Forest

Long, C. 1987: Time and the forest. *Forest & Bird 18(2)*: 16–18.

[This article features the proposals of the Kaimai Action Group of the Kaimai National Park Promotion Council, and includes comments on the Conservation Act, which became law on 1 April 1987. Since 1972, local groups had been active in pressing for greater protection for forest in the Kaimai-Mamaku region, and the Mamaku outliers Puwhenua, Otanewainuku, Kaharoa and Rotoehu (where kokako were breeding). In 1987, burning of cleared indigenous forest for establishing radiata pine was still proceeding off Galaxy and Omanawa Roads. Following a visit by conservationists to burned parts of the Waipari-Kuhatahi valley in 1983, NZ Forest Products Ltd agreed to reserve remaining forests in these valleys (where kokako still survived)—AEB.]

Keywords: Kaimai National Park—proposal, Kaimai National Park Promotion Council, Kaimai Action Group, tourism, history, kokako—habitat, *Callaeas cinerea*, forest conversion

Lynch-Blosse, B.R. 1998: Ignimbrite stratigraphy of the southern Mamaku Plateau region, North Island, New Zealand. Unpublished MSc thesis in Earth Science, University of Waikato, Hamilton. 170 p.

[From the author's abstract:]

Geological mapping has been undertaken in the south-western Mamaku Plateau in an area to the south of Putaruru and bordering the Tokoroa Plateau, North Island. The stratigraphy of the region comprises rhyolitic ignimbrites, plinian-fall tephra deposits with interbedded volcaniclastic sediments, loess, and palaeosols. Ages of the deposits range from 1.21 Ma to 0.22 Ma, spanning much of the history of the TVZ [Taupo Volcanic Zone]. This thesis investigates the stratigraphy and petrography of the area and a detailed (1:25,000) geological map has been compiled.

Keywords: geology, Mamaku Plateau, Taupo Volcanic Zone, volcanicity, Mamaku Ignimbrite

Lynch-Blosse, B.; Briggs, R. 2001: Volcanic geology of the southern Mamaku Plateau. Geological Society of New Zealand annual conference 2001, 27–29 November, Hamilton. 133 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: geology, Mamaku Plateau, Taupo Volcanic Zone, volcanicity, Mamaku Ignimbrite

Manville, V. 2003a: Dissection of an ignimbrite plateau, aftermath of the 64 ka Rotoiti eruption, Bay of Plenty, New Zealand. P. 133 in: Proceedings of the XVI INQUA Congress, Reno, Nevada, July 24–30, 2003.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: Taupo Volcanic Zone, Rotoiti eruption, volcanicity, Mamaku Ignimbrite, geology

Manville, V. 2003b: Fire and water: Late Quaternary megafloods in the Taupo Volcanic Zone, New Zealand. P. 66 in: Proceedings of the XVI INQUA Congress, Reno, Nevada, July 24–30, 2003.

[From the author's abstract:]

The Rotorua caldera, formed at 220ka during eruption of the Mamaku Ignimbrite, contains both post-Mamaku lake sediments and extensive highland terraces developed after eruption of the Rotoiti Breccia from the adjacent Okataina caldera at 64ka again blocked the outlet.

Keywords: Taupo Volcanic Zone, megafloods, volcanicity, Mamaku Ignimbrite, geology

Marsh, S.; Blake, M. 1997: A survey for North Island kokako in the Mokaihaha Ecological Area and part Horohoro Conservation Area, Mamaku Plateau. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 16 p. plus maps of bird distribution.

[From the authors' abstract:]

During February, March and April 1997 a walk-through census of North Island kokako (*Callaeas cinerea wilsoni*) was carried out by the authors, to determine the status of kokako in the Mokaihaha Ecological Area and adjacent Horohoro Conservation Area. Fifty kokako were found, including 18 pairs, 13 singles and one confirmed juvenile. Results from this census were compared to previous Wildlife Service surveys, and the implications of introduced predators and browsers on long-term kokako viability within a podocarp/hardwood forest discussed. Recommendations on the future management of the forest for kokako and other endemic wildlife are made.

[The census covered the 1445 ha of Mokaihaha Ecological Area and 691 ha of adjacent conservation forest. Most of the forest north of the Tikitiki Stream was unlogged, mainly rimu/matai and tawa-kamahi forest types, with scattered emergent rimu above a tawa canopy (forest type M2 of Nicholls (1966)).

A forest type map is shown in appendix one, with plantations of radiata pine adjacent to or near all boundaries of the survey area, and partially-logged indigenous forest on the eastern side, between the Tikitiki and Pukerimu Streams south of the Ecological Area. Mean elevation of the study area is 650 m a.s.l. To survey the area, taped kokako song was played every 200–300 m along walk lines. 'The nucleus of the population—eight pairs and four single birds—is found in a 100 hectare area on the western side.' Other kokako occurred mainly in the interior of the Mokaihaha Ecological Area, with few or no birds on the southern, eastern and northern edges of the surveyed area (location map in appendix 3).

There has been a marked reduction in the numbers and extent of distribution of kokako since the surveys of the Fauna Survey Unit of the NZ Wildlife Service in 1970 and 1977. There are general observations of other bird species and wildlife, with three bats seen and only one recording of kakariki. Kaka were commonly recorded. Robins and whiteheads were common in both logged and unlogged forest, and in adjacent mature pine plantations. No kiwi or blue ducks were recorded. Signs of possum were seen throughout the forest, and the authors consider that damage to understorey plants was severe as a result of general browsing and antler rubbing of saplings by red deer. Recommendations for management include control of predators and browsing animals, monitoring of kokako nesting success, and enlargement of the Mokaihaha Ecological Area to the south—AEB.]

Keywords: kokako, *Callaeas cinerea*, kokako—survey, kokako—population, Mokaihaha Ecological Area, Horohoro Conservation Area, forest types, bird observations, possum—browse, *Trichosurus vulpecula*, predator control, red deer, *Cervus elaphus*

Marwick, K. 1982: Report on recreation development and potential in the Kaimai – Mamaku State Forest Park (1975–81). New Zealand Forest Service, Tauranga (unpublished). 33 p. plus appendices.

[This report gives results of a 1981 survey of recreational activities in the Kaimai Mamaku State Forest, when it was managed by NZFS and the Tauranga District Office. It is mainly concerned with the northern region of the Park, north of SH29 and thus outside the area covered by this bibliography. There is only brief mention in the text of the southern region, previously known as State Forest 3, Mamaku State Forest: 'General consent of the public is for the area of State Forest 3 to be retained as "wilderness" for those that seek this experience. At present it is remote and used mainly by hunters and occasionally by tramping clubs' (pp. 16–17). Reference is made to the considerable use of the Ngatuhoa Lodge as an Outdoor Education Centre (p. 24 and appendix III). The Rapurapu walk to three large kauri trees is described in appendix VI.

The concept of 'Nature Trails' is mentioned (p. 16) and might be considered for one of the former experimental areas of FRI that has recently been incorporated into the Patetere Scenic Reserve—see annotation for Department of Conservation (2002). These areas have been used informally to give botanical and ecological insights to interested persons. The northern area, near SH5, has exceptional regeneration of podocarps, both natural and planted, in typical Mamaku reverting cutover forest. The central area by Cecil Road was chosen for its advanced and abundant podocarp regeneration.

It has been suggested that this area may be suitable for a fenced mainland island (MCS, pers. obs.). See Department of Conservation (1996) for recreation priorities that also recognise the values of indigenous wildlife in the southern region of the Park between SH29 and SH5—AEB.]

Keywords: recreation, wilderness, Patetere Scenic Reserve

McArthur, N. 2003: Mamaku Forest (Galaxy Road) large bush remnant plant and bird species list. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished).

[Scientific and common names are given for 44 fern and allied species, 29 indigenous shrub and tree species, and some adventive weeds (found mainly on road margins), which were identified while establishing a 20 m × 20 m vegetation plot. Nine of the most common indigenous bird species in Mamaku Forest are listed, including robin, tomtit and whitehead. This species list is roughly comparable with reverted cutover forest now in Patetere Scenic Reserve and formerly in the FRI Experimental Reserve. Old-growth forest was probably podocarp/tawa with tawari and kamahi—AEB.]

Keywords: flora, fauna, birds, species list, bush remnant, monitoring, Mamaku Forest

McEwen, M. 2005: Charles Fleming, environmental patriot. A biography. Craig Potton Publishing House, Nelson. 382 p.

[This biography outlines the activities of Sir Charles Fleming, a leading conservationist who pressed for cessation of logging and clearing of New Zealand's lowland indigenous forest over a period of 20 years. Specific references to the forests of the Mamaku Plateau are made on 40 pages, which include pleas for reserves to be made in tawa-dominant forest most suitable for kokako habitat. See annotation on Fleming (1969); this article on 'Mammon on the Mamaku' followed expression of his views on conservation, first made public in an address to an Australian and New Zealand Association for the Advancement of Science (ANZAAS) conference in Adelaide, and attracted much attention in New Zealand. In 1968, the Government agreed to a 99-year lease to NZ Forest Products Ltd of thousands of hectares of State Forest on the Mamaku Plateau for utilisation of tawa before clearance, burning and conversion to plantations of radiata pine (pp. 201–203). These operations continued to 1984, and gave rise to much protest from the public and environmental organisations. In particular, there was opposition to clearance of forest in steep-sided valleys down to the banks of entrenched streams with associated roadworks, which result in sedimentation. The company eventually made reserves in parts of valleys such as those of the Kuhatahi and Waipari where kokako still existed.

Many of the proposals made by Sir Charles and others relating to reservation of Mamaku Forest with kokako and indigenous fauna were eventually acted upon, with informal reservation of strips of pine forest or natural vegetation beside streams. See annotation on Nicholls (1978) for Ecological Areas; and Crook et al. (1971), Crook (1975, 1978) and Saunders (1983) for results of fauna surveys and reserve proposals.

Kokako populations survive on the Mamaku Plateau and its flanks, possibly sustained by DOC measures to control predators in the Mokaihaha and Opuiaki Ecological Areas and also in reserves in Rotoehu and Kaharoa Forests on the eastern margins of the Plateau. Sir Charles Fleming had written to the manager of a private company clearing and burning parts of Kaharoa Forest for planting of pines to suggest reservation of forest with kokako (see Cashmore et al. 2002). 'Later the kokako habitat at Kaharoa was protected in a conservation area and a trust established to control predators' (p. 287). Several indigenous forest blocks were reserved in the Onaia catchment—AEB.]

Keywords: reserve proposals, Mamaku Plateau, wildlife conservation, kokako—habitat, *Callaeas cinerea*, environmental organisations, forest conservation

McEwen, W.M. 1982: Cone development and phenology of podocarp tree species. Project Record No. 43. Forest Research Institute, Rotorua (unpublished). 5 p. plus colour photos.

[This article covers the development, phenology and morphology of the male and female cones of seven podocarp species, with 30 colour photos of developmental stages, mainly of trees in the Rotorua District. Sampled trees on the Mamaku Plateau or its fringes included miro and rimu from Dansey Road Scenic Reserve, Hall's totara and matai at the eastern margin of

the former FRI experimental area north of SH5, tanekaha by Cecil Road (central experimental area) and Fitzgerald Glade (Tukorehe Scenic Reserve).

All trees examined were dioecious. Most podocarps are dioecious (although it is known that some trees of miro, matai and tanekaha can be predominantly one sex with a few branches of the other sex; AEB, pers. obs.) and presumably self-pollinating in the case of isolated miro bearing fruit in gardens. Bushy young miro trees regenerated at the margins of farmland were observed to bear heavy crops of fruit in some years in the central Mamaku experimental area. Miro seedlings and saplings contributed the most abundant podocarp regeneration in tawa-dominant forest where assessed by sampling in Mamaku Forest (see Beveridge 1973)—AEB.]

Keywords: podocarp—cones, phenology, Mamaku Plateau, rimu, *Dacrydium cupressinum*, miro, *Prumnopitys ferruginea*, kahikatea, *Dacrycarpus dacrydioides*, matai, *Prumnopitys taxifolia*, totara, *Podocarpus totara*, Hall's totara, *Podocarpus hallii*, tanekaha, *Phyllocladus trichomanoides*, Cecil Road—central experimental area, Fitzgerald Glade, Tukorehe Scenic Reserve

McEwen, W.M. (Ed.) 1987: Ecological regions and districts of New Zealand: Sheet 2 Central North Island from Meremere to Eastern Hawkes Bay. *New Zealand Biological Resources Centre Publication No. 5.* Department of Conservation, Wellington.

[This map covers the Mamaku Plateau and its flanks, the area most relevant to this bibliography that lies within parts of three Ecological Districts and three broader Ecological Regions. The northern fall of the Mamaku Plateau is within the Otanewainuku Ecological District and the Northern Volcanic Plateau Region; the western fall is in the Tokoroa Ecological District and the Western Volcanic Plateau; the rest of the Plateau and streams draining into Lake Rotorua form part of the Rotorua Ecological District, situated to the north of the Central Volcanic Plateau. Concise descriptions of land forms, volcanic centres and land use for the Ecological Districts and Regions are given on the pocket topographic map at a scale of 1:500 000. The ecological characteristics of each Ecological District give it identity; descriptions based on the keywords given below are contained in a booklet—AEB.]

Keywords: geology, climate, soils, vegetation, birds, land use, mammals

McKelvey, P.J.; Nicholls, J.L. 1957: A provisional classification of North Island forests. *New Zealand Journal of Forestry 7(4)*: 84–71.

[The forest types that have been mapped and described on forest type map sheets covering the Mamaku Plateau and its flanks were based on this 1957 classification. See Nicholls (1966, 1967a–c) for forest type map sheets—AEB.]

[Later expanded and updated by Nicholls (1976). Unfortunately, no concordance between the two classifications was ever published—MCS.]

Keywords: forest types—map, forest types—descriptions

McQueen, D.R. 1961: Indigenous-induced vegetation and *Pinus radiata* on volcanic ash soils. A Symposium. Pp. 1–14 in: 1961 symposium. *Proceedings of the New Zealand Ecological Society 8.*

[The study area lies to the west and south of the Mamaku Plateau in the Tokoroa District. The composition of vegetation types is given for fire-induced seral shrubland, the understorey of planted radiata pine, and shrubland resulting from clearfelling where radiata pine has locally failed to regenerate. This 'biotically induced' vegetation was 7–14 years old on soils derived from Taupo pumice or older ash showers. A species list is given for the three broad vegetation types.

John Nicholls (pers. comm.) has said that repeated fires before and after European settlement occurred along the margins of the Mamaku Plateau, although generally failed to spread into the upper parts of the Plateau, while old-growth forest remained in high-rainfall areas (up to 3000 mm/year)—AEB.]

Keywords: fire-induced vegetation, understorey plants, pine plantations, shrubland on logged pine sites, plant list, Tokoroa District

Milner, D.M. 1998: Mamaku Ignimbrite: source and features. Geological Society of New Zealand and New Zealand Geophysical Society, joint annual conference, 30 November – 3 December 1998. 260 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: Mamaku Ignimbrite, Mamaku Plateau, geology, Taupo Volcanic Zone, volcanicity

Milner, D.M.; Cole, J.W.; Wood, C.P. 2000: Geochemistry and emplacement of c.225 ka Mamaku Ignimbrite. Geological Society of New Zealand and New Zealand Geophysical Society, joint annual conference, 27–30 November 2000. 176 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: Mamaku Ignimbrite, Mamaku Plateau, Rotorua Caldera, geology, Taupo Volcanic Zone, volcanicity

Milner, D.M.; Cole, J.W.; Wood, C.P. 2003: Mamaku Ignimbrite: a caldera-forming ignimbrite from a compositionally zoned magma chamber in Taupo Volcanic Zone, New Zealand. *Journal of Volcanology and Geothermal Research 122*: 243–264.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: geology, Taupo Volcanic Zone, Mamaku Ignimbrite

Moberly, B. 1984: Interplanting of reverted indigenous cutover with exotic species in State Forest 3, Mamaku. Project Record 970. Forest Research Institute, Rotorua (unpublished). 114 p. Includes illustrations.

[This is a detailed report on the performance of 18 exotic species and some rimu interplanted over 54 ha of reverting indigenous cutover forest, situated north of a 100-m-wide strip of old-growth tawa/podocarp forest flanking SH5. Group and strip plantings were made from 1959 to 1961 in a matrix of residual tawa-dominant forest and a dense growth of shrub hardwoods resulting from earlier logging. Partial logging of podocarps was started by Steele Bros in 1904, although further logging by Arahiwi Sawmilling Co. removed more podocarps, with the best tawa taken from Sawmill Area No. 45 on the eastern side of this trial area.

East of Galaxy Road, rimu, totara and kahikatea were interplanted over 40 ha. The total trial area of over 100 ha containing FRI Sample Plot R312 was previously included in the northern Mamaku experimental area of FRI and was recently incorporated in the Patetere Scenic Reserve. See Department of Conservation (2002) on the Nature Heritage application, with discussion of conservation values and ecological significance.

Bryan Moberly's report is mainly concerned with the site preparation methods used, planting patterns, and survival and growth of the exotic species up to 1983. The most successful species by 1983 was Tasmanian blackwood, which has since reached rotation length and harvestable size (by 2006 or earlier), especially in planted groups surrounded by tawa. Removal of blackwood from this trial area and from margins of the central experimental area by Cecil Road, together with less successful plantings in Horohoro Forest, must have been considered in recent years. From the 1950s to 1987, NZFS encouraged experimental interplanting (also called 'supplementary planting' or 'enrichment planting') of cutover indigenous forest, using both podocarps and exotic species. In the Mamaku trial described above, the introduced species have not been removed (see Nicholas & Steward 2004).

Although some exotic conifer species and the eucalypt species have become well established and reached a large size approaching 60 years in age, a number have died or remained 'unthrifty' as a result of competition with indigenous vegetation. There is abundant, slowly developing natural regeneration of rimu and miro over parts of the 100-ha experimental area of the former sample plot R312, while the podocarp plantings east of Galaxy Road are emerging from the indigenous understorey and will in time form a high forest canopy with podocarps and tawa dominant over most of the 260-ha area of the former northern experimental area of the former Mamaku Research (State) Forest. See Nicholas & Steward (2004) for blackwood interplanting—AEB.]

Keywords: interplanting—exotic and indigenous, Mamaku cutover forest—reverted, blackwood, *Acacia melanoxylon*, blackwood—removal, conservation, ecological values

Morgan, M.D. 1986: Geology of the northern Mamaku Plateau. 306 p. with illustrations, plus maps. (Held at University of Waikato, Hamilton.)

[Not viewed by the authors of this bibliography—BRC.]

Keywords: geology, Mamaku Plateau

Native Forest Action Council 1976: Horohoro Forest: the Bush Tramway option. Native Forest Action Council, Auckland Branch (unpublished). 39 p. plus 4 appendices.

[This report recommending rehabilitation of a disused bush tramway also contains a strong plea to cease all logging in the remaining area of Horohoro Forest (at that time State Forest 31), near the southern margin of the Mamaku Plateau. The reservation of a 4000-acre area of virgin forest, named the 'Horohoro Forest Reserve' is called for, and it is suggested that the existing extent of bush tramway from the State-owned Railways Mill in Mamaku township to the southeastern corner of the proposed Reserve be rehabilitated and used as a tourist attraction. This Bush Tramway option was proposed because it was envisaged that the Mamaku Sawmill would have to close with the exhaustion of indigenous timber supply from the remaining forests of the Mamaku Plateau, leading to unemployment in the township.

The Bush Tramway, last used for log extraction in 1975, was not rehabilitated, although there is still a sawmill in Mamaku, milling mainly logs of radiata pine from plantations in the region that were first established in the 1960s and 1970s, following clearing and burning of the sites of former podocarp and podocarp/tawa forest. The area of the suggested 'Horohoro Forest Reserve' became the Mokaihaha Ecological Area, where the population of kokako has continued to survive (see Marsh & Blake 1997).

There is some interesting background information to the proposals, including a chapter on the natural landscape of the Mamaku Plateau with sketch maps, as well as historical aspects of logging and milling of the indigenous forest on the Mamaku Plateau, and the construction and use of the Mamaku Bush Tramway.

In the 1970s, public concern was aroused by the far-reaching smoke from burning of cutover indigenous forest over 20 000 acres leased by the Government to NZ Forest Products Ltd for the utilisation of residual tawa and establishment of radiata pine plantations. Two of the appendices consist of supporting statements by Sir Charles Fleming and Professor John Morton, both of whom emphasise the scientific values and appeal of virgin indigenous forest—AEB.]

Keywords: Mamaku Bush Tramway, tourist facilities, recreation, conservation values, history of logging, sawmilling, burning for site preparation, clearing of indigenous forest, logging—partial

Nelson, R.O. 1974: Problems and campaigns that lie ahead. *Forest & Bird 193*: 14–17.

[The author, an outgoing President of Forest & Bird, refers to key sites of concern in the conservation of forests. A major concern is the future of the Mamaku Forest and the Kaimai Forest. He considers that too much of these forests is being planned for conversion to exotics, and emphasises the great scenic and recreational value of the remnants of the previously extensive forests and their importance as habitat for birds that are now becoming rare.

The Kaimai Mamaku State Forest Park was created in 1975, with a substantial area of indigenous forest zoned for partial logging (see New Zealand Forest Service 1977, 1982); the 1982 management plan was never implemented—AEB.]

Keywords: conservation, Mamaku Forest, conversion of indigenous forest, endangered biota—birdlife

New Zealand Forest Service 1976–1986: Annual reports Kaimai-Mamaku State Forest Park. Conservator of Forests. New Zealand Forest Service, Rotorua.

[Ten reports for years ending 1977 to 1986. Each annual report averages 4–8 pages in a standard format, with the first report issued after proclamation of the Kaimai Mamaku State Forest Park on 23 October 1975.

An Advisory Committee was appointed for meetings and field visits to consider matters of park planning and management, and was involved in the preparation of a new management plan in 1982 and subsequent submissions. The first Forest Management Plan (1976–82) was signed in September 1977 (see New Zealand Forest Service 1977). There is little specific mention of the northern Mamaku Forest in the southern section of the Park, except for improvements to forest access from the Ngatuhoa Lodge, to the Rapurapu kauri, and along the old bush tramway from Wood's Mill site to the Waiomou Stream.

In 1977, the Scientific Co-ordinating Committee examined proposed Ecological Areas (see New Zealand Forest Service 1980). The Park was administered from the Tauranga office for most of the 10 years, with an animal control station at Gordon. Assistance with recreation and amenity was a main activity, although several surveys were undertaken on wildlife, animals, vegetation and recreational development (see Dale & James 1977; New Zealand Forest Service 1981).

A new draft management plan produced in January 1983 attracted much public comment and many submissions, creating 'a year of controversy' (see New Zealand Forest Service 1982). In 1985, it was reported that following a change of Government, the revised management plan could not be finalised and that there had 'been no clear mandate for management [of the forest] for the past three years'. All planting of indigenous species had ceased (including planting of kauri—2000 had been planted in the old logging area beyond Ngatuhoa Lodge)—AEB.]

Keywords: Kaimai Mamaku State Forest Park, recreation planning, management plans

New Zealand Forest Service 1977: Kaimai-Mamaku State Forest Park: Management Plan 1976–1982. New Zealand Forest Service, Rotorua. 23 p. plus 4 references, 4 appendices and 5 maps.

[This first management plan for the Kaimai Mamaku State Forest Park was approved by the Minister of Forests in September 1977. The Forest Park was established by NZ Gazette notice on 23 October 1975, following 2 years of public debate on the management of State Forests in the area. Only the northern part of Mamaku Plateau forests, south of SH29, is included in the Park and is therefore of direct relevance to this bibliography. The part of the former Mamaku State Forests within the Park covered 11 800 ha, with 9250 ha recorded as virgin (old-growth) forest and the remainder recorded as cutover forest, usually with residual tawa and scrub. Rimu was the main species removed by logging.

There are frequent references to the Mamaku Plateau and its forests throughout the plan. The northern Mamaku forests are described as 'very largely undisturbed by utilisation, although are being damaged by noxious animals and domestic stock (mainly feral and farm cattle) in certain areas'. In a descriptive chapter giving outlines of topography, geology, soils and vegetation, the Mamaku Plateau is referred to briefly; it was formed by ignimbrite flows 'and subsequently arched up to 600 m along a north–south axis'. The easy terrain of the central Plateau is free draining, except for impeded conditions toward the headwaters of the Mangapapa River (where beech forest occurs). Deeply entrenched streams on the western side of the Plateau flow into the tributaries of the Waihou River.

Like the Kaimai Ranges and the Whakamarama Plateau to the north, the Mamaku Plateau forms a watershed, with waters arising in the forests being of vital importance to flanking lowland communities. Soils in the Mamaku Plateau are derived from volcanic ash showers, with older showers giving rise to 'yellow brown sandy silts and clays with high amounts of phosphate-fixing allophane'—greasy and compacted when wet, with low infiltration in sub-soils, leading to rapid run-off (see Rijkse 1979).

The description of vegetation classes in appendix 1 is based on an account by J.L. Nicholls (1974b) and is also shown on Map 4 attached to the plan. The main class on easy terrain of the Mamaku Plateau was rimu-tawa (Class D). There are a few isolated patches of kauri along the western edge of Mamaku Forest, with the most southerly tree only 3 km north of SH5. 'There is a small portion of a large tract of logged former podocarp – hardwood – beech forest in the headwaters of the Mangapapa and Mangorewa Streams on the Mamaku Plateau, very little of which is in State Forest.'

This plan was written at a time when environmentalists and many members of the public were increasingly active in opposing any form of logging in indigenous Crown forests. There had been considerable opposition to extensive logging of residual tawa on the Mamaku Plateau south of SH5, on State Forest land leased to a private company. This forest had been previously logged for podocarps (mainly rimu), although the residual canopy of tawa was left substantially intact. This background may have led to the proscription of logging of indigenous forest over the period of this plan, while an 'Indigenous Management Zone' was retained to allow future options

as 'long-term timber reserves' in this plan and the next draft plan for the Park (New Zealand Forest Service 1982).

The current plan does not mention the presence of kokako in Mamaku Forest, although a 'Scientific Area Zone' with forest types of outstanding scientific interest is recognised, with mention of reserve proposals for Opuiaki, Rapurapu, Mangapapa and Tauwharawhara Biological Areas (subsequently termed Ecological Areas) totalling 1275 ha and shown on Map 2, together with 3760 ha in the Indigenous Management Zone for Mamaku Forest.

Deer populations were said to be low over the whole Park area. Trapping of possums by private operators was considered to have little impact on populations. It is stated that 'over much of the forest, damage (by possums) is neither serious nor prolonged, especially where ungulates are absent'[11].

A draft management plan was prepared soon after formation of the Park in 1975, and in July 1976 the public was invited to submit comments. Thirty-six submissions were made and the current plan contains a 10-page analysis of the comments, conceding some points and refuting others (see New Zealand Forest Service 1983a).

In addition to the five maps in the list of contents and contained in a pocket of the document, a further 'interim map' shows numbered tracks, three of which are located south of SH29: Ngatuhoa South Lodge to Waipapa Hut and Hiwiroa Road; Wood's Mill (just north of SH5) to Waiomou Stream; and Rapurapu Kauri Track—AEB.]

Keywords: Kaimai Mamaku State Forest Park, forest management plan, Mamaku Forest

New Zealand Forest Service 1978: Ecological Area recommendation maps. File 31/6/10/10, 1st Jan. 1978. Scientific Coordinating Committee, New Zealand Forest Service (unpublished copies). FRI file with maps now kept at Landcare Research, Hamilton. 9 p. Maps.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: Ecological Area—proposals, Rotorua Conservancy—west, Mangorewa State Forest 19, Kaharoa State Forest 33, Horohoro State Forest 31, Mangapapa Ecological Area, Matahana Ecological Area, Onaia Ecological Area, Rapurapu Reserve, Mangorewa Reserve, Pukerimu

[11] Where ungulates (mainly red deer) are absent or in low numbers (such as in north Mamaku Forest, west of Galaxy North Road), possum damage by browsing foliage and fruits of shrubs may not be obvious, as with damage to crowns of kamahi. Impact of possums on birdlife is not mentioned in this paper.

New Zealand Forest Service 1980: Inspection of Ecological Area proposals in Mamaku-Rotorua Area, Scientific Co-ordinating Committee. 6–10 February 1978. New Zealand Forest Service, Rotorua. 9 p. plus map.

[This document includes a 5-page report by J.L. Nicholls dated December 1977, describing proposed Ecological Areas and giving an introductory account of the Mamaku Plateau and its indigenous forest. The recommendations of the Scientific Co-ordinating Committee for eight proposed Ecological Areas in the southern part of Kaimai Mamaku State Forest Park, managed by Rotorua (Forest) Conservancy, are presented briefly in a memo dated 26 February 1980 from the Head Office of NZFS to the Conservator of Forests, Rotorua. The comments of the Conservator were sought, and it was stated that new procedures for setting up Ecological Areas were to be announced. It was implied that conservancies needed to agree with proposals of the Committee so that final proposals could be approved by the Minister before being published in a gazette notice. The Committee recommended extension to the areas of the Onaia, Mokaihaha, Mangapapa, Opuiaki and Mangorewa Ecological Areas, and acceptance of areas submitted by Conservancy for the Rapurapu, Matakana and Pukerimu Ecological Areas.

It is interesting to note that the Committee also recommended inclusion of radiata pine stands adjacent to indigenous forest with a population of kokako in the Rotoehu Ecological Area. Conservancy did not agree with the idea that some radiata pine might be left through a physical rotation 'to examine indigenous vegetation succession from the pine stand'[12]. These concepts might be applied to the radiata pines flanking the Mokaihaha Ecological Area with its population of kokako.

Ninety-year-old stands of radiata pine and Douglas fir previously existed on the Kaingaroa Plateau near the road from Rotorua to Murupara, and were of much interest to visiting ecologists for the diversity of the understorey of indigenous species and the number of indigenous insectivorous birds; these stands were felled and must be a rarity in central North Island. Some old stands of a range of exotic conifers with an understorey of indigenous shrubs are present in part of Whakarewarewa Forest, Rotorua (see Introduction of this bibliography).

Included in a folder with this report is another entitled 'NZ Forest Service, Ecological Area proposals in the Mamaku and Rotorua area'—see annotation for Nicholls (1978)—AEB.]

Keywords: Ecological Area—proposals, Scientific Co-ordinating Committee

---

[12] See Forest Research Institute (1991). A dense undergrowth has developed beneath 50-year-old *Pinus elliotii* beside a road in Rotoehu Forest where kokako move in the pine canopy. Palatable shrubs were heavily browsed by deer in most parts in the 1960s.

New Zealand Forest Service 1981: Tramping and walking tracks in the Kaimai/Mamaku State Forest Park. New Zealand Forest Service, Rotorua. 31 p. plus maps.

[Of the 22 tracks described in detail, only two are within the Mamaku region south of SH29. These are the Ngatuhoa Lodge to the Waipapa Stream track via Frankham's old logging road, and the Rapurapu kauri track. Two other tracks not yet opened to recreational use in 1981 were named as the Hiwiroa Road to a lake, and Wood's Mill to Waiomou Stream.

Park and track descriptions were updated by the Department of Conservation (1994b) in a folding brochure—AEB.]

Keywords: Kaimai Mamaku State Forest Park, guide book, trails

New Zealand Forest Service 1982: Draft revision of the Kaimai-Mamaku State Forest Park Management Plan, 1982–1992. New Zealand Forest Service, Rotorua. 49 p. plus folding maps, references and 7 appendices.

[The preface explains that this plan is a draft revision of the first management plan for the Kaimai Mamaku State Forest Park, which covered the period 1976–1982. The concept of 'multiple use' for State Forest Parks is explained in a preamble. As the first plan has been fully annotated (New Zealand Forest Service 1977), only additional information will be considered here for this revision, dealing with the section of the Park south of SH29 that is mainly the northern part of the Mamaku Plateau forests.

No final plan was produced from this revision, as NZFS was disestablished in 1987 and DOC was formed, with different management objectives that dispensed with the NZFS concept of 'multiple use' and any future intent to remove wood from the indigenous forest. There is a fuller general description of the Park (8 pages), with some additional information on the Mamaku forests. Isolated kauri occur in the Kakahu Stream catchment, although access is difficult and it is easier to follow the Rapurapu track to the kauri, 8 km to the north, near SH29.

Although the main forest type on the Mamaku Plateau is emergent rimu with northern rata over a dense canopy of tawa and kamahi, there are stands of dense podocarps with dominant rimu and Hall's totara, tanekaha and toatoa in the headwater basins of the Opuiaki Stream. A wildlife survey was carried out in Mamaku State Forest in 1977 (Crook 1978), and Opuiaki Ecological Area was established after recognition of its high wildlife values. Maps showing the distribution of kokako, kaka, robins and parakeets are included in appendix 2.

An indigenous management zone was retained in this draft plan (although it became obsolete with no final plan produced). Brief descriptions are given for designated Ecological Areas: Rapurapu (kauri near southern limit); Opuiaki (as above with extension); and Mangapapa (logged rimu/beech with regeneration). Longer descriptions are given in appendix 1.

Only a very scattered population of red deer is said to exist in Mamaku Forest, with probable liberation points to the north. The whole park has been colonised by possums, with active private trappers apparently having

little effect on reducing populations. While the long-term effects of possum browsing on forest canopy trees is said to be well documented, the effects on forest regeneration are not clearly understood and possum-proof enclosures are difficult to build.

Deer- and possum-proof exclosures and open control plots (with access to possum and deer) were established in an FRI trial in Whirinaki Forest in 1960, from which it was found that both deer and possums damaged planted rimu and kahikatea seedlings at a time of peak browsing animal populations. On a recent visit to the Whirinaki Forest Sanctuary, where areas of dense pole-sized rimu regeneration had become established in old Maori clearings, AEB observed that the tips of leaders of many small matai and miro seedlings had been removed, though these species are generally found to be amongst the least palatable as larger seedlings of podocarps (AEB, pers. obs. January 2006).

On the Mamaku Plateau, an understorey of palatable shrubs has usually been found to occur in both old-growth forest and forest retaining a tawa canopy after removal of podocarps by logging when deer populations have been low, at least until the last decade.

Submissions on this draft revision of the management plan were invited in 1983, and were to be analysed and discussed with the Forest Park Advisory Committee (established in 1976) before a final plan was written; no final plan was ever written. For an analysis of submissions, selected submissions and a full compilation, see New Zealand Forest Service (1983a–c)—AEB.]

Keywords: management plan—draft, Kaimai Mamaku State Forest Park, Mamaku Plateau

New Zealand Forest Service 1983a: Analysis of submissions on Kaimai-Mamaku State Forest Park draft management plan, 1982–1992. New Zealand Forest Service, Rotorua. Unpaginated (54 sheets).

[This is the first of two volumes covering submissions on the draft management plan for the Kaimai Mamaku State Forest Park—see Part 2 (New Zealand Forest Service 1983c) for a fuller compilation. This first volume has no references.

There are no page numbers beyond the 6-page introduction, which lists five types of submissions and has a summary of major issues, listing areas of concern.

In a preface, the Park Advisory Committee comments that 'The submission process provided the opportunity for the expression of a general concern against exploitation of indigenous forest, and this provided the bulk of the substance of the submissions received'. This first volume (Part I) has excerpts from selected submissions, with the submission numbers on margins, although the presenters are not identified here.

No final management plan was produced by NZFS. Many protests on prescriptions of the Forest Service were against indigenous management zoning, the utilisation of any wood from indigenous trees, the planting of exotic species in the Park, and the concept of 'multiple use' (except for recreation, protection, water use and scientific reserves). These prescriptions

have applied since DOC was established in 1987. In this section of Part I on submissions, there are few references to forest on the Mamaku Plateau, or the park area south of SH29. However, the attitudes and opinions of the public and interested organisations on the management of a Forest Park received a good airing, with some useful contributions to the controversies of the time—AEB.]

Keywords: management plan—draft, Kaimai Mamaku State Forest Park, environmental values

New Zealand Forest Service 1983b: A guide to Kaimai-Mamaku Forest Park. Map, scale 1:50 000. New Zealand Forest Service, Rotorua. Text and colour painting on back.

[This coloured topographic map shows the northern and southern regions of the Kaimai Mamaku Forest Park, with tracks in two sections and an index to the location of recreational facilities, historic sites, rivers and streams. Six forest types are indicated. The location of kauri sites at the species' 'generally regarded' southern limit is shown near the Kakahu Stream, north of the Waiomou Road. The part of Mamaku State Forest leased by NZ Forest Products Ltd and converted to radiata pine plantation is shown south of the Park and SH5, as well as near Galaxy Road north of SH5. Retention of indigenous vegetation in some stream catchment areas is shown, including areas by the Kuhatahi and Waipari Streams, where kokako were present in the 1970s. The map text has an account of the forests, geology and soils, with a brief reference to native wildlife, as well as detailed information on tracks. See Department of Conservation (2000) for a revision of this map—AEB.]

Keywords: Kaimai Mamaku Forest Park, recreation, walking tracks

New Zealand Forest Service 1983c: Kaimai – Mamaku Forest Park. Submissions on draft Management Plan revision 1983. New Zealand Forest Service, Rotorua. Unpaginated (160 p.).

[This second volume is possibly the fullest compilation of submissions made on the 1983 management plan revision for the Kaimai Mamaku Forest Park prepared by NZFS. See New Zealand Forest Service (1983a) for analysis of submissions, New Zealand Forest Service (1983d) for selected submissions, and New Zealand Forest Service (1982) for the draft management plan revision. There is no index to the submissions within this fuller compilation, although the last item in the folder is an 8-page press release by NZFS, outlining the concept of multiple use and conservation, and proposals in the draft management plan inviting public comment. The fullest submission (40 p. including 51 references) is presented by the Joint Campaign on Native Forests, which was based in Nelson and consisted of four environmental organisations. This submission contains a section on the 'Inadequacy of Ecological Reservation', which is annotated here as Anon. (1983b).

There are a few specific references to the Mamaku Plateau and the area of the Park south of SH29, particularly on the subjects of ecological reserves. The Wildlife Service has a 22-page submission. The submission from the Soil Bureau of DSIR includes a succinct account of the 'Mamaku soils', which are all podzolised yellow-brown loams (now known as 'allophanic soils'): 'In the Mamaku Plateau area the rhyolite tephra is dominant, since a number of tephras (Mamaku Ash, Rotoma Ash, Waiohau Ash, Rotorua Ash, some Kawakawa tephra, Okareka Ash) originated from the Okataina Volcanic Centre. Loess and the fairly thick Mangaone beds on ignimbrite can also be found in the south. The Opuiaki Ecological Area on the Mamaku Plateau in the south should contain representative examples of the main landforms and soils of the range'—AEB.]

Keywords: management plan—submissions, Kaimai Mamaku Forest Park, Ecological Reserves, Mamaku soils, tephra, conservation, Opuiaki Reserve

New Zealand Forest Service 1983d: Kaimai-Mamaku State Forest Park draft management plan, 1982–1992. Part 2. Selected submissions in full. New Zealand Forest Service, Wellington. Unpaginated (73 sheets).

[There is no introduction by NZFS to this second volume on submissions on the Kaimai Mamaku State Forest Park draft management plan, where contributions are identified by name, address, organisation and submission number.

Analysis and submission excerpts are covered by the first volume (Part I; New Zealand Forest Service 1983a). The wide range of views expressing personal, group, local and broader interests constitute a useful compendium of attitudes to indigenous forest management and environmental values in the 1970s and early 1980s. Submissions reproduced in full comprise those of particular groups, such as environmental (including a 9-page submission from Forest & Bird) and recreational organisations. All submissions from local bodies and advisory bodies to Government, government departments, industry and professional organisations such as NZ Forest Products Ltd and the New Zealand Institute of Foresters are reproduced.

The high wildlife value of the Mamaku State Forest north of SH5 is especially emphasised as a habitat for kokako, 'containing one of the largest remaining areas of more suitable habitat for the species'.

This document has a 9-page press information release by NZFS at the end; this summarises proposals of the draft management plan 1982–1992—AEB.]

Keywords: Kaimai Mamaku State Forest Park, management plan—draft, submissions—selected

New Zealand Herald 2002a: Native duck at risk of extinction. ***The New Zealand Herald, 10 October 2002.***

[The IUCN World Conservation Union threatened species publication the 'Red List' or 'Red Book' lists the blue duck (whio) as endangered. The Mamaku Plateau is one of several former habitats where the blue duck has disappeared—AEB.]

[DOC also uses a system for ranking threatened species, whereby the blue duck is listed as 'Nationally Endangered' (Hitchmough et al. 2007[13])—BRC.]

Keywords: birds, whio, blue duck, *Hymenolaimus malacorhynchos*, Forest & Bird, endangered biota, conservation

New Zealand Herald 2002b: Row as rare State-owned forest put up for sale. ***The New Zealand Herald, 16 October 2002.***

[Records strong protests by environmentalists over the proposed sale of 450 ha of State-owned indigenous forest at Mamaku by the Crown Research Institute Forest Research, Rotorua. One block (near SH5) contains a wetland (with fernbirds), which has a covenant on its use (see annotation for Department of Conservation 2002). The two blocks of 450 ha are now managed by DOC in the Patetere Scenic Reserve—AEB.]

Keywords: Forest Research Institute, indigenous forest—reserves, wetland, land development, business, land sales, environmental protest, conservation

New Zealand Herald 2004: Kokako numbers up in Kaimai-Mamaku Forest Park. ***The New Zealand Herald, 28 May 2004.***

[North Island kokako numbers are reported to have increased in Kaimai Mamaku Forest Park. A survey of the Opuiaki Ecological Area on the Mamaku Plateau recorded seven adult pairs of kokako, 12 single birds, and three newly fledged chicks. The increase was attributed to the success of a pest control operation in 2003—AEB.]

Keywords: kokako, *Callaeas cinerea*, Opuiaki Ecological Area, pest control, conservation

New Zealand Wildlife Service 1983: Protected areas review—Kaimai-Mamaku State Forest Park and adjoining ecological districts—wildlife habitat data. New Zealand Wildlife Service, Department of Internal Affairs, Wellington.

[A Schedule of Sites of Specific Wildlife Importance (SSWI) located in the Kaimai-Mamaku Plateau region, identified by the Fauna Survey Unit of the Wildlife Service, Department of Internal Affairs. All habitats are listed in sequence as they appear on the attached maps; that is from north to south, west to east. The bound report is prefaced by a memo of explanation from

---

[13] Hitchmough, R.; Bull, L.; Cromarty, P. (Comps) 2007: New Zealand Threat Classification System lists—2005. Department of Conservation, Wellington. 194 p.

the Director of the Wildlife Service to the National Parks Authority (dated 19 October 1983 in WIL 19/2/4). Two notes in the memo are as follows:

> '—A series of topographic maps (NZFS I series) numbering and identifying each site listed in the schedule are enclosed. The approximate boundaries of the Ecological Districts are shown on the maps.
>
> '—It should be noted further that the large forest tracts of the Mamaku Plateau between the Kaimai Highway in the north (SH 29) and the Atiamuri Highway (SH 30) in the south, and bounded by the western fall of the plateau and the Rotorua-Tauranga Highway (SH 33) to the east are the subject of the FSU report.'

The maps are not enclosed. Each sheet lists the value rating, number, name, map number, grid reference, area, ecological region, and description of each site (c. 200). The corridor to the Mamaku Plateau in the south (No. 22A) and the Upper Mangorewa Gorge (No. 91) are listed for outstanding value. Tunnel Road Bush (No. 124), the Ecological Reserve by Galaxy Road (No. 125), Dansey Road Scenic Reserve (No. 127), Arahiwi Scenic Reserve (No. 165), Mt Ngongotaha Scenic Reserve (No. 171), and Pukerimu Forest Reserve (No. 190) are listed for moderate–high value. See Rasch (1989) and Saunders (1983) for further details and proposals for the Mamaku Plateau—AEB.]

Keywords: protected areas, Mamaku Plateau, Mamaku Plateau—flanks

Nicholas, I.; Steward, G. 2004: Mixtures: planting blackwood in New Zealand indigenous vegetation. Pp. 78–83 in: Blackwood management. Learning from New Zealand. Proceedings of an International Workshop, Rotorua, New Zealand, 22 November 2002.

[One section of this report refers to an FRI trial with interplanting of blackwood in a tawa-dominant cutover area of the Mamaku Forest. Group planting was done in 1959–1961 and subsequent assessments of growth showed that blackwood grew vigorously for 30 years before many trees declined in vigour and significant mortality occurred. Sap sucker (psyllid insects) attack on foliage was a possible cause of crown decline. Various site preparation methods were tested to create canopy gaps. Concerns about the potential capacity of blackwood to invade indigenous forest in New Zealand are discussed. From surveys and field assessments, it has been concluded that blackwood is not an invasive weed of closed canopy indigenous forest, although it can regenerate from seed or root suckers on some more open sites. Regeneration from root suckers from interplanted blackwood groups has occurred beside Galaxy Road North in the Mamaku trial area. The trial area of 54 ha interplanted with blackwood and other exotic species has recently been included in the Patetere Scenic Reserve, together with a further 40-ha block containing a large trial area that had podocarp species interplanted during 1959–1961 (see Department of Conservation 2002)—AEB.]

Keywords: blackwood—Mamaku inter-planting trials, blackwood, *Acacia melanoxylon*, blackwood—regeneration, Patetere Scenic Reserve

Nicholls, J.L. 1963: Vulcanicity and indigenous vegetation in the Rotorua District. A symposium. Pp. 58–65 in: *1963 Proceedings of the New Zealand Ecological Society 10*.

[The Mamaku Plateau forms only the western part of the region described. In this region, the main forest tracts, as they are thought to have existed in the mid-19th century, are shown on a map, along with the distribution of three broad forest classes—podocarps predominant, beeches present and hardwoods predominant. The most common forest class described is rimu-rata/tawa, which covers much of the Mamaku Plateau and grades into rimu-tanekaha/tawa in flanking gorges. There are also stands of hard beech in some of the Mamaku gorges. Rimu-red beech/tawa occurs near the centre of the Plateau, with some hard beech and silver beech. Rimu-matai/tawa forest occurs on the southern fall of the Mamaku Plateau, where soils are derived from Taupo Ash and are deeper than further north, and the forest once contained huge totara (now mostly long-fallen logs). The map shows six locations of widely separated small stands of kauri. Topography and the distribution of ash showers older than Taupo have influenced soil formation and drainage, and hence forest type. Polynesian fires probably reduced marginal forests in the districts and were followed by later fires, resulting in development of scrub, fern and heath during the past 100 years (e.g. south and west of the Mamaku Plateau). After southern forests were devastated by the Taupo eruption, a 'post Taupo' forest dominated by podocarps (including matai and totara) probably developed on coarse soils—see Smale et al. (1997) and forest type maps of Nicholls (1966, 1967a–c, 1974b)—AEB.]

[Radiocarbon dating and ring counts together suggested that a mature fallen totara in Horohoro Forest established c. AD 640—MCS.]

Keywords: volcanicity, vegetation, indigenous forest—pattern, forest types, podocarp forest, beech forest, *Nothofagus* spp., hardwood forest, kauri, *Agathis australis*, soil influences, fire-induced vegetation, Taupo Volcanic Zone

Nicholls, J.L. 1966: Map sheet N76: Rotorua. Forest type map of New Zealand. Ecological survey of New Zealand's Indigenous Forests. Series No. 2. 1:63 360. Forest Research Institute, New Zealand Forest Service.

[Maps and describes forest types on the Mamaku Plateau, including the forests that were later included in the Ecological Areas of Mokaihaha and Pukerimu on the southern part of the Plateau. See Nicholls (1978) for further descriptions of the proposed Ecological Areas.This map sheet has the rhyolite dome of Mt Ngongotaha at its centre, with the southern and central parts of the Mamaku Plateau to the west of Rotorua. Mapping was based on aerial photos taken in 1945–48 and uses the forest classification proposed by McKelvey & Nicholls (1957). The main forest types mapped were in the type N forest class (logged forest with tawa predominant) and type D (rimu-rata/tawa-kamahi) on ridges between stream valleys, with type G5 (rimu/miro-tawa-kamahi-tawari) in gorges.

The text on the map sheet was written in 1964 and has good summaries of physiography, soils, climate, wild animals, water resources and logging

history. Since then, nearly all the forest of the main tract on the crest and upper flanks of the Mamaku Plateau, as mapped on this sheet, has been cleared and converted to plantations of exotic conifers, mainly radiata pine. Exceptions are the Ecological Areas established during the late 1970s, Scenic Reserves, and some riparian areas of entrenched stream valleys and small areas of private land.

Logging began near Mamaku in the 1890s and 'was largely confined to the plateau crest and south-west flank until 1945, in forest within reach of tramways and steam-driven log haulers'. Earlier logging removed mostly podocarps, although tractors were then used for logging, with temporary roads created. Hardwoods were also removed as on Mt Ngongotaha, with type D forest (broadleaved forest) mapped near a cleared summit surrounded by type N forest. Forest type O1 (tawa-kamahi-hard beech-silver beech) is mapped north of SH5 (on poorly drained ground) and was logged to Gamman's tramway for podocarps since 1900 and for red beech split for posts to 1955, with more subsequent regeneration consisting of hard and silver beech. The Mangapapa Ecological Area was established at a later date by NZFS in this forest type O1. The author notes that red deer were at that time very rare west of Rotorua, although possums had been liberated on Mt Ngongotaha and near Mamaku in the early 1900s. See Pracy (1974), who referred to official liberation points on Ngongotaha and at Arahiwi in 1951, although believed that unauthorised liberations must have led to widespread populations much earlier. Nicholls notes that most northern rata were standing dead in a number of forest types on the Plateau, probably with reference to 1951 reports of the National Forest Surveys and later Ecological Surveys of NZFS—AEB.]

Keywords: forest types—map, forest types—descriptions, physiography, logging—history, pine plantations, water resources, wild animal distribution, Mangapapa Ecological Area, south and central Plateau

Nicholls, J.L. 1967a: Map sheet N66: Matamata. Forest type map of New Zealand. Ecological survey of New Zealand's Indigenous Forests. Series No. 2. 1:63 360. Forest Research Institute, New Zealand Forest Service.

[This map shows the forest types as they were in 1943 when aerial photos were taken and used in forest surveys. Only a small area of this map sheet on the lower right-hand side is relevant to this bibliography, as it shows the substantial area of old-growth forest then existing between SH29 in the north and extending south to Hiwiroa trig at the southern end of the Kaimai Range, and thus covering the northwestern Mamaku Plateau with streams tributary to the Waihou and Wairoa Rivers. The text on the map sheet, written in 1965, refers to the 'gradually sloping although gorge-cleft western flank of the Mamaku rhyolite plateau'. The tract of high forest between SH29 and Hiwiroa was incorporated into the Kaimai Mamaku Forest Park in 1975 and remains unlogged. It includes the Opuiaki Ecological Area and conservation forest surrounds where type D1 (rimu-rata/tawa-kamahi) is the main forest type. On the broken and steep terrain of the Plateau crest are forest types G4 and G5 with rimu/tawa-kamahi-tawari. The irregular outline of the forest margin on the western flanks of the Plateau has secondary forest or scrubland (types N7, N8, P1), indicating burning of forest in Polynesian times.

The Tukorehe Scenic Reserve (also known as Fitzgerald Glade) is mapped as type N7 (rata/tawa-rewarewa-mangeao-kamahi). A small enclave of type B is mapped on steep faces above Rapurapu and Kakahu Streams near the forest edge south of SH29; this is described as containing a few large kauri. Adjacent shrubland along Rapurapu contains abundant kauri saplings—AEB.]

Keywords: forest types—map, forest types—descriptions, physiography, western Plateau, Opuiaki Ecological Area

Nicholls, J.L. 1967b: Map sheet N67: Te Puke. Forest type map of New Zealand. Ecological survey of New Zealand's Indigenous Forests. Series No. 2. 1:63 360. Forest research Institute, New Zealand Forest Service.

[The forest types mapped on the western half of this sheet include the northern and northeastern faces of the Mamaku rhyolite Plateau, extending 'from Lower Kaimai to Kaharoa'. The Kaharoa Plateau lies to the northeast of the Mamaku Plateau and is described as a 'wing of the Mamaku Plateau'. The text on the map sheet was written in 1965 and follows the format of the other type maps in this series. The forest types on the Mamaku Plateau are the same as those on the western side, which was mapped and described on sheet N76 (Nicholls 1966), viz. in class N (logged forest with tawa predominant), type D1 (rimu-rata/tawa-kamahi) on easy terrain on the Plateau crest, and G5 (rimu/miro-tawa-kamahi-tawari) in the many gorges. Logging history is also comparable with that described for sheet N76. Gamman's tramways, constructed from the 1920s, extended east to Puwhenua and the upper catchment of the Mangorewa and Mangapapa Rivers and northwards to the Omanawa Road. The rimu/beech forest mapped as type H3 in the upper Mangorewa catchment was logged later until the 1980s, leaving an area of old-growth forest in the Mangorewa Ecological Area (AEB, pers. obs.).

Most of the cutover forest on easy terrain was converted to radiata plantations, as shown in the Ngongotaha topographic map 260-U15 (Land Information New Zealand 2000a).

A small area typed as B1 has a few large kauri and occurs 'beside the Wairoa River near Lower Kaimai and six miles further south besides its tributary, the Mangapapa River'. Where kauri forest was burnt many years earlier, kauri saplings and poles are locally abundant in the consequent lower forest and shrubland—AEB.]

Keywords: forest types—map, forest types—descriptions, physiography, soils, logging—history, pine plantations, water resources, wild animal distribution, Mangorewa Ecological Area, northern Plateau flanks

Nicholls, J.L. 1967c: Map Sheet N75: Arapuni Forest type map of New Zealand. Ecological Survey of New Zealand's indigenous forests. Series No. 2. 1:63 360. Forest Research Institute, New Zealand Forest Service.

[The eastern side of this map shows the forest types on the western flank of the Mamaku Plateau, with streams issuing from indigenous forest frequently entrenched in deep gorges. The streams are spring fed and have constant flow. Forest types on the western flanks of the Mamaku Plateau are mapped as a mosaic of rimu-rata/tawa-kamahi (types D1, D2), logged forest with tawa dominant (N class), small stands of hard beech (type K5) on steep gorge faces, and patches of rewarewa-kamahi second-growth forest (P1), probably from burning in Polynesian times, with pole podocarps in places usually close to high forest. Descriptions were written in 1965—AEB.]

Keywords: forest types—map, forest types—descriptions, physiography, western Plateau flanks

Nicholls, J.L. 1968: Forest types and Scientific Reserves, South Auckland Land District. Forest Research Institute, Rotorua. Unpublished File note 31/6/1/4, 5 August 1968, held at Landcare Research, Hamilton. 18 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: forest types, scientific reserves, Mamaku Plateau, scenic reserve list

Nicholls, J.L. 1974a: Proposed Kaimai-Mamaku Forest Park areas of scientific importance and their conservation. File note in FRI 31/6/6/1. 31 July 1974. Forest Research Institute, Rotorua. Unpublished File note held at Landcare Research, Hamilton. 6 p. plus map.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: scientific reserves, Kaimai Mamaku State Forest Park

Nicholls, J.L. 1974b: Rotorua Forest Class map. New Zealand Forest Service. Mapping Series 6. Sheet 5 1:250 000.

[This sheet, which maps the groups of forest types constituting the forest classes, shows the whole Mamaku Plateau, with streams radiating from its crest and forming tributaries to the Waikato and Waihou Rivers to the west, the Wairoa River to the north, and the Kaituna River to the northeast. It also shows the southern part of the Plateau, with Horohoro Forest containing the headwaters of tributaries that flow into the Ngongotaha and Utuhina Streams, which themselves flow into Lake Rotorua, providing the sources of Rotorua's water supply. Explanatory notes to the class map are contained separately from the map in a 3-page leaflet with references. Most extensive are the classes of tawa (left predominant by the logging of podocarps or sometimes by crown fires in the rimu-tawa class of vegetation that occurred before podocarps were logged). A substantial tract of the tawa-beech class is shown in the upper catchment of the Mangorewa River,

which was previously logged for rimu and beeches and had local regeneration of red beech, hard beech and silver beech up to pole size.

Most of these classes were relogged subsequently to utilise tawa and other residual trees, and were then cleared and converted to radiata pine plantations in the next two decades, with reservation of old-growth forest or other indigenous vegetation in eight Ecological Areas, riparian strips and gorges. See references for forest types on maps N76, N66, N67 and N75 (Nicholls 1966, 1967a–c)—AEB.]

Keywords: forest class map, forest class descriptions

Nicholls, J.L. 1978: New Zealand Forest Service Ecological Area proposals in the Mamaku-Rotorua area. Forest Research Institute, Rotorua (unpublished). 5 p. plus Forest Class map.

[This report was written in preparation for a visit of the Scientific Co-ordinating Committee to proposed Ecological Areas from 6 to 10 February 1978; it consists of notes by John Nicholls, FRI, December 1977, comprising 'an introductory account of the Mamaku Plateau and its indigenous forests, and a concise outline of the Ecological Areas proposed by the Conservator of Forests, Rotorua, as shown on the accompanying map'. The Forest Class Map, Rotorua (1975), shows the different indigenous forest classes with the location of eight proposed Ecological Areas. There are valuable notes on the Mamaku Plateau, covering physiography, climate, ash deposits (beds) and soils, the forest pattern, and the influence of humans—AEB.]

Keywords: Ecological Area—descriptions, Mamaku Plateau—forests, ash deposits (beds) and soils, Rapurapu, Opuiaki, Mangapapa, Mangorewa, Onaia, Matahana, Pukerimu, Mokaihaha

Nicholls, J.L. 1989: Mangorewa Field Trip. *Rotorua Botanical Society Newsletter 17*: 7–8.

[The Mangorewa Ecological Area was visited by members of the Rotorua Botanical Society. Three additional taxa were found below 450 m a.s.l., following the checklist made by Druce & Ogle (1975) in the general area. A further 12 taxa were found above 450 m a.s.l., including a seedling of a rare hybrid of red and black beech near the Mangorewa hut, where red, hard and silver beech also occurred. The latter three species are common in the Mangorewa Ecological Area, but black beech has not been reported. Black beech is rare over the whole Mamaku Plateau, although a small stand occurs on the western side by Leslie Road. Rare hybrids between hard and black beech have been found in the same area (Waipari catchment, and one in the headwaters of the Ngongotaha Stream). See also Clarkson (1981) for a botanical survey of the adjacent Mangorewa Scenic Reserve—AEB.]

Keywords: Mangorewa Ecological Area, botany, beech distribution, Mamaku Plateau, beech hybrids, *Nothofagus* spp., species list

North, M. 1997: Kokako, Research by Management Programme. Adult census October 1997. Unpublished report for the Bay of Plenty Conservancy, Department of Conservation, Rotorua. 12 p. plus maps and 11 references.

[This report deals with monitoring of the kokako population in part of Rotoehu Forest, mainly from 1990 to 1998, both before and following a pest control programme (1994–1997). Although well outside the Mamaku Plateau region generally considered in this bibliography, the results of the management programme in Rotoehu Forest have some relevance to pest control measures and kokako population surveys centred in the Mokaihaha and Opuiaki Ecological Areas in Mamaku forests. In 1998, the Rotoehu kokako study area, enlarged to 440 ha of tawa-dominant forest (logged for podocarps in the 1940s), was found to have a population 'at around 100 kokako, including 40 pairs'. The 1997–1998 census showed that 'the very significant increase in [kokako] numbers [started] since pest control began in 1994–95'.

Part of the present Pongakawa Ecological Area was an FRI experimental area from the 1960s. High populations of deer and possums were indicated by the browsing of rimu seedlings planted in secondary kamahi forest and the rapid disappearance of tawa seeds placed in quadrats and eaten by possums (tawa seeds are not eaten by ship rats), as well as by the strong depletion of the original palatable understorey species. A deer-proof fence, constructed c. 1960, soon showed a marked increase in palatable species, including some not represented outside the fence, despite being occasionally breached (AEB, pers. obs.).

During recent visits to Rotoehu Forest to remeasure ecological transects to monitor long-term vegetation trends, there have been marked changes in the understorey of the young tawa seedlings, possibly depleted by possums eating tawa seeds and changes in microclimate (MCS, pers. obs.). The transect remeasurements and recorded vegetation changes must have relevance for kokako diet. In the 1960s, the kokako were seen feeding on supplejack berries near Miro Road (AEB, pers. obs.)—AEB.]

Keywords: kokako, *Callaeas cinerea*, kokako—population, pest control, kokako—breeding, vegetation changes, Rotoehu Forest, research by management

O'Connell, B. 1999: A baseline study of *Paryphanta busbyi* in Kaimai Ranges Region. Tauranga Area Office, Department of Conservation, Tauranga (unpublished). 20 p. with illustrations, plus 16 references.

[The study area was one of three sites within the Kaimai Ranges where *Paryphanta busbyi* (the kauri snail), a nocturnal carnivorous land snail, had been transferred from Dargaville c. 30 years previously. The site, 'on the north-western edge of the Mamaku rhyolite plateau at 324m asl is on private land within an area of 227ha of virgin forest with rimu, kahikatea, tawa and rewarewa and areas of tree ferns'. The site is south of SH29, within the area covered by this bibliography.

The author concludes that this kauri snail has established itself successfully on the site, having found 19 live snails and 20 empty shells in the study area. The species is identified as *P. busbyi*. All empty shells showed signs of rat attacks, rats being one of the many agents that endanger this threatened endemic snail. Study methods are described and recommendations given for safe-guarding this snail population. Information is given on the preferred habitat of the snail—AEB.]

Keywords: kauri snail, *Paryphanta busbyi*, habitat, rat, *Rattus* spp., rat—prey, conservation

Owen, K.L. 1999: Bird survey of the Opuiaki Ecological Area and adjoining Kaimai-Mamaku Conservation Park, Bay of Plenty 1975. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 14 p. plus maps and 11 references.

[The author took part in the wildlife survey of 1975, which was conducted over 9700 ha of forest, then known as Mamaku State Forest 3. Ian Crook, in 'Fauna Survey Unit Report No. 9' (1978), emphasised the status and distribution of North Island kokako, with less comment on other indigenous birds. Owen's (1999) report gives further information on eight bird species and sign of introduced wild animals from records made during 5-minute bird counts or within 100 m of the stations. Taped calls of the kokako were played at some stations.

The dominant forest type in the central part of the survey area (now the Opuiaki Ecological Area), which covered 3816 ha, was rimu-rata/tawa-kamahi, with occasional large emergent rimu and abundant tawa (Nicholls 1974b). Most of the area surveyed was unlogged podocarp and podocarp/tawa forest on the northern Mamaku Plateau, and lies in the Otanewainuku Ecological District.

Appendices 1–8 include figures of the 1975 distribution of eight bird species (New Zealand falcon, New Zealand pigeon, kaka, parakeets, rifleman, whitehead, North Island robin and North Island kokako), showing their locations at bird-recording stations. Four falcons and only two (yellow-crowned) parakeets were recorded, and there were few rifleman. New Zealand pigeon and kaka were recorded as widespread (though few in numbers). Robins were abundant and widespread. The total number of whiteheads (40) was considered to be low in view of the large area of apparently suitable habitat surveyed. Kokako were recorded at 43% of stations and were distributed throughout the study area, except where there had been recent vegetation disturbance. Possums were also present throughout the area, although numbers were considered to be low, and cattle sign was often recorded. Deer were recorded at only two stations. The author notes a recent observer's comment that possums had become abundant (by 1999), as well as some evidence of canopy collapse, which may not be directly related to possum browsing—AEB.]

Keywords: bird survey, Opuiaki Ecological Area, Kaimai Mamaku Forest Park, kokako, *Callaeas cinerea*, kaka, *Nestor meridionalis*, forest types, cattle, *Bos taurus*, deer, *Cervus* spp., possum, *Trichosurus vulpecula*

Palmer, D.J.; Lowe, D.J.; Payn, T.W.; Hock, B.K.; McLay, C.D.A.; Kimberley, M.O. 2005: Soil and foliar phosphorus as indicators of sustainability for *Pinus radiata* plantation forestry in New Zealand. *Forest Ecology and Management 220*: 140–154.

[From the authors' abstract:]

We investigated how multiple-crop forestry has influenced the magnitude and variability of soil and plant phosphorus (P) fertility and site disturbance. Kinleith Forest, on Mamaku Plateau, covers > 100,000 ha and comprises mainly plantation *Pinus radiata*. Three study areas in the forest were chosen to represent natural state (native forest), first crop of *P. radiata* (24 years growth), and second crop of *P. radiata* (4 years growth of second crop). The adjacent areas have similar relief and climate, and the soils are all the same age, being predominantly Andic Haplohumods developed in 1770 calendar-year-old non-welded tephra (Taupo Ignimbrite, ca. 0.5–0.8 m in thickness) and overlying a buried paleosol on earlier tephric material.

[One of the three study sites (each 120 m × 200 m), which was located in the Mokaihaha Ecological Area, was characterised as having soils in their original state (upland native podocarp/broadleaved forest) (see Smale et al. 1997)—BRC.]

Keywords: radiata pine, *Pinus radiata*, soil condition—phosphorus, Mokaihaha Ecological Area

Pardy, G.F. 1983a: Performance of podocarps planted in reverted cutover forest, SF3. Part 1. Hand-cleared gaps. Project Record 254-1. Forest Research Institute, Rotorua (unpublished). 32 p. plus 16 tables in appendices and location plans.

[This report outlines the methods used to establish 5000 nursery-raised podocarps in hand-cut gaps along lines over 11 ha of residual and regrowth forest on the crest of the Mamaku Plateau. Growth and survival are recorded for the 16 years from first planting in 1960. The report is one of four on performance of podocarps, using different methods of site preparation, all of which are annotated in this bibliography (see Pardy 1983b–d) and summarised by Beveridge & Bergin (2000). Release of planted seedlings from suppression by competing vegetation was carried out at 7 and 16 years for some groups, with a full assessment of each planted group in 1976. Only dominant or potentially dominant saplings were measured for height in sampled groups in 1976, although all groups were described. Groups of 9, 13 or 25 seedlings were planted at centres approximately 20–30 m apart, with cleared groups 6–12 m in diameter. The importance of microsite is emphasised, with low survival on compacted or poorly drained ground, or where toetoe and *Gahnia* had become densely established in place of shrub hardwoods.

Survival of all planted rimu, kahikatea and totara was around 60% for the period 1960–1976, although average height (including many suppressed seedlings) was only 1.6–2.4 m for the three species. In the best-grown groups, survival was over 70% and height c. 3 m. Much detailed and useful information is given in the text or appendices, including the history and site description of the trial area, the nature of vegetation invading hand-cut gaps, the ability

of each planted species to compete with regrowth, and their survival and growth on different microsites. Guidelines for improving the performance of podocarps and the efficiency of site preparation include use of larger planting stock (only 40–50 cm tall in this trial), a reduction in the number planted per canopy gap (a cluster of 3–5 seedlings per gap) and careful selection of microsites. Rimu was considered to be the best performing species, owing to its tolerance to suppression or shaded conditions for long periods and ability to respond to increased overhead light. Rimu grew more uniformly over a wider range of sites than totara and kahikatea, though these species had comparable rates of height growth and survival.

Lack of releasing from competing vegetation for the first 7 years after planting resulted in slow early growth of all podocarps and some were smothered and died. In the summer of 1982/83, at about 22 years after planting, all competing vegetation in the planted groups was removed, with the object of producing 'light wells'; this resulted in much better growth of podocarps (see Beveridge & Bergin (2000) for results 40 years after planting). Browsing of large-leaved shrubs was not recorded on this site, which was apparently only visited by occasional deer, although had an unassessed population of possums. Insect damage was recorded for each species planted, with least damage to rimu.

The habitat was marginal for planted tanekaha and matai, both of which have developed abundantly at the northern edge of the central Mamaku Experiment Area by Cecil Road, where tawa was removed to fuel haulers during early logging, resulting in a frosty site with small-leaved shrubs (AEB, pers. obs.).

In the current trial area, the author states that there was no natural regeneration of matai (p. 27). Planted matai had a survival of 61%, although annual height growth of all seedlings was only 3 cm. The trial site at 550 m a.s.l. is described as comparatively harsh, with poor drainage and cold winter climate (pp. 3, 25), which is typical of the Mamaku Plateau, where rainfall is 2000 mm per year and there are 40–50 ground frosts annually. Soils are not particularly fertile, with high allophane content. Soil samples taken from the trial site are described as podzolised sandy loams (see Rijkse 1979).

This trial and other enrichment trials in which indigenous tree species were planted to restore a high forest in Mamaku Forest have been recorded in some detail, as there is now increasing interest in rehabilitating disturbed indigenous forest elsewhere and returning some plantations of exotic conifers to indigenous forest—AEB.]

Keywords: podocarp—enrichment trial, group planting, reverted cutover forest, Mamaku Plateau, podocarp—survival and growth, toetoe sites, shrub hardwood sites, hand-cut groups for planting, podocarp—ecology, forest restoration

Pardy, G.F. 1983b: Performance of podocarps planted in reverted cutover forest, Mamaku, SF3. Part 2. Tractor-cleared lanes. Project Record 254-2. Forest Research Institute, Rotorua (unpublished). 7 p. plus tables and graphs.

[This trial area was flatter and more seasonally wet than the sites described in Part 1 (Pardy 1983a). The method of clearing 10–20-m-wide lanes for blanket planting 5700 bare-rooted nursery-raised kahikatea, rimu and totara over 3 ha left a site exposed to frosts and wind, and the strips of residual forest left between lanes tended to disintegrate over the period between planting in 1961 and the final measurement of survival and growth in 1974. The tractor blading left the ground scraped and compacted or with various degrees of topsoil mounding, resulting in uneven growth of planted podocarps. There was some overall site selection, with kahikatea planted on wetter ground and totara on drier sections. At 13 years after planting, survival of kahikatea was 92%, and survival of rimu and totara around 72%. The invasion of cleared ground by grasses and pioneering indigenous shrubs is recorded. Following the early invasion of Yorkshire fog, a dense growth of toetoe developed, particularly on scraped or compacted ground, while areas with topsoil had wineberry and karamu, or longer lived shrubs such as pate, fuchsia, kanono, mahoe and fivefinger, which eventually suppressed much of the toetoe. After 13 years, mean height of the podocarps was 2–3 m, with most remaining in competition with invading vegetation in the absence of more than minimal releasing at intervals of measurement. Rimu was the species most tolerant of a range of microsites and a greater degree of shade. It also had minimal insect damage (planting stock was small for the conditions at only 23 cm in height). At 20 years after lane clearing, pioneer growth of wineberry and karamu was dying out, allowing increased light and an increase in the rate of podocarp growth.

The method of lane clearing by tractors is not recommended for this harsh upland site. Instead, hand-cutting of regrowth or more discrete disturbance by machine for establishment of small groups of podocarps are favoured site preparation methods if supplementary planting is to be done in any reverting cutover forest where sources of seed of tree species have been removed, as they result in far less destruction of residual forest—AEB.]

Keywords: site preparation, reverted cutover forest, Mamaku Plateau, podocarp—survival and growth, podocarp—enrichment trial, tractor-cleared lanes, forest ecology

Pardy, G.F. 1983c: Performance of podocarps planted in reverted cutover forest, SF3. Part 3. Tractor cleared gaps. Project Record 255. Forest Research Institute, Rotorua (unpublished).

[In 1961, around 15 000 bare-rooted nursery-raised rimu, kahikatea and totara were planted in tractor-cleared canopy gaps over 30 ha of reverted cutover forest in the northern experimental area near SH5 on the Mamaku Plateau at 550 m a.s.l. Each plot contained 13, 25 or 41 seedlings of a single species in circular gaps. Sample measurements were last made in 1974 and gave an overall survival of 86% for kahikatea, 75% for rimu and 49% for totara. Survival was not affected by group size. Over 13 years, the mean annual height increment was 12–13 cm for all three species. A trial to release podocarp seedlings by using chemical spraying 2 years after planting was not effective in increasing survival or height growth. The tractors avoided patches of residual high forest and steeper ground, as shown in a location plan with numbered planted groups and lines.

The trial site and vegetation invading gaps and competing with planted podocarps are described in reports on hand-cut groups and tractor-cleared lanes (Pardy 1983a, b), each of which provides guidelines for more effective methods for establishing podocarps—AEB.]

Keywords: podocarp—enrichment trial, group planting, Mamaku Plateau, podocarp—survival and growth, forest restoration, reverted cutover forest

Pardy, G.F. 1983d: Performance of podocarps planted in reverted cutover forest, SF3. Part 4. Totara planted in hand cleared gaps, 1959. Project Record 255. Forest Research Institute, Rotorua (unpublished). 16 p. plus tallies and graphs.

[This was a small trial in which 200 totara seedlings were group planted (interplanted) and measured on a site broadly described by Pardy (1983a–c) for the same 40-ha block. This block was also used to assess the growth of planted totara, rimu, kahikatea and tanekaha, along with small numbers of matai, miro, hinau and tawa over a period of 13–16 years; see Pardy & Steward (1989) for tawa and miro, and Steward (1986a) for hinau.

In this trial, totara seedlings were planted in 1959. These were mainly nursery-raised wildings from Pureora Forest planted in hand-cleared canopy gaps. Final measurements were made in 1976, at which time totara survival was 92% and the mean height of the most vigorous two seedlings in each group was 3.7 m. An initial application of blood and bone and a single releasing from competing vegetation after 4 years gave no significant benefit, and nor did the use of four exotic nurse species, most of which had died after 17 years, never having been required.

This trial tested the performance of totara on an extreme site for the species, near its upper altitudinal range and in competition with vigorous shrub hardwoods and ferns, some of which coppice vigorously after cutting (e.g. pate, mahoe and kanono). Some trees were also planted on unsuitable microsites with poor drainage, or on ground compacted by earlier logging. Totara is regarded as one of the podocarps least tolerant of shade after

germination of seed in natural conditions, and in this trial nursery-raised totara seedlings, which were planted at a height of 40 cm, showed the characteristic persistence of the species once established[14] by planting, with high survival at 17 years, despite a relatively slow growth that averaged 20 cm per year. In 1982, all planted groups in this trial (across 40 ha of the whole experimental area) were inspected, dominance status of the totara was judged and type of regrowth was assessed. Totara was released from overtopping vegetation and some dominant trees were pruned (assessment data on file in 'Mamaku' archive at Scion, Rotorua). The release and tending of planted podocarps in this trial and over the whole 40-ha experimental area allowed most trees to expand their crowns above the shrub hardwoods, with some reaching heights of 10–13 m at 40 years after planting. Totara has shown vigorous growth at another extreme site at Aratiatia, where totara was planted in the open on coarse Taupo pumice and slow-acting 'Magamp' was applied at planting (MCS, pers. obs.). These contrasting sites indicate the large potential for restoration planting of totara in the central North Island—AEB.]

Keywords: totara—Mamaku planting trials, *Podocarpus totara*, group planting, restoration planting

Pardy, G. 1989: Assessment of long-term indigenous planting trials at Mamaku, Woodhill and Kaingaroa. Contract report 11. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 10 p. plus tables.

[This report outlines a rehabilitation and revegetation workplan for podocarps (recording survival and growth) for restoration planting in contrasting conditions: wet climate (Mamaku), sand dunes (Woodhill), and dry harsh and frosty upland (Kaingaroa).

In the Horohoro trial on the southern Mamaku Plateau, rimu and kahikatea seedlings were planted in canopy gaps in partially-logged forest (where most sound rimu had been removed) on an upland site (550 m a.s.l.). At 11 years after planting, survival rates of both species were 90% or more, while height growth rates were moderate (18 cm/year for rimu and 23 cm/year for kahikatea). For further annotations on this trial, see Pardy & Wicken (1988) and Wilcox (1985). The trial area was included in the southeastern part of the Mokaihaha Ecological Area and was established in 1983.

The Kaingaroa trial of 12 ha, which is also included in this report, was established on a harsh, frosty site, also at 550 m a.s.l., with podocarps planted beneath a thinning canopy of *Pinus ponderosa*. A recent inspection of the Mamaku trial (AEB and Mike Wilcox (Foresty consultant) on 20 October 2006) has shown that at 44 years after planting, dominant rimu and totara with full crowns averaged 8–10 m in height and 15–25 cm diameter. The

[14] Totara seed may germinate and remain as small seedlings under 15 cm tall on shaded sites under natural conditions; they will not grow enough to become established and reach tree size unless light increases. The critical period is the small seedling stage. In this trial, the period did not exist, as 40-cm-tall seedlings were planted and light increased by tending. In 2006, planted totara trees up to 30 cm diameter and 10 m tall were noted (AEB, pers. obs.).

vigorous blackberry reported at 25 years has been totally suppressed by the closing canopy of the podocarps (AEB, pers. obs.)[15].

The main conclusion in this report is that 'native conifers have proved very adaptable, being established successfully on a range of sites under varying canopy, soil and climate conditions. Rimu has proved to be the most successful of the three podocarp species planted, maintaining better form and vigour, and being more shade tolerant'—AEB.]

Keywords: podocarp—planting trial, restoration planting, Horohoro Forest, Kaingaroa Forest, podocarp—survival and growth

Pardy, G.F.; Bergin, D.O. 1992: Performance of native conifers planted in the early 1960's. *New Zealand Tree Grower, February 1992*: 2–5. Illustrated.

[A brief appraisal is given of the extensive 1961 Mamaku trials, during which podocarps were planted on sites prepared using different methods. On a cool, wet plateau, 550 m a.s.l., survival at 26 years after planting for kahikatea, rimu and totara was 78%, 62% and 56%, respectively. There was minimal releasing from dense regrowth until 15 years after podocarp establishment, although complete releasing was carried out in the summer of 1982/83. At 26 years after planting, the height of the three main podocarp species was 5–7 m for dominant young trees throughout the trial area. Site preparation methods are described and much detail of the trials is given in earlier reports (Pardy 1983a–d). This appraisal at 26 years updates the earlier accounts of podocarp performance in the trial, and compares growth rates at Mamaku with the faster growth of podocarps planted in warmer, lowland sites on more fertile soils—AEB.]

Keywords: podocarp—planting trial, performance of planted podocarps, site preparation, harsh upland sites, Mamaku Forest

Pardy, G.F.; Cashmore, P.; Owen, K.; Griffiths, R. 1999: Conservation and research values of three Mamaku Plateau Forest Research Limited Experimental Blocks. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 16 p. plus 3 colour aerial photos and 21 references.

[Excerpt from authors' introduction and background:]

Purpose of the report: This report describes the nature conservation values associated with three areas of land located on the Mamaku Plateau and currently owned by (New Zealand) Forest Research Limited (figure 1). This report was largely compiled from existing reports and unpublished information.

Prior to April 1987, the Forest Research Institute (FRI) had almost unlimited access to State Forests to conduct long-term experimental work with both exotic and native tree species. With the dissolution of the NZ Forest Service in April 1987, the Ministry of Forestry (MOF) which took over responsibility

[15] Tane's Tree Trust (www.tanestrees.org.nz/; viewed 2007) records contain information on this work, as well as other experimental work undertaken in central North Island indigenous forest, including Mamaku, Pureora and Whirinaki Forest Parks. Topics covered include conservation, management and ecology, as well as restoration planting with indigenous trees.

for managing FRI was in the position of possibly losing access to land for long-term trial work, or having direct control over some experimental areas. They included some of the first radiata pine establishment trials on the Mamaku Plateau near Rotorua, also some of the best and most successful FRI indigenous plantings. Consequently, proposals were submitted by the Ministry of Forestry to the Parliamentary Land Allocation Committee to have three separate areas on the Plateau vested in the Ministry as an experimental forest. This submission was accepted and approved by the special Ministerial Co-ordinating Committee on State Owned Enterprises, on 26 November 1986.

The three experimental blocks cover 645ha of previous State Forest land, now Crown land near Rotorua on the Mamaku Plateau. Of the total area, 84% is in indigenous forest, 8% in exotic forest and 8% in pasture in three separate blocks of 260ha (North Block), 278ha (Central Block) and 107ha (South Block).

[The situation in 1999 was that FRI had reduced its long-standing commitment to indigenous forest research and had no further interest in long-term monitoring of early plantings of indigenous trees, or measures to restore disturbed indigenous forest. Steps had been taken to prepare for the sale of the three experimental blocks, part of which could be used as lifestyle blocks through changes in planning zone. For further developments, see the Nature Heritage Fund application to purchase the northern and central experiment areas (Department of Conservation 2002).

This report gives an excellent account of the conservation and research values of each of the northern, central and southern blocks in terms of botanical, wildlife and future research values. Descriptions and research history of each block are given. Aerial colour photos show the location of each block, access routes and some features such as terrain, canopy density, clearings and wetland. Other features are shown in smaller-scale plans. Much of the content of this report, with some updating, is included in the report on the Nature Heritage application by Department of Conservation (2002). Annotations have been made for many of the papers in the reference list or mentioned in the text, including those of Pardy (1983a–d) for podocarp plantings, and Steward (1986a, b) and Steward & Klomp (1988). The conclusions of this report emphasise the point that all three blocks can serve as ecological corridors, linking them with large areas of forest with high botanical and wildlife values. All blocks also contain some areas of grassland and exotic tree species, which could eventually revert naturally to indigenous vegetation and to high forest, especially if the process can be aided or hastened by undertaking restoration measures, including retention of shelter by manipulation of exotic species before their total removal. The northern and central blocks were purchased from FRI by the Nature Heritage Fund in 2002, and in 2006 were managed by DOC as parts of the Patetere Scenic Reserve—AEB.]

Keywords: conservation—values, research—values, experimental reserves, Mamaku research forest, planting trial, forest restoration, wildlife and botanical values, Patetere Scenic Reserve

Pardy, G.F.; Steward, G.A. 1989: Performance of planted and natural tawa and natural miro seedlings in gaps in reverted cutover forest. Project Record 2373. Northern Wildlands Research Field, Forest Research Institute, Rotorua (unpublished). 8 p.

[The trials outlined in this report were established in 1961, when little was known about the survival ability and growth rates of tawa and miro seedlings. These are two of the most shade-tolerant of indigenous tree species in central North Island forests, where their natural regeneration can be abundant on the most suitable sites. It was known that natural regeneration of both species could occur in small, natural canopy gaps, although the gaps made by earlier logging of rimu had been occupied by a dense growth of shrub hardwoods on the moister sites, suppressing development of small natural miro and tawa seedlings. Small gaps in the lower canopy were created for planting by the removal of groups of shrubs, most species of which produce vigorous coppice shoots from cut stems.

This trial was in part of the former northern FRI experimental area in Mamaku Forest, located just to the north of the narrow strip of old-growth forest by SH5, and the area is now incorporated in the expanded Patetere Scenic Reserve.

Over a period of 16 years, natural tawa seedlings less than 1.5 m in height grew at the same slow rate as nursery-raised seedlings, with a mean annual height increment of around 2 cm and a survival rate of around 80% on sloping, better drained ground. In contrast to the slow growth of smaller tawa seedlings, large naturally occurring tawa seedlings or saplings (over 1.5 m high initially) grew faster, with a mean annual height increment of 11 cm. This was approximately the same growth rate as miro seedlings or saplings, which also had a comparable survival rate.

Enrichment planting with miro and tawa is not required for restoration of disturbed tawa/podocarp forest, as tawa regenerates continuously on ridges or better drained ground and miro regeneration has been found to occur abundantly in reverting cutover forest on the Mamaku Plateau (see Cameron 1959)[16]. In the northern FRI experimental area, miro may be present in all size classes on suitable sites (as for tawa), with some reaching pole or small tree size, following a reduction in residual upper canopy density since the last logging operation over 60 years ago; see Beveridge (1973) for comment on miro regeneration, and Smale (1981) for growth rates and mortality of tawa.

The crowns of taller kamahi are subject to possum browsing and generally show signs of dieback or thin crowns (see Fitzgerald 1977). Windfalls of kamahi, tawa and tawari have occurred, and pioneer shrub hardwoods such as karamu and wineberry have died on disturbed ground, starting to decline at 10–15 years age after regenerating in patches cleared for planting podocarp groups—AEB.]

Keywords: tawa and miro regeneration, *Beilschmiedia tawa*, *Prumnopitys ferruginea* podocarp—survival and growth, regeneration, Mamaku Plateau, forest ecology, canopy gaps, Patetere Scenic Reserve

---

[16] Regeneration sampling was carried out in the southern and central FRI experimental areas in 1962, although results have not been found in FRI records (AEB, pers. obs.)

Pardy, G.F.; Wicken, A. 1988: Performance of cluster-planted rimu and kahikatea in selectively-logged forest, Horohoro State Forest 31, Mamaku Plateau. Department of Conservation Contract report No. 14. Forest Research Institute, Rotorua. Also issued as Indigenous Forest Management Project Record No. 1803. 11 p.

[This work illustrates the concept of 'cluster planting' nursery-raised podocarps on selected microsites on disturbed ground, following an uncontrolled partial logging in 1975, which removed all the best rimu and left few larger-crowned trees to serve as seed trees. Clusters consisted of 3–5 close-planted seedlings per selected microsite, according to degree of soil compaction, in canopy gaps made by logging. Nine podocarp seedlings were planted for every tree removed by logging. The trial was established in 1976, and sample assessments of height growth and survival were made at intervals until 1987. At 11 years after planting, survival of podocarps was high—89% for rimu and 92% for kahikatea—despite some trampling by stray cattle and dense growth of toetoe on some sites. The 50-ha trial site is now included in the southern part of Mokaihaha Ecological Area, managed by DOC.

Possums were present in the area, but no deer were reliably reported in the 1970s. The only damage to planted seedlings recorded was from insects, with loss of leaders as a result of larvae of the stem-boring longhorn beetle, *Navomorpha lineatum*, resulting in bushy multiple-stemmed crowns on some 30% of kahikatea and rimu. Invasion of logging gaps by shrub hardwoods, toetoe and ferns is described, although most planted seedlings were released from competition at the time of earlier measurements. At 11 years after planting, the mean annual height increment was 20 cm for both rimu and kahikatea, although some kahikatea had an annual height growth of 30 cm. Invading shrubs still dominated some planted clusters, although surviving podocarps were emerging from toetoe, which formed a dense 2-m-high cover in large canopy gaps. The residual forest canopy was dominated by tawa and was considered to be opening through crown deterioration and windfall.

After cluster planting, two additional trials were established in 1977 to assess the effect of six different fertilisers applied to planted rimu and kahikatea, and four chemical sprays to release seedlings from competing vegetation. The authors consider that the fertilisers had no significant effect on growth and survival of the podocarps, and the use of chemical sprays reduced vegetation competition for up to 2 years (see also Wilcox 1985)—AEB.]

Keywords: Horohoro Forest, podocarp restoration planting, cluster planting trials, rimu, *Dacrydium cupressinum*, kahikatea, *Dacrycarpus dacrydioides*, fertiliser, chemical releasing, podocarp—survival and growth, canopy gaps

Parrot, G.E.; Parsons, J.W. (Comps) 1989: FRI (Forest Research Institute) trials in Horohoro and Whirinaki Forests. Forest Research Institute, Rotorua (unpublished). 18 p. Includes illustrations.

[Only one trial with a location map is referred to in Horohoro Forest—now in the Horohoro Forest Conservation Area, by McPherson's Road. This trial consisted of the planting of small groups of rimu and kahikatea seedlings in 1976 along log-extraction tracks, following an uncontrolled partial logging operation where the best rimu logs were removed leaving the unwanted matai (see Wilcox 1985; Pardy & Wicken 1988). The total area covered by the group planting was 50 ha. The logging tracks were quickly invaded by toetoe. A sample measurement of the growth and survival of the podocarp seedlings was made by George Pardy in 1988. The objective of the trial was to restore podocarps to the forest canopy over the long term, with early assessment of the influence of soil compaction and fertiliser application at planting time—AEB.]

Keywords: podocarp—planting trial, Horohoro Conservation Area, group planting trial

Penman, J.T. 1988: Volume, taper, and bark thickness in seedlings and cuttings from Mamaku Forest, New Zealand. *New Zealand Journal of Forestry Science 18(3)*: 311–317. Includes 11 references and 5 tables.

[From the author's abstract:]

A row-by-row comparison of 'bulk collected' *Pinus radiata* D. Don cuttings and seedlings was planted out in 1970 on a cleared indigenous cutover site in Mamaku Forest.

[The site was at the western side of the former northern FRI experimental area in Mamaku Forest. The radiata pines were removed and further pines planted by 1996. As cutover tawa forest exists on three sides of the pine plantings adjacent to the northern margin of the Scenic Reserve by SH5, the pines could be harvested and the site returned to indigenous vegetation (AEB, pers. obs.). These pines were felled and the area replanted by FRI—AEB.]

Keywords: radiata pine, *Pinus radiata*

Pracy, L.T. 1974: Introduction and liberation of the opossum (*Trichosurus vulpecula*) into New Zealand. *New Zealand Forest Service Information Series No. 45*. New Zealand Forest Service, Wellington. (2nd ed.; first printed 1962.) 28 p. plus map showing liberation points.

[The only references to the official authorised liberation points for possums near the Mamaku Plateau mentioned are Ngongotaha and Arahiwi in 1951, although Oropi Forest is listed for 1893, and liberations were made in 1905 and 1906 by the Rotorua Lakes (Rotoiti, Okareka, Rotoma, Okataina).

Pracy notes that unauthorised liberations from New Zealand-bred stock had occurred on a large scale. In a discussion on the colonisation and establishment of possums, Pracy refers to different views about their spread and comments

that the combination of 'opossums' and deer should have been dealt with in the context of greater damage to forests where both are present.

On the Mamaku Plateau, possums have been widespread for at least 50 years (possibly 100 years through unauthorised liberations), while deer have spread more slowly, being absent or rarely recorded over the past 10 years in some northern parts, e.g. in the Opuiaki Ecological Area (AEB, pers. obs.)—AEB.]

Keywords: possum, *Trichosurus vulpecula*, possum—liberation, Mamaku Plateau

Pullar, W.A.; Birrell, K.S. 1973: Age and distribution of Late Quaternary pyroclastic and associated cover deposits of the Rotorua and Taupo Area, Central North Island, New Zealand. *New Zealand Soil Survey Report No. 1*. New Zealand Soil Bureau, Department of Scientific and Industrial Research.

[Not seen by the authors of this bibliography.

A note by Shaw et al. (1990) in 'Bibliography for Te Urewera National Park' states that this 'Includes maps of basal tephra beds, thickness of cover deposits, subsurface loess deposits, isopachs and tephra volumes and the relationship of cover deposits, to underlying rocks'. As the paper refers to tephra from the Taupo and Kaharoa eruptions, and these occur in both the Urewera Park and on the Mamaku Plateau, Pullar & Birell's work is relevant to the Mamaku Plateau soils and ecology—BRC.]

Keywords: geology, Rotorua, Taupo, tephra, loess, volcanicity

Rasch, G. 1989: Wildlife and wildlife habitats in the Bay of Plenty region. Unpublished report under contract to the Department of Conservation, Rotorua. 93 p. plus 74 references, 6 appendices, tables and maps.

[The forests of the Mamaku Plateau and its flanks are located on the western side of the Bay of Plenty region that was surveyed by the Fauna Survey Unit over the years 1982–1984. Sites of Special Wildlife Importance (SSWI) are shown by numbers on a pocket map, while their descriptions and ranked values are given on sheets interleaving the text, listing name, number, map reference, area and tenure of each site. A brief account of the Mamaku Plateau forests, which are classed as 'significant forests in the Bay of Plenty region', is given on pages 12 and 13, summarising the overview of Saunders (1983), which is annotated in this bibliography.

Sixteen SSWI sites are ranked as having outstanding value in the Mamaku Plateau, which extends north to Puwhenua Forest and east to the Kaharoa Plateau. A long corridor of forest extends from the Kaimai Mamaku Forest Park to the Mangorewa and Puwhenua Forests. A particularly important site on the Mamaku Plateau is the Opuiaki Ecological Area, while a number of smaller or less important sites on and adjoining the Mamaku Plateau are included in an alphabetical index for SSWI sites. It is noted that exotic conifer forests, which can support populations of indigenous insectivorous birds, can sometimes act as corridors for indigenous wildlife.

There are introductory accounts of background, topography, vegetation, wildlife and the influence of human settlement in the Bay of Plenty region, and a chapter on methods used and results obtained by the Fauna Survey Unit. A chapter on wildlife in the Bay of Plenty lists the sites where threatened and endangered birds and reptiles occur, and their distribution is shown on maps in an appendix. The Mamaku Plateau area has kokako, kiwi, blue duck, New Zealand falcon, kaka and (rarely?) parakeets, as well as the striped skink and forest gecko. There is one record of the land snail *Paryphanta busbyi* (p. 91), which has survived transfer to the Kaimai Ranges (O'Connell 1999). It is finally stated (p. 93) that the enhancement of forest quality through the control of browsing mammals and the establishment and maintenance of forest corridors should be the major issue regarding wildlife sites in the Bay of Plenty. It could also have been stated that control of predators such as possums, rodents and mustelids is essential on some sites—AEB.]

Keywords: wildlife habitat, protected areas, Mamaku Plateau, Mamaku Forest, forest corridor

Rijkse, W.C. 1979: Soils of Rotorua Lakes District, North Island, NZ. *New Zealand Soil Survey Report No. 43*. New Zealand Soil Bureau, Department of Scientific and Industrial Research, Wellington. 43 p. plus 44 p. appendix and folding map.

[The soils on the crest of the Mamaku Plateau are classed as podzolised yellow-brown loams (allophanic soils) below layered tephra, and are mapped mainly as Mamaku loamy sand and Mamaku Hill soils. An area along and to the east of Gamman's tramway (with beech forest) is mapped as Mangorewa sandy loam. The steep slopes of entrenched stream valley are mapped as Arahiwi steepland soils.

Physical and chemical properties of the soils are described. The soils classed as podzolised yellow-brown loams on the Mamaku Plateau occur in high-rainfall areas at elevations above 550–600 m a.s.l. They are formed from the older, more weathered tephra with only a thin (10–15 cm) patchy cover of Kaharoa Ash and Taupo Pumice. Tephra in the subsoil or near the surface on the Mamaku Plateau include ash showers from the Okataina (Volcanic) Centre. Mamaku Ash, which occurs near the surface in the northern parts of the Mamaku Plateau, is described as a brown, greasy sandy loam, consisting mainly of allophanic clay, as in the former FRI experimental areas now in the Patetere Scenic Reserve (AEB, pers. obs.). Photos of soil profiles described on the flanks of the Mamaku Plateau (Oturoa Road) and near the crest (South Road) are included. The Soil Information Sheet in the appendix describes the features of the soils mentioned above—AEB.]

Keywords: soils, tephra, vegetation, climate, topography, soil profiles, land use, soils map

Rudge, M.R. 1986: Presidential address. Science, land management, and accountability. *New Zealand Journal of Ecology 9*: 1–10.

[The author deplores the ongoing attrition of forests, scrublands and wetlands in New Zealand, and gives a historical perspective:]

Although it is the action groups that attract well-deserved attention, some of the best scientists in New Zealand have also argued for many years that the attrition of native biota should be halted. Prominent among them have been 'the two Knights of conservation', Sir Charles Fleming and the late Sir Robert Falla, and Professor John Salmon. They have between them produced many articles and speeches to professional colleagues, administrators, politicians, and lay public. Sir Robert, defender of the great wetland areas of New Zealand (Falla 1975) failed to prevent the huge losses to them over his lifetime or since. Fleming, in a plea for the forests, wrote his essay 'Mammon on the Mamaku' (Fleming 1969), see also McEwen (2005). Yet we look at the Mamaku and other lowland native forest areas today, and lament what is still happening to them both aesthetically and scientifically in the name of commerce.

[The argument for a conservation ethic is presented and the author believes that 'the key lies in the concept of the ancient Gondwanaland super continent'. He wants the scientific basis for managing the natural environment to be more generally accepted.

The defining of Ecological Areas in Crown forests as representative areas of forest ecosystems was proposed by John Nicholls of FRI, and was recommended to NZFS and Government by a Scientific Co-ordinating Committee in the 1970s. These Ecological Areas in central North Island, including the forest of the Mamaku Plateau with its population of kokako, are often the localities for research on birds and other endangered biota—AEB.]

Keywords: ecology, endangered biota, land use, land development, conservation, Gondwanaland, science and politics

Saunders, A.J. 1983: Wildlife and wildlife habitat values of the Mamaku Plateau—an overview. *Fauna Survey Unit Report No. 37*. New Zealand Wildlife Service, Wellington. 57 p. plus 9 folding maps, 38 references and 6 appendices.

[This overview covers forest under various tenures on the Mamaku Plateau and its flanks, with the study area shown on Map 1, one of a series of pocket maps showing locations of points of interest discussed in the text.

An introduction emphasises that the Mamaku Plateau is a nationally important wildlife habitat resource 'requiring urgent action for establishment of reserves to protect sites of special interest'. The scope of the text is wide, and includes outlines of the history of logging of the indigenous forest from the 1880s and the history of State Forest leases approved by a Cabinet Committee on Forestry in 1968, which resulted in logging of residual forest for tawa pulpwood and conversion to plantations of radiata pine on some 13 000 hectares that had been cleared of indigenous forest. An assessment of the forests and wetlands of the Mamaku Plateau was carried out by the

Fauna Survey Unit of the Wildlife Service over a period of some 6 weeks in October/November 1982. Survey methods are described, and there are brief accounts of terrain and vegetation. Previous wildlife surveys on the Plateau are reviewed, and the distribution and characteristics of threatened and endangered birds and habitat requirements are discussed. Thus, there are accounts of kokako, kaka, blue duck, kiwi and fernbirds. No parakeets were located during the recent survey. A few sightings of the New Zealand falcon were made. Wildlife habitat values are discussed for each of the eight forest areas surveyed, each of which has parts reserved as indigenous forest and parts converted to exotic conifers, mainly radiata pine. Forests owned by, or leased to, private companies are also covered. Most of these private forests have changed ownership in recent years, although approaches to managers on matters of reserves for birdlife have resulted in reservation of some riparian indigenous vegetation and other areas that are too small for long-term habitation of kokako but useful for other indigenous birds, which sometimes include robins.

The author makes wide-ranging proposals for reserves in all tenures. Recommendation for the greater protection of larger blocks of forest for threatened or endangered species, which was also proposed by Crook (1978), have been partly realised by the establishment of eight Ecological Areas (see Nicholls 1978), particularly the larger forest areas of Mokaihaha and Opuiaki.

This report provides a basis not only for reservation of these Ecological Areas (originally reserved mainly as representative forest types in the region offering diversified habitats), but also for protection of smaller sites, as discussed (New Zealand Wildlife Service 1983; Rasch 1989). Studies of kokako populations and behaviour have been made in the Mokaihaha and Opuiaki Ecological Areas, and have been linked with measures to control possums and rats, both of which are now recognised as significant bird predators.

Written at a time approaching the disestablishment of the New Zealand Wildlife Service and NZFS (and their replacement by DOC in 1987), and following a decade of rising awareness of the values of indigenous forest and wildlife in central North Island forests, the author also reviews general literature on establishing reserves or protected areas, and specific papers on the Mamaku Plateau situation. Kokako distribution maps or records of kokako distribution have since been included in reports on later surveys in the Mokaihaha and Opuiaki Ecological Areas.

Map 5 shows kokako distribution on the Mamaku Plateau, in the former State Forests of Mamaku and Horohoro and also in the eastern outliers of the Plateau in Puwhenua, Otanewainuku and Mangorewa Forests. Kokako were present in headwater catchments of the Ngongotaha and Utuhina Streams, which flow into Lake Rotorua—AEB.]

Keywords: forest ecology, wildlife values, Mamaku Plateau, wildlife habitat, reserve proposals, birds, bird populations

Shaw, W.B. 1991: The vegetation and flora of Kaharoa Conservation Area. *Rotorua Botanical Society 24*: 21–29. Includes appendices and map.

[In 1985, the author carried out a field survey of part of Kaharoa State Forest, now designated as the Kaharoa Conservation Area. The 381-ha area lies between the Mangorewa and Onaia Streams on the Kaharoa Plateau. Ten vegetation types are described for forests, shrubland and scrubland. The main type is rewarewa/kamahi forest. Rewarewa also occurs in four other types of secondary forest, probably resulting from fires dating back to early Maori times. Tawa, mangeao, kohekohe, tawari and tanekaha are also found in this lowland forest (200–300 m a.s.l.). Two small stands of radiata pine are in two different age classes and can act as a nurse to the indigenous shrubs where the canopy is open. Scrub is regenerating on disused vehicle tracks, roads and clearings, following earlier logging of rimu and some large tawa. Despite the modified nature of much of the block as a result of human interference or browsing animals, 217 indigenous and adventitious taxa were recorded. A list of vascular species and a vegetation map are appended. A healthy population of para (king fern) was found and should be protected from browsing animals. At the time of survey, deer, possums and goats were said to be present in low numbers—AEB.]

Keywords: Kaharoa Conservation Area, vegetation types, king fern, *Marattia salicina*, botany

Shaw, W.B.; Milligan, G. 1998: Lagoon Road field trip and herbarium visit. *Rotorua Botanical Society 31*: 8–11.

[Three wetlands were visited on 6 June, with access from the end of Lagoon Road. Grid references are given. The first wetland had been grazed and was a former swamp forest. Wallace (1994) noted that DOC had described an open lagoon: 'This lagoon is about 1 to 1.5 metres deep in winter but usually dries out completely in summer. The margins have been mostly very modified by grazing and forestry operations. A large number of tree stumps occur throughout the lagoon (probably kahikatea and rimu); the cause of the demise of trees is uncertain but it is likely that the area has been burnt in the past' (p. 8).

During the 1970s, when burning of clear-felled cutover indigenous forest was the general practice, a desiccant aerial spray was often applied to aid the combustion of slash and produce a cleaner site for planting radiata pine. Some swampy or poorly drained areas were covered by spraying and were too wet for subsequent planting. A second, smaller wetland had been degraded by earlier grazing, but during this visit was seen to be fenced and in much better condition. The third wetland visited was fringed by kahikatea swamp forest and was recorded as 'relatively intact' and in 'very good condition'. These wetlands have been visited by botanical groups on a number of occasions; see Cashmore (2005, 2006) for more recent visits—AEB.]

Keywords: wetland, lagoons, botany

Shaw, W.B.; Perfect, A.J.; Beadel, S.M. 1999: Survey and monitoring priorities for the Tauranga Area, Department of Conservation. Volumes I and II. Wildland Consultants Ltd. Unpublished report for Tauranga Area Office, Department of Conservation, Tauranga. Volume I: 42 p. Volume II, Appendices: 472 p.

[Authors' summary:]

Compilation of biodiversity information on land parcels administered by the department within the Tauranga Area. Includes: botanical and fauna conservation rank (measures for conservation management prioritisation), flora, and fauna lists, information on threatened species, references to vegetation maps, threats to protected areas, including introduced pest plant and animal species.

[Volume I provides a summary of the sections listed above, and Volume II provides the inventory on each land parcel, excluding topographic maps. The land parcels administered by DOC in the Mamaku Plateau area (c. 2005) are shown on Fig. 1; see keyword list below—BRC.]

Keywords: biodiversity, inventory, conservation, Kaimai Mamaku Forest Park, Rapurapu Ecological Area, Opuiaki Ecological Area, Waiomou Stream Marginal Strip, Rapurapu Stream Marginal Strip, Tapapa Stewardship Area, Selwyn Scenic Reserve, Wairoa River Marginal Strip, Kopurererua River Marginal Strip, Tautau Stream Marginal Strip, Hidden Gorge Scenic Reserve, Omanawa Stewardship Area, Omanawa Scenic Reserve, Tautau Reserve, Omanawa River Marginal Strip, Gammans Block, Puwhenua Forest, Mangapapa Ecological Area

Shaw, W.B.; Thompson, K.; Steward, G.A. 1990: Bibliography for Te Urewera National Park. Project Record no 2343. Forest Research Institute, Rotorua (unpublished). 180 p.

[While there are many specific references to Te Urewera National Park in this report, there are wider general references relevant to indigenous forests of New Zealand, some with brief notes. Of particular relevance to Mamaku forests are papers under the headings of 'Geology' and 'Soils', dealing with volcanicity and ash showers in the Rotorua and Taupo regions, e.g. items by J. Healy, W. Pullar and C. Vucetich, some of which are annotated in this Mamaku bibliography—AEB.]

Keywords: geology, soils, volcanicity, tephra, ash showers

Skudder, D.B. 1991: Report on vegetation assignment (Mt Ngongotaha). Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished).

[This report was written as a student's assignment, primarily to prepare a species list for a small study area at the southern margin of Mt Ngongotaha Scenic Reserve, within an 80-ha block in Ngati Whakaue ownership, classed as Protected Private Land and administered by DOC. The study area consisted of low forest once logged for podocarps, and contained an ecotone with adventive species fenced from pasture land. Hinau and large mahoe are listed

as canopy trees. Rewarewa seedlings are recorded, although no podocarp regeneration is mentioned. Kawakawa is noted as the most common shrub species—see Clarkson (1987) for full botanical survey of Mt Ngongotaha Scenic Reserve—AEB.]

Keywords: Mount Ngongotaha, vegetation, species list

Smale, M.C. 1981: Growth and mortality of tawa in virgin and logged forest, Mamaku Plateau. *Production Forestry Division Indigenous Forest Management Report No. 32*. Forest Research Institute, Rotorua (unpublished).

[Author's précis:]

Growth and mortality of tawa were assessed over 17 years in three 0.4 ha plots in rimu/tawa-kamahi forest on the Mamaku Plateau. One plot was unlogged, one had had podocarps removed 22 years earlier, and one had had tawa sawlogs removed 6 years earlier and podocarps before that. Diameter growth rates increased through sapling and pole phase, levelling-off in trees at 2–4 mm/annum. Growth rates of smaller stems reflected light environment, with faster growth in better light, which is probably why their growth rates were faster in logged plots. Suppressed small stems (less than 5 cm DBH) had high mortality rates; tree mortality occurred only in the lightly logged plot but was not obviously attributable to logging disturbance. Projected times taken to reach 40 cm from 5 cm DBH were 130 years in logged plots and 320 years in virgin forest.

Keywords: tawa—growth and mortality, *Beilschmiedia tawa*, Mamaku Plateau

Smale, M.C. 1985: Rapurapu Field trip. *Rotorua Botanical Society Newsletter 5*: 22.

[A previous visit to the Ecological Area was described in *Rotorua Botanical Newsletter 4* (pp. 29–30) by John Nicholls. On this following visit, *Nertera dichondrifolia*, distinguished by the presence of hooked hairs on the leaves, was found. Crimson rata (*Metrosideros carminea*) was seen gracing an old stump, and there was debate about *Cyathea cunninghamii*, quite common in the locality.

Kauri were visited up a nearby spur carrying seral (fire-induced) vegetation, and invading maritime pine (*Pinus pinaster*). 'With the end of uncontrolled fires in areas such as this it is apparent that some of the floristic diversity, inherent in a range of vegetation types at various stages of development, will inevitably disappear in future' (p. 22). *Lindsaea viridis, Hymenophyllum atrovirens* and small kauri seedlings growing on bare ignimbrite faces were seen—AEB.]

Keywords: Rapurapu Ecological Area

Smale, M.C. 1986: The indigenous flora of the Mamaku Plateau. *Rotorua Botanical Society Newsletter 8*. 3 p.

[Author's note repeated in full:]

A recent compilation of the native vascular plants of the Mamaku Plateau, from Opuiaki Ecological Area in the north to Horohoro Bluffs in the south, revealed some 350 species and hybrids [see Bellingham et al. 1985]. This compares with 450 odd species on the adjoining Kaimai Range, including Mt Te Aroha (Druce & Haydock 1982), which encompasses higher altitudes (maximum of 950 m cf 840 m asl) and latitudes. The Mamaku Plateau lacks the extensive montane forests of the Kaimai Range, and is below the southern limit of a great number of northern species.

Of the conifers present, only 'true' totara (*Podocarpus totara*) is of local occurrence, being confined to valley floors in the western gorges. However, a number of angiosperm trees occur only locally. Red and silver beech are confined to the Mangorewa and Mangapapa catchments in the north-east, while black beech occurs in one isolated stand (Leslies Road) above a western gorge. Live northern rata (*Metrosideros robusta*), once widespread, is now local. *Mida salicifolia* appears decidedly restricted, although it is often confused with *Nestegis spp* [*sic*], and may be more widespread. Narrow-leaved maire (*N. montana*) has only been recorded in the north, while black maire (*N. cunninghamii*) is confined to the south-western fall where Taupo pumice is significant. *Paratrophis microphylla*, a true lowland species, reaches into some western gorges.

There is a small upland component of the flora in toi (*Cordyline indivisa*), orihou (*Pseudopanax colensoi*), haumakaroa (*P. simplex*), *Cyathodes empetrifolia*, *Epacris alpina* (at its northern limit), *Lycopodium fastigiatum*, thousand-leaved fern (*Hypolepis millefolium*), holy grass (*Hierochloe redolens*), silver tussock (*Poa laevis* auct NZ), mountain daisy (*Celmisia gracilenta*), *Helichrysum filicaule*, *Astelia* sp. (aff. *nervosa*), mountain myrrh (*Oreomyrrhis ramosa*) and haka (*Viola cunninghamii*). All are of restricted occurrence. Many of the upland species of the Kaimais, however, such as cedar (*Libocedrus bidillii*) and its associated filmy fern (*Hymemophyllum malingii*), pink pine (*Halocarpus biformis*), yellow-silver pine (*Lepidothamnus intermedius*), mountain toatoa (*Phyllocladus alpinus*), blue tussock (*Poa colensoi*), eyebright (*Euphrasia cuneata*), gentian (*Gentiana* aff. *spenceri*) and mountain foxglove (*Ourisia colensoi*) are absent, reflecting a lower average altitude.

Apart from trees mentioned earlier, a number of other true lowland species also appear to be of local occurrence. They include heketara (*Oleania rani*), ramarama (*Lophomyrtus bullata*), puka (*Griselinia lucida*), tawhirikaro (*Pittosporum cornifolium*), kiekie (*Freycinetia baueriana* ssp. *banksii*), white rata (*Metrosideros colensoi*), *Blechnum fraseri* (at its southern North Island limit), *Diplazium australe*, mangemange (*Lygodium articulatum*),

probably at its regional southern limit, *Schoenus tendo*, *Gnaphalium keriense* and kahakaha (*Collospermum hastatum*). Another northern limit is noteworthy: *Gahnia rigida* in natural and induced bogs in the north-east (Wallace 1986). This and other recent discoveries suggest that more remains to be found on our back doorstep.

[Refer to Druce & Haydock (1982) for higher altitude montane forest of the Kaimai Range, and Bellingham et al. (1985) for native vascular plants of the Mamaku Plateau especially the Opuiaki Ecological Area. Refer to Clarkson (1981), Hosking & Hutcheson (1986) and Nicholls (1989) for beech forest.

Podocarpus totara is said to be confined to the valley floors in the western gorges, with one large tree recorded in the Mokaihaha Ecological Area. *Podocarpus hallii* occurs on the upper Mamaku Plateau at 550 m a.s.l., often on poorly drained ground. *Podocarpus totara* was planted from 1959 in the former northern FRI experimental area (now in the Patetere Scenic Reserve). Inspection over recent decades showed some mortality on open, poorly drained sites and foliage browning on some well-grown trees that subsequently produced dense green crowns (AEB, pers. obs.)—AEB.]

Keywords: botany, flora, vegetation list, species list, Mamaku Plateau

Smale, M.C.; Burns, B.R.; Smale, P.N.; Whaley, P.T. 1997: Dynamics of upland podocarp/broadleaved forest on Mamaku Plateau, central North Island, New Zealand. *Journal of the Royal Society of New Zealand 27*: 513–532.

[From the authors' abstract:]

Forest composition was examined on one hectare of upland *Dacrydium cupressinum-Prumnopitys taxifolia/Weinmannia racemosa-Beilschmiedia tawa* forest on south Mamaku Plateau, central North Island, New Zealand, a site of catastrophic volcanic disturbance *circa.* 1900 years ago.

Larger-scale studies over longer time periods and over larger areas are needed to determine definitively the regeneration strategies of the conifers. The unexpectedly high proportion of building-phase forest suggests a period of substantial canopy collapse within the past century. Widespread fallen podocarps on the forest floor indicate the presence of dense conifer forest on the site in the discernible past, lending support to the extension of the 'lozenge' regeneration model suggested initially for *Agathis australis* to tall podocarps as well.

Keywords: botany, ecology, vegetation, podocarp forest, population dynamics, forest growth cycle, Mamaku Plateau

Smuts-Kennedy, C.J. 2002: A survey for Hochstetter's frogs in the Otawa and Otanewainuku Forests. Unpublished Wildland Consultants Ltd contract report for Tauranga Area Office, Department of Conservation, Tauranga. 9 p. plus 6 appendices, map and colour photos.

[This survey, conducted from February to April 2002, included Oropi Forest in three blocks of land administered by DOC. Seven Hochstetter's frogs (*Leiopelma hochstetteri*) were found in 2 of 38 streams/tributaries in Otawa Forest, on the site where the frog was originally found in 1992. These surveyed forests lie to the northeast of the Mamaku Plateau and no native frogs were found on the Mamaku Plateau to the south, which is composed of much younger rhyolite and ignimbrite flows than the geological structure of frog habitats in the northern Kaimai Ranges and Otawa. See also Smuts-Kennedy (2003) for native frog survey of the Kaimai Ranges—AEB.]

Keywords: Hochstetter's frog, *Leiopelma hochstetteri*, Hochstetter's frog—survey, Otawa Conservation Forest

Smuts-Kennedy, J. 2003: A survey for Hochstetter's frogs on conservation land in the Kaimai Range. Contract report by Wildland Consultants Ltd prepared for Northern Region Frog Project, Department of Conservation, Hamilton. 15 p. plus 16 references and 2 maps.

[The survey region extended northward from the southern boundary of SH29. This survey was undertaken in May–June 2003. Five specimens of Hochstetter's frog were found, all in northern parts of the Kaimai Ranges, as shown on Map 1. The five frogs were found at or near the edge of clear stream water, beneath rocks. The preferred habitat is on steep slopes of 'minimally – degraded stream head waters' on sites shaded with overhead vegetation. Locations of survey sites are shown on Map 2 for the southern Kaimai Range, with five locations where Hochstetter's frogs had previously been found. The current survey did not extend this frog's known range southwards. The report notes that experienced observers are required for a survey of this kind. The general methods and field techniques described will be useful for future frog surveys. Past work on surveys for native frogs and their habitats are reviewed—AEB.]

Keywords: Hochstetter's frog, *Leiopelma hochstetteri*, Hochstetter's frog—survey, Kaimai Ranges

Somervell, B. 2004: Sawmills and Bush Tramways of the Mamaku and Rotorua Districts. Rotorua and District Historical Society, Rotorua. 143 p. plus appendices, photos and sketch maps.

[This well-sourced historical account of logging of indigenous forest and sawmilling includes many operations on the Mamaku Plateau, with mills located in or near the Mamaku township from the earliest times of European settlement in the area. A detailed record has been compiled of the major operators of sawmills and tramways from 1888 to the mid-1950s, by which time logs could be transported by roads to mills more distant from the forest. The account is also well illustrated with photos and sketch maps of logging operation and sawmills. Virgin or partly-logged forest dominated by rimu, rata and tawa is shown close to the early mills. Logs were at first pit-sawn and timber or logs were hauled directly to the mills by bullocks. Tramways were then constructed with wooden or steel rails, and logs were extracted to them by steam haulers. Steam haulers and steam engines were fired with tawa wood. Crawler tractors were used in the forest from the mid-1930s, when steam haulers were banned by the State Forest Service in at least one logging operation, owing to fire hazard (p. 97). From the early 1940s, trucks converted for use on tramway rails were used (horses had at first hauled logs along tramways). The State Forest Service sales for timber output in 1924 indicated that 80–90% of timber cut was rimu and miro, with the remainder consisting mainly of totara, kahikatea and matai, as well as beech from some areas (p. 8). Logging over the period covered was selective or partial in the sense that only the most desirable timber trees were felled, predominantly rimu. This often left much of the tawa canopy, except where tawa was used to fire steam engines or was sold for firewood along with rata. Post splitters and firewood suppliers followed main logging operations and utilised some rimu, totara and red beech.

It was recorded that large rata 'died off suddenly in the 1920's', before the spread of possums (p. 5).

It seems probable that possums reached the Mamaku Plateau in the early 1900s, using information from reports such as Nicholls (1966) and the unauthorised liberations of possums recorded in Pracy (1974). There has been much discussion about the causes of mortality for single rata trees or 'combines' (rata and the 'host' tree, usually rimu), and the role that possum browsing may play in the decline of rata vigour in central North Island forests. Brejaart (1998)[17] refers to the decline of rata (and totara) in the Rata-nu-nui Ecological Area, Pureora Forest Park, and Hosking (1994)[18] discusses probable damage by possum browsing in the decline of northern rata and other indigenous trees within Whirinaki Forest Park. In the 1960s, there were still many standing, dead rata or combines, and some still-living trees emergent over the logged residual forest in Horohoro State Forest (SF31). Partial crowns of rimu also survived on some combines. These combines

---

[17] Brejaart, R. 1998: Rata-nu-nui forest condition. Waikato Conservancy, Department of Conservation, Hamilton (unpublished). 12 p.

[18] Hosking, G. 1994: Report on northern rata dieback: Minginui faces. *Conservation Advisory Science Notes 66*. Department of Conservation, Wellington. 4 p. plus map.

must represent an old cohort of great age. Rata was still being felled using explosives and being split for firewood in the 1960s (AEB, pers. obs.).

Gamman's main tramway north of SH5 existed until 1969 and became Galaxy Road North, later extended to Omanawa. Gamman's tramways worked ridge forest between stream valleys where some riparian indigenous forest was retained. Much logging was carried out using tramways on the easy terrain of the central Mamaku Plateau. After pulpwood logging of tawa in cutover forest from the 1970s, many areas on easier terrain or wider gullies were cleared and converted to plantations of radiata pine.

Three pamphlets giving short popular accounts of pioneering Mamaku families and their logging and sawmilling enterprises have been compiled and published by L. Fleet, Mamaku Photographic Gallery, Mamaku. These pamphlets are:

- A.W. Roe Ltd, Mamaku, 1898–1928
- Steele Bros, Mamaku 1888–1954
- Kusabs and Mountain Rimu Timber Co. 1894–1916

Technical details are given in Somervell's book.

The mill and logging operation of T.J. Wood & Co. (1933–1959) are described and illustrated on pages 63–64. The tramway north of SH5 ran through the forest known as the Woods Mill block, in which five kokako were found in 1994 in residual forest near the tramway (Wills 1997)—AEB.]

Keywords: history of logging and milling—Mamaku forests, bush tramways, northern rata—decline, *Metrosideros robusta*, possum—impact, *Trichosurus vulpecula*

Spurr, E.B. 1993: Feeding by captive rare birds on baits used in poisoning operations for control of brushtail possums. *New Zealand Journal of Ecology 17*: 13–18.

[From the author's abstract:]

Non-toxic plain and cinnamon-flavoured carrots and cereal-based baits used in poisoning operations for control of the brushtail possum (*Trichosurus vulpecula*) were offered to seven species of captive rare birds at Mt Bruce National Wildlife Centre. Antipodes Island parakeets (*Cyanoramphus unicolor*) preferred carrot to cereal-based baits, North Island kokako (*Callaeas cinerea wilsoni*) and North Island saddlebacks (*Philesturnus carunculatus rufusater*) preferred cereal-based baits to carrots, although the other species showed no bait preference. Most baits eaten were greater than 2 g. Some individuals of all species also ate cinnamon-flavoured baits. However, cinnamon deterred North Island kaka (*Nestor meriodionalis septentrionalis*), Antipodes Island parakeets, and kokako from feeding on baits the first day offered, though not subsequently.

[Two species in the trials (North Island kokako and North Island kaka) occur on the Mamaku Plateau. Past work on pest poisoning is referred to, with aerial poisoning for the control of possums carried out in Horohoro Forest several times since 1968. In 1978, the 'New Zealand Forest Service banned such operations, until further research clarified the risk to non-target birds'.

On the Mamaku Plateau, populations of kokako occur in the Ecological Areas with mainly old-growth forest in Horohoro Forest (Mokaihaha) on the southern part of the Plateau and in the northern part (Opuiaki). An understorey of palatable plants occurs in both areas, with deer absent or rare in the Opuiaki Ecological Area, and rare until recently in the Mokaihaha Ecological Area. Possums are a pest in both areas, presumably with the usual high populations of ship rats that are generally present in central North Island indigenous forest (see King et al. 1996b)—AEB.]

Keywords: possum, *Trichosurus vulpecula*, pest control—possums, Horohoro Forest, kokako, *Callaeas cinerea*

Stafford, D.M. 1988: The new century in Rotorua. Ray Richards Publisher and the Rotorua District Council. 428 p.

[This includes a number of brief references to the Mamaku settlement; the difficulties of travel over the Mamaku Plateau by the Rotorua–Tirau road; the importance of the timber industry for employment and development in the Rotorua district in earlier years, with logging and milling near Mamaku village; and the bush sickness that restricted farming until the 1930s, when the cobalt deficiency in the soils was remedied—AEB.]

Keywords: history—Mamaku settlement, timber industry, logging, milling, farming—bush sickness

Steele, R. 1980: Mamaku—fire and frost. Pp. 79–86 in Stafford, D.; Steele, R.; Boyd, J. (Eds) 1980: Rotorua 1888–1980. Rotorua and District Historical Society Inc.

[Roger Steele provides an illustrated account of the fortunes of the Mamaku village from its first settlement in the 1880s, when the pioneering Steele family started logging and built sawmills nearby. The timber was at first pit sawn in the forest and transported by recently constructed roads to Rotorua and Hamilton. The Steeles built a tramway from their Maraeroa Mill to the new railway, which reached Mamaku in 1893. See also Jennings (1994) and Somervell (2004) for a history of Mamaku village and accounts of logging the forests of the Mamaku Plateau—AEB.]

Keywords: Mamaku village history, logging, milling

Stephens, D. (Comp.) 2005: Mokaihaha and Pukerimu Forests. Unpublished report held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua. 9 p. plus 15 references and 3 appendices with lists of plant species.

[This is a broad account of the ecological features of the Mokaihaha Ecological Area (1445 ha), with a note on Pukerimu Ecological Area (120 ha). The introduction notes that these Ecological Areas 'are important indigenous forest included within lands affected by Te Arawa claims Wai 316 (Ngati Whakaue) and Wai 531 (Ngati Kea and Ngati Tuara)'.

The report records three 1-day visits in 2004 and 2005 by interested groups, including the ecologists and botanists David Stephens, Paul Cashmore and Ewen Cameron. Some forest descriptions, bird surveys and technical aspects

are taken from several papers annotated in this bibliography (see Nicholls 1966; Crook 1975; Saunders 1983; Marsh & Blake 1997; Smale et al. 1997).

A gazette notice dated 28 June 1985, dedicating the forest of the Mokaihaha, noted that 'this area is dedicated as an ecological area for the preservation and protection of the remaining unmodified tract of the rimu-tawa forest type associated with the Mamaku Plateau and is located in the headwaters of the Mokaihaha and Takapuhurihuri Streams'.

While the northern and western parts of the reserve have not been modified by logging and have been shown by surveys to have the highest numbers of kokako, the eastern and southern parts have been partially logged for podocarps, mainly rimu. The whole conservation area is now surrounded by exotic forest, and several sources have referred to populations of robins and whiteheads in Mamaku exotic conifers and the protective value of a buffer strip being retained. Like other central North Island forests, the Mamaku forests have the ubiquitous possums and populations of mustelids and ship rats, which can be predators of birdlife. Red deer were rarely seen in the 1960s, but are now having a strong impact on palatable understorey shrubs in the western part of the Mokaihaha Ecological Area, apparently invading from the adjacent radiata plantations on the western side. In the 1970s, there was heavy logging of part of the dense podocarp forest by the Pukerimu Stream to the south of the Mokaihaha Ecological Area, with felling of large tanekaha (AEB, pers. obs.).

The lists of vascular indigenous species (with Maori names included) in the appendices resulted from the recent visits by botanists, who also provided notes on the vegetation and birdlife. The understorey plants were more damaged (by deer) in the western part of the reserve compared with those in the cutover forest on the eastern side, between Lake Rotohokahoka and South Road. It is noted that Rotohokahoka Lagoon was renowned for eeling, and that 'one of the three principal Maori tracks crossing the Mamaku Plateau ran from the headwaters of the Utuhina Stream, passing close by Rotohokahoka' and then probably alongside the Takapuhurihuri Stream to Te Whetu (see Collins 1977)—AEB.]

Keywords: Mokaihaha Ecological Area, Pukerimu Ecological Area, Maori claims, forest types, environmental values, wildlife surveys, kokako, *Callaeas cinerea*, vegetation, plant list, predator control, pine buffers

Stevenson, P. 2004: Plenty of steam left in tracks for hikes/bikes. *The New Zealand Herald, 22 April 2004*.

[This article suggests tramping from Putaruru to Rotorua over the Mamaku Ranges by following the rail line, which has been unused for 2 years. It also mentions the possibility of a steam train for the journey in the future. A submission for leaving the 49-km Putaruru–Rotorua track in place has been made to the newly formed State-owned enterprise, TrackCo—BRC.]

Keywords: rail line use, tourism, recreation, tramping, Mamaku Plateau

Steward, G.A. 1986a: Growth of planted hinau (*Elaeocarpus dentatus*) on the Mamaku Plateau. Project Record 1223. Forest Research Institute, Rotorua (unpublished). 10 p. plus 7 references.

[The trial site is located within a former FRI experimental block containing a range of indigenous tree plantings over an area of 40 ha of forest. This had previously been logged for podocarps (mainly rimu) and is reverting to shrub hardwoods, with a canopy of residual tawa, kamahi and tawari. The hinau trial is situated just to the north of the former scenic strip beside SH5, and the whole experimental area is now part of the Patetere Scenic Reserve. For other trials assessing performance of podocarps and tawa, see Pardy (1983a–d) and Pardy & Steward (1989).

In 1980, nursery-raised hinau seedlings of West Taupo wilding origin (grown-on in the FRI nursery, Rotorua) were planted in groups of eight in hand-cut canopy gaps. Growth and survival were assessed after 5 years, at which time survival was 87%. Annual average height increment increased from 5 cm in the first year to 31 cm in the fifth year. Statistical tests confirmed that height growth on north-facing slopes was substantially better than on south-facing slopes or flat sites (with poorer drainage). After 5 years, some seedlings were up to 4 m in height, with annual height increments exceeding 75 cm on the best sites. A light incidence of browsing damage to leaders of hinau seedlings was recorded after the first 2 years' growth (probably by deer as occasional visitors to forest where the understorey of palatable plants was virtually intact).

Initially, planting stock was multi-leadered, although single leaders soon became dominant. At 5 years, all hinau were single-leadered saplings, with slender stems. The author notes that mature hinau trees often flower and fruit prolifically [with fruit being a favoured diet item of kereru and kaka], so that with 'the ability to become quickly established hinau could be a useful species to establish in the restoration of disturbed forest'. The seed of both hinau and miro are, however, often eaten and cached in quantity by ship rats (Beveridge 1964[19]). While saplings of hinau have been prominent in cutover forest of the Mamaku Plateau, seedlings are now scarce in some central North Island forests (MCS, pers. obs.)—AEB.]

Keywords: *Elaeocarpus dentatus*, hinau planting, canopy gaps, reverted cutover forest, Mamaku Plateau, Patetere Scenic Reserve

---

[19] Beveridge, A.E. 1964: Dispersal and destruction of seed in central North Island podocarp forests. *Proceedings of the New Zealand Ecological Society 11*: 48–55.

Steward, G.A. 1986b: History of site preparation methods and early performance of exotic species in Horohoro Forest (SF31). Project Record 1069. Forest Research Institute, Rotorua (unpublished). 33 p. plus 9 references.

[The bulk of this report consists of a detailed account of experimental site preparation treatments for conversion of logged and reverting cutover forest to an array of exotic conifers and broadleaved species, with most of the cleared area established in radiata pine and Douglas fir from 1966 to 1968.

In the 1960s, research policy for central North Island indigenous forest cutovers was to assess their potential for regeneration and management as indigenous forest with or without interplanting of indigenous or exotic species. When tawa was not dominant or lacking, and there was a low canopy of shrub hardwoods with sparse podocarp regeneration, site preparation trials for conversion was in line with NZFS policy. On the Mamaku Plateau, a first assessment of the condition of cutover forest was carried out by R.J. Cameron, the results of which were recorded in 1959 (Cameron 1959). A regeneration sampling of tree species in two FRI experimental areas in Mamaku and Horohoro Forests was undertaken in 1962[20] (AEB, pers. obs.).

Extensive trials to 'rehabilitate' cutover forest with planting of both indigenous and exotic tree species were carried out in the FRI northern experimental block (see Pardy 1983a–d). The FRI central experimental block (by Cecil Road) had exceptionally good early podocarp regeneration in parts (following early hauler logging), and a tree canopy (mainly tawa) was maintained over such parts. These two former experimental areas are now included in the Patetere Scenic Reserve (Department of Conservation 2000).

The southern experimental area of 130 ha in Horohoro Forest contained a partial canopy of tawa near its altitudinal limit (about 700 m a.s.l.) and was established after line sampling of residual trees and podocarp regeneration showed abundant small regeneration of miro and tawa seedlings, although a scarcity of rimu and other podocarps. The site preparation methods described in this report covered some 40 ha, leaving 90 ha of dense shrub regrowth with little or no tawa in the southern part of the block, which became surrounded by radiata plantations established by a private forestry company in the 1970s.

The introductory section on climate, soils, forest type, early logging (1940–1941) and composition of the cutover forest are still relevant. The author records that (in 1965) 'massive emergent rata combines, many of which were dead or moribund, were present at a frequency of about one combine per hectare, mainly with old rimu'.

Climate data were gathered over 7 years from September 1965 and gave an annual rainfall of 2240 mm, some 300 mm more than the rainfall at Mamaku township. An extreme minimum ground temperature of –10.4°C was recorded in a block cleared by burning. At 700 m a.s.l., the experimental area is on

---

[20] A method for sampling regeneration of tree species in cutover indigenous forest was described and demonstrated on a field visit during the 1964 FRI Land Clearing Symposium. The detailed results of sampling in the Mamaku cutover forest have not been found in the former FRI records of Indigenous Forest Management.

the crest of the south Mamaku Plateau, close to the Mokaihaha Ecological Area, and could eventually be returned to indigenous forest. Harvesting of radiata pine that had established over some 40 ha started in 1997, and the area was then re-established in radiata pine. A further 30 ha were harvested and replanted later (AEB, pers. obs.).

In this area of high rainfall and humid climate, there was considerable loss of radiata pine foliage due to needle cast fungi and mortality of pine seedlings as a result of Armillaria root rot in earlier years. Toetoe was found to be a host for Armillaria root rot (in addition to tawa stumps as a common host) (also see Forest Research Institute 1976). The crest of the southern Mamaku Plateau may therefore be considered as unsuitable for plantations of radiata pine. See also annotation for Steward & Klomp (1988), for earlier management of the 'Mamaku Research Forest' containing three experimental areas—AEB.]

Keywords: site preparation, Horohoro experimental area, exotic planting, climate—records, Armillaria root rot—radiata pine, *Pinus radiata*, fungi, reverted cutover forest, forest types

Steward, G.A. 1988: Forest Research Institute records on past silvicultural practices in New Zealand native forests. Forest Research Institute, Rotorua (unpublished). Indigenous Forest Management Group Project record no. 2084. 88 p.

[This report is a catalogue of 11 FRI files on indigenous forest with a base number of 28 (for indigenous forest management) covering the period 1954 to 1986. The entries give author, date, title, file reference and keywords for reports, file notes, letters, diary notes and other reference material, on such topics as seed collection, nursery practice, outplanting, forest regeneration and ecology, as well as general silviculture, policy and management issues. Some items refer specifically to forest on the Mamaku Plateau, including the podocarp planting trials and other studies in the former three FRI experimental areas. Files are held at Scion, Rotorua, and photocopies of items may be obtained—AEB.]

Keywords: silvicultural tending, indigenous forest—species, vegetation description, restoration planting, seed collection, nursery practice

Steward, G.A.; Klomp, B.K. 1988: Management plan for Mamaku Research Forest 1988–1992. Ministry of Forestry, Forest Research Institute, Rotorua (unpublished). 21 p. plus maps and references.

[This report outlines experimental work undertaken by FRI staff from 1960 to 1988 in three FRI experimental areas constituting the former 'Mamaku Research Forest' and covering 650 ha of previously logged podocarp/tawa forest situated on the central Mamaku Plateau.

The central and northern experimental areas were purchased in 2003 by the Nature Heritage Fund, as reported in the annotation of Department of Conservation (2002), and are now part of the Patetere Scenic Reserve. The southern experimental area, by South Road in Horohoro Forest, was considered to be of less conservation value, though forming a partial corridor

between the Mokaihaha Ecological Area and forest in the headwaters of the Utuhina Stream, which flows into Lake Rotorua. Former experimental work in the Horohoro Forest is covered by the annotated report of Steward (1986b), while work of continuing relevance for forest restoration planting in the northern area (north of SH5) is covered by the annotated reports of Pardy (1983a–d, 1989), Pardy & Bergin (1992), Pardy et al. (1999) and Steward (1986a).

Steward & Klomp (1988) cover some of the work carried out in the central experimental area, by Cecil Road. Several trial blocks are indicated on a plan of the area (fig. 3) and are worth recording in an historical context. These include an area with an exceptional number of podocarp seedlings enabling establishment of a trial to compare growth of groups of natural seedlings with growth of nursery-raised planted rimu seedling groups, which were assessed from 1962 to 1981. The small canopy gaps made before planting were found to be insufficient for vigorous growth of podocarp seedlings in tawa-dominant forest.

The best growth of podocarps up to small tree size and including tanekaha, Hall's totara and matai is to be found by Cecil Road, where tawa was presumably removed to fire the boilers of steam-driven machines in early logging by haulers (see Somervell 2004). The small-leaved, frost-hardy shrubs replacing tawa have provided successional vegetation suited to podocarp regeneration (see Beveridge & Bergin 2000).

The objective of another trial (referred to as project 4; G.A. Steward, pers. comm.) in the central experimental area was to attempt to re-establish a native forest cover with a range of indigenous shrubs and trees on a hard pasture site with and without ground ripping before planting. Most species planted failed in competiton with grass on a site that had a climate reflecting that in open parts of the Plateau, with 50–100 ground frosts occurring per year, both in winter and during the growing season. This trial indicates that frost-hardy pioneer species are required for forest restoration on some harsh, open upland sites.

Each of the three experimental areas has small plantings of exotic species (conifers and hardwoods), some of which could be harvested and restored to indigenous vegetation. The trial block on the eastern salient of the central experimental area is, perhaps, the earliest interplanting of exotic conifers in indigenous forest in New Zealand, established as a sample plot in 1928—AEB.]

Keywords: experimental areas, forest restoration, regeneration ecology

Steward, G.A.; Shaw, W.B. 1988: Catalogue of Forest Research Institute records on Protected Natural Areas, Vol. II. Forest Research Institute, Rotorua.

[See above. References from this volume are indexed to FRI files 31/6 Forest Sanctuaries—Volume 19, and 36/5 Plant and Plant Ecosystems—Volumes 1A, 1B. There are a few specific references to Mamaku forests: Mt Ngongotaha, No 19; Pukerimu, Nos 47, 48—AEB.]

Keywords: protected natural areas, scientific reserves, Ecological Areas, species list, forest types

Steward, G.A.; Shaw, W.B.; Krogh, L. 1987: Catalogue of Forest Research Institute records on Protected Natural Areas, Vol. I. Forest Research Institute, Rotorua. 145 p.

[References relevant to the Mamaku region are those in the index under 'Mamaku Plateau', 'Mamaku SF3', 'Horohoro SF31' and 'Kaimai-Mamaku State Forest Park', totalling 85 items, and those dealing with proposals and extensions for Mangapapa, Mangorewa, Mokaihaha, Opuiaki, Pukerimu, Rapurapu and Rotohokahoka Ecological Areas. The proposals for Ecological Areas, scientific and other reserves are usually accompanied by forest type descriptions, generally by John Nicholls, with recommendations supported by a Scientific Co-ordinating Committee going to Rotorua Forest Conservancy. The proposal for a Matahana Ecological Area in the southeast of Horohoro Forest did not apparently receive final approval, and nor did proposals by the Royal Forest & Bird Protection Society for an Ecological Reserve in the catchments of the Waipari and Kuhatahi Streams (AEB, pers. obs.).

This catalogue is compiled from 18 volumes of FRI files with a base number of 31/6 covering a period from 1965 to 1986. The catalogue entries give author, date, title, file reference and keywords for reports, file notes and correspondence on protection of natural areas; see references to a Scientific Co-ordinating Committee in Nicholls (1978) and New Zealand Forest Service (1980). Files have been transferred to Landcare Research, Private Bag 3127, Hamilton, and photocopies are available on request—AEB.]

Keywords: protected natural areas, scientific reserves, Ecological Areas, species list, Mamaku forest types

Stokes, E. 1983: Ngamanawa. A study of conflicts in the use of forest land. University of Waikato, Hamilton, published for the Ngamanawa Incorporation. 129 p. plus appendices, maps and bibliography.

[This document is a well-sourced history of the Ngamanawa Incorporation, formed in 1971 to represent the interest of the owners of the Ngamanawa Block. This Block of several thousand hectares is now mainly forest land, with pine plantations or reserves of indigenous vegetation in gorges, and is situated in the upper catchment of the Wairoa River, including the tributary catchments of the Omanawa, Mangapapa and Opuiaki Streams, which flow northwards from the centre of the Mamaku Plateau. The conflicts in land use have been engendered by the taking of land for hydro-electric power generation (the Mangapapa Hydro-Electric Power Scheme), and for the further logging of indigenous forest, followed by clearing and conversion to radiata pine plantations. The Ngamanawa land owners have been involved in intense debate on their right to decide on the use of their land, in opposition to environmentalists who objected to further logging of indigenous forest. In a chapter on traditional history, it is suggested that one Maori legend may be an allegorical version of conflict between the incursion of coastal people, seeking food sources in the forest, and the people who lived in the forest and later used it as a refuge. NZFS sources are used for the description of the forest, which was originally mainly podocarp/tawa.

A history of logging and milling of the Ngamanawa indigenous forest is outlined. Forest exploitation started in the upper Wairoa catchment in the 1880s. George Gamman established a mill at Omanawa in 1911, with logs extracted by tramway from forest on the Mamaku Plateau. See Gammon (1910) for his walk from Mamaku towards Tauranga. The management plans of NZFS for the Kaimai Mamaku Forest Park are discussed (New Zealand Forest Service 1976–1986, 1977, 1982, 1983a, c), with the reactions of environmentalists. The Mangapapa scheme for hydro-electric power development, using waters from Ngamanawa forests and involving the taking of some Ngamanawa land under relevant Acts, is also mentioned.

In 1970, NZFS assessed the suitability of some 4000 ha of Ngamanawa Forests for leasing parts that could be converted to exotic plantations. This was some 60% of the total area, the balance of which consisted of steep gullies and gorges. A map of vegetation cover for the Ngamanawa Forest is shown (fig. 15). A lease of some 2000 ha was negotiated with NZ Forest Products Ltd in 1976, with 2000 ha to be cleared after logging of residual tawa. Conservationists and other interested groups were involved in the ensuing debate of protection for the upper Wairoa catchments (fig. 16)—AEB].

Keywords: Ngamanawa Forest, land use—conflict, indigenous forest—reserves, exotic forestry, conservation values

Stone, H. 2003: Report on meeting of the Rotorua Lakes Strategy Joint Committee of Rotorua District Council with discussion on nutrient input to Lake Rotorua. *Daily Post*, *Rotorua, 4 December, 2003*.

[In this report there is a statement from Paul Dell, Lakes Project Co-ordinator, who said that a large part of Lake Rotorua's nutrient input is from ground water in the Mamaku Plateau, which could be more than 50 years old and contained a high level of nitrogen. Phosphorus was also entering the lake from ground water stored in volcanic rock within the catchment area. Currently, the two biggest contributors to Lake Rotorua's (poor) water quality were the constant flow of ground water and the land use within the catchment. 'The issue is more complex than what was thought in the 1990's' (see also Dell 1982a, b)—AEB.]

Keywords: Lake Rotorua nutrients in ground water, water quality, water storage in volcanic rock

Taylor, G. 1984: Observations on the biology of two butterfly species (Lepidoptera) in forests of the Mamaku Plateau, North Island, New Zealand. *Mauri Ora 11*: 51–55.

[From the author's abstract:]

Observations are given on habitat use, behaviour, activity and numbers of Helm's butterfly, *Dodonidia helmsii* and the Australian painted lady, *Cynthia kershawi* in forests of the Mamaku Plateau. *D. helmsii* was most common where sedges (*Gahnia paucifolia*) were abundant and was on the wing in late December to early January. *C. kershawi* was seen in February and March. The presence of painted ladies with pink-tinged wings indicated the species may have been breeding locally. If so, this is the first recorded instance of overwintering in New Zealand.

Keywords: biology, butterflies

Taylor, G.A. 1985: The effects of logging on forest bird communities on the Mamaku Plateau. Unpublished MSc thesis, University of Canterbury, Christchurch. 314 p. plus map, 9 figures, 15 plates, 25 tables and 52 references.

[From the author's abstract:]

This study was designed to examine the effects of logging on forest bird communities. The study was conducted in forests on the Mamaku Plateau, c. 20 km north, north-west of Rotorua (38°10'S, 176°14'E) in the North Island, New Zealand. The Mamaku Plateau is a large (40,000+ ha) ignimbrite plateau with deeply dissected river gorges. The forest areas were originally podocarp-hardwood although extensive logging for timber extraction has left a mosaic of regenerating native forest areas and unlogged riparian reserves. Some substantial areas of unlogged forest still occur in Kaimai-Mamaku State Forest Park and Otanewainuku State Forest. Extensive areas of regenerating native forest have been clearfelled to exotic plantations, principally of *Pinus radiata*.

The vegetation was analysed by the New Zealand Forest Service Reconnaissance and Plot Sampling Technique described in Chapter 3. I found that native plant species were most diverse in lowland forests, especially in gully habitats whereas introduced plants were scarce in unlogged forest and most abundant in exotic plantations. However, the exotic plantations still had extensive native species understoreys including many flowering and fruiting species favoured by birds. Logged forests had higher diversities of plants than unlogged forests because of the increased number of seral plant species in the cutover clearings.

Unlogged forests were similar in structure with tall dense closed canopies, emergent podocarps, particularly rimu, and a diverse subcanopy and shrub hardwood tier. Litter was the main ground cover. Logged forests shared these dense lower understorey plants although the canopy and emergent trees were those species extracted by logging operations and the forest had an open structure above 5 m.

The exotic plantations were c. five years and c. 18 years old and had open structures designed for optimal sawlog production. Unlogged forests had

the richest native forest bird species diversity including the common insectivorous and frugivorous species and sometimes the rare kokako and kaka. These last two species were absent from exotic plantations and only a few vagrant kokako were located in cutover forest. Most of the smaller native insectivores were widespread in all forest habitats and appear to be generalists in habitat use. Robins and whiteheads were scarce in logged forests although surprisingly were abundant in the mature pine plantations. The frugivorous tuis, bellbirds and silvereyes were widespread in all forest habitats including exotic plantations although had marked seasonal changes in abundance between forests depending on the availability of flowering and fruiting plant species. New Zealand pigeons were scarce in exotic plantations. Kiwis [*sic*] were recorded in both logged and unlogged native forests although were absent from pine plantations. The richness of native bird species was similar in all blocks because of the occurrence of species favouring open habitat (harriers and pipit) in logged forests and exotic plantations.

Introduced bird species were generally absent from unlogged forest. Only the chaffinch and blackbird appeared to breed in all forest blocks [Ebert (2002) has recorded nesting of magpies and black-backed gulls in the Mokaihah Ecological Area]. Some finches were vagrant in unlogged forests during the autumn and winter. The introduced birds appeared only to penetrate native forest after logging had opened a niche for these species by the removal of the dense canopy and the creation of open forest clearings and roadside marginal vegetation. The most diverse introduced avifauna were found in young exotic plantations. However, many introduced species favouring young plantations were absent or scarce in the older plantations suggesting that forest structure is important to these birds' requirements.

In general, modified habitats had the most diverse forest bird communities, mainly because of the presence of the generalist native bird species and the numerous introduced species. The species richness of these forests is nevertheless low compared with studies in Australia and the United States. The bird communities in each forest reflect changes in the avifauna associated with logging.

[Past work on forest bird populations is broadly reviewed, including studies by Crook et al. (1971), Crook (1975, 1978) and Saunders (1983) on the forests of the Mamaku Plateau, and point to the need for larger protected areas. Field work was carried out in ten study areas in two clusters: the western group, including five blocks west of Galaxy Road in the catchment of the Mangapapa Stream, and the eastern group, including five blocks east of the Tauranga Direct Road. There were two study areas in the Kaimai Mamaku State Forest Park: by Hiwiroa Road (Plateau ridge) and in the Waiomou Stream valley. Five study areas were in forests controlled by private forest companies. The study areas included virgin (old-growth) podocarp forest; partially-logged forest from which rimu was logged from the 1940s or earlier (called regenerating native forest, usually with a partial canopy of tawa), and exotic plantations, mainly radiata pine established on cleared indigenous forest sites. The pine plantations were around 5 or 18 years old, the older stands (some of which had recently been thinned) being described as having open structures designed for optimal sawlog production on a 30-year rotation. Some private

forest areas may have a different regime and much shorter rotation for pulp wood (AEB, pers. obs.).

At 18 years of age, the oldest pine plantations could not be termed 'mature', although thinning operations at 16–18 years would have had a strong impact on bird habitats; also, most first rotations of radiata pine planted on cleared indigenous forest sites have patches where pine establishment has failed for various reasons, including infection of seedlings by Armillaria root rot, allowing growth of indigenous shrubs.

Kiwi had been recorded by Taylor in previous studies on the Mamaku Plateau, and were recorded in this study in both logged and unlogged forest, although not in pine plantations. The mean number of birds at each 5-minute recording station in the ten study areas is given in table 16 (p. 120). Totals of 21 native bird species and 14 introduced bird species were recorded. Low numbers of kokako and kaka were recorded in several study areas, significantly in the two unlogged areas of Kaimai Mamaku Forest Park (Hiwiroa Road and Waiomou Stream). Kaka appear to be becoming rare on the Mamaku Plateau (refer to Saunders 1983), and parakeets were not recorded in the author's survey. It is observed that 'throughout the Northern Mamaku Plateau, exotic plantations will always be less than 2km from native forest' (p. 217), implying that seed of indigenous plants will be dispersed to exotic plantations by native birds such as tui, bellbird, silvereye and kereru. Amongst recommendations, agreement is expressed with Saunders' (1983) view that there should be forest corridors linking major river catchments and forest tracts, provided by partially-logged indigenous forest if necessary. Such reverting indigenous forest could also provide buffers to riparian reserves. The ecology of the North Island robin should be studied on the Mamaku Plateau, as its forests probably provide the best remaining habitats for this species. Taylor recorded few signs of deer in his study areas and none in forest west of Galaxy Road North where undergrowth is dense.

It is noted that insectivorous birds and silvereyes were using the young radiata pine plantations (5 years old) off Galaxy Road, whilst they were usually more common in older plantations (p. 216).

Plantations in this area are on wet soils of older ash showers, high in allophane, where tawa crowns were often thin or ragged following the logging of podocarps and before tawa were removed in a second logging prior to clearing and conversion to pines (AEB, pers. obs.). Compaction of soils and mortality of radiata pine (which was increased by infection by Armillaria fungal attack, with rhizomorphs spreading from tawa stumps) would create canopy gaps, allowing early invasion of wineberry and other fruiting shrubs (see Forest Research Institute 1976)—AEB.]

Keywords: research—birds, forest bird survey, logging—impact, Mamaku Plateau—environmental aspects, species diversity, forestry operations, pine plantation—birdlife, riparian vegetation, tawa forest—residual, *Beilschmiedia tawa*

Taylor, N.H. 1953: The soil pattern. Pp. 11–12 in: Symposium on the ecological significance of the central North Island ash showers. *Proceedings of the New Zealand Ecological Society 1*.

[Soil-forming processes in ash beds are described for 'ash-beds of paroxysmal origin, and ash-beds of intermittent origin'. Significant soil processes in the Mamaku Plateau region include the Taupo shower erupted from the region of Lake Taupo (c. AD 200) and reaching the southern Mamaku Plateau in Horohoro Forest, and the Rotorua shower, the oldest deposit covering the sides of the steep v-shaped valleys in the Plateau surface near Mamaku. The Kaharoa showers (later dated at c. AD 1300) were erupted from the Tarawera region (Okataina volcanic centre)—BRC.]

Keywords: soil-forming ash showers, Taupo Ash, Rotorua Ash, Horohoro, Mamaku, volcanicity, Kaharoa Ash

Thornton, J. 1985: Field guide to New Zealand geology: an introduction to rocks, minerals, and fossils. Heinemann Reed, Auckland.

[This book contains a brief account of geology of the Mamaku Plateau, with the author stating that it 'was built up from the Rotorua Volcanic Centre in a series of layers' that can be viewed from Leslie Road (photograph). The author states that there is some difference in geological opinion in the lumping or splitting of the ignimbrite classifications, and has lumped them together as Mamaku Ignimbrite in a figure labelled 'Ignimbrites in the Central North Island'—BRC.]

Keywords: geology, Mamaku Plateau, Leslie Road, Mamaku Ignimbrite

Thyne, C. 2006: Opuiaki Ecological Area kokako nest monitoring and survey, November 2005 – March 2006. Natural Resource Solutions contract report for Tauranga Area Office, Department of Conservation, Tauranga (unpublished). 8 p. plus 4 maps and 6 appendices.

[This report is in the same format as that of Hudson (2005), and continues with the record of kokako breeding and behaviour within the Opuiaki Ecological Restoration Area. In March 2006, there were nine pairs of kokako and 13 singles within the Ecological Area, giving a net increase of three pairs since March 2005. Six of the nine pairs were known to breed, producing four fledged chicks in the current season. Mustelid trapping was carried out in addition to another season's successful control of possums and rats, as a result of which 25 stoats and two ferrets were trapped. Recommendations are made for continued predator control and monitoring of kokako for nesting in the 2006–2007 season—AEB.]

Keywords: kokako—breeding, kokako—survey, *Callaeas cinerea*, pest control—mustelids, Opuiaki Ecological Area

Vucetich, C.G.; Pullar, W.A. 1963: Ash beds and soils in the Rotorua District. A symposium. *Proceedings of the New Zealand Ecological Society 10*: 65–72.

[The Mamaku Plateau occupies only a small part of the 12 000 square miles estimated to have been covered by ash more than 12 inches thick on at least one occasion during the Late Quaternary period and erupted from one or more of the four eruptive centres named in this paper. The nature of the eruptions and the ash beds formed from the ash falls are described. The degree of destruction of existing forest and recovery of vegetation are discussed. The relatively old beds of Mamaku Ash and Rotorua Ash found on the Mamaku Plateau were formed from ash erupted mainly from the Okataina and Waitahanui eruptive centres. The authors, in commenting on the Holocene ash deposits, state that 'all older beds are present on the western margin of the Mamaku Plateau towards Tirau although they are absent on the crest of the Mamaku Plateau, where Rotorua Ash rests directly on Ignimbrite'—AEB.]

Keywords: ash deposits (beds) and soils, Mamaku Plateau, volcanicity, eruptive centres, geology, vegetation, Taupo Volcanic Zone

Wallace, S. 1986: A new northern limit for *Gahnia rigida*. *Rotorua Botanical Society Bulletin* 7: 12–13.

[This report discusses the discrete distribution of this sedge and its recent discovery in two mires on the Mamaku Plateau at 520 and 552 m a.s.l., just south of latitude 38°, its most northerly distribution—AEB.]

Keywords: *Gahnia rigida*, mires, Mamaku Plateau

Wallace, S.W. (Lead Comp.) 1985: Indigenous vascular flora of Opuiaki Ecological Area, Kaimai-Mamaku State Forest Park, 390–460m. Unpublished report held on file at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua. 2 p.

[Compiled by 15 ecologists and botanists located at FRI, Rotorua, on 24 April 1985. Contains a list of 164 indigenous species and 8 adventive species, arranged by life form, and includes 55 fern species, and 43 tree and shrub species (see also Bellingham et al. 1985)—AEB.]

Keywords: plant list, Opuiaki Ecological Area

Wallace, S.W. 1988: Distribution and status of the North Island kokako in the Eastern Region. A review. *Technical Report Series No. 5*. Department of Conservation, Rotorua. Text: 16 p. plus 18 references. Appendices: 50 p. plus topographic maps.

[The review covers six Ecological Regions, although this annotation deals mainly with two forest areas in the Northern Volcanic Plateau Ecological Region—the north Mamaku Plateau and the south Mamaku Plateau. Appendix one is a record of all kokako observations in the Eastern Region from 1877 to 1988, with notes on the location and map references. Appendix two contains copies of the relevant topographic maps of NZ Map Series 1, with kokako locations marked. Most of the Mamaku Plateau recordings for kokako are marked on map sheets N66, N67 and N76, mainly in clusters.

In his review of previous work, the author notes that much of our present knowledge of local kokako distribution had come from field surveys carried out by the Fauna Survey Unit (FSU) of the Wildlife Service since 1970, supplemented by other observers. Papers on the Mamaku Plateau forests annotated in this bibliography cover Crook (1975, 1978) and Saunders (1983). Since 1988, relevant annotated papers on population and habitat studies of kokako on the Plateau include Marsh & Blake (1997), Owen (1999), Buckingham et al. (2000), Wills (1997) and Wilke (2002). On the north Mamaku Plateau, there is a large continuous kokako population, with 151 birds recorded in 1975 from over 100 stations and concentrated at the northeastern end of the Opuiaki Ecological Area. In 1988, kokako were still present in Puwhenua and Mangorewa Forests.

On the south Mamaku Plateau, FSU surveys found a dense population of kokako in the 1970s in the forest that is now included in the Mokaihaha Ecological Area. Part of the Horohoro Forest survey in 1982 found kokako in the catchments of several streams on the western fall of the Plateau, and also in the headwaters of the Ngongotaha Stream (protection forest in Horohoro) and in catchments of the Utuhina, Te Reinga and Aorangi Streams (owned by a private forest company).

Included in the recommendations for future work is a regular monitoring programme for the kokako populations and their habitats in Horohoro and north Mamaku for the Mamaku Plateau (essentially the Mokaihaha and Opuiaki Ecological Areas and adjacent areas). Measures to control predators of birds such as ship rats and possums have been carried out over the past decade to encourage successful breeding of kokako in these two Ecological Areas—AEB.]

Keywords: kokako—population distribution and status, *Callaeas cinerea*, Mamaku Plateau

Wallace, S.W. 1994: Wetlands between Roy Road, Te Pu and Galaxy Road North on the Mamaku Plateau. Unpublished notes held at Bay of Plenty Conservancy Office, Department of Conservation, Rotorua. 10 p.

[Not viewed by the authors of this bibliography—BRC.]

Keywords: wetland

Whinam, J.J.; Hope, G.S.; Clarkson, B.R.; Buxton, R.P.; Alspach, P.A.; Adam, P. 2003: *Sphagnum* in peatlands of Australasia: their distribution, utilisation and management. *Wetland Ecology and Management 11*: 37–49.

[From the authors' abstract:]

In comparison to the Northern Hemisphere, Sphagnum peatlands are an unusual and infrequent component of the Australasian landscape. Most peatlands in Australasia are primarily composed of either Restionaceous or Cyperaceous peats. Sphagnum peatlands in Australia and Papua New Guinea/ Irian Jaya (now West Papua) are largely located in montane and alpine environments, although also occur down to sea level in New Zealand and as moss patches on some subantarctic islands. Fire is a major determinant of the characteristics of peatlands in Australasia.

Sphagnum peatlands in Australasia are likely to be adversely affected by drainage, burning, grazing, trampling, global warming and peat mining.

[This review with many references mentions the Mamaku Plateau as having examples of North Island sphagnum bogs induced or increased by forest logging in an upland area with high rainfall. Gamman Mining is one of three active sphagnum peat mines in the North Island, New Zealand, that is subject to requirements to restore the peatland back to bog. The review covers the ecology of sphagnum bogs, harvesting of sphagnum and restoration—AEB.]

Keywords: sphagnum, forestry, logging, wetland

Whitaker, T. 2000: Herpetofauna of the Opuiaki Ecological Area, northern Mamaku Plateau. Tauranga Area Office, Department of Conservation, Tauranga (unpublished). 19 p. plus 33 references.

[From author's summary and introduction:]

The Opuiaki Ecological Area—on the southern end of the Kaimai Range, approximately 25km south west of Tauranga, and approximately 25km north west of Rotorua—was designated because of its high biological value (Crook, 1978). It has been identified as having particular conservation value for indigenous birds, including the endangered North Island kokako (*Callaeas cinerea*) (Crook 1978; Willis 1994; Innes & Flux 1999).

Prior to this survey there was no information on the herpetofauna within the Opuiaki Ecological Area. Several relatively common lizard species are widespread in the Tauranga/Mamaku Plateau region (Pickard & Towns 1988, ARDS 2000). There is a single record of the endangered striped skink (*Oligosoma striatum*) from Ngawaro, approximately 12km to the east (Whitaker 1993a), and Hochstetter's frogs (*Leiopelma hochstetteri*) are known from the central Kaimai range, to the north, and from Otawa, an isolated peak to the east near Te Puke (ARDS 2000).

Any of these species could occur within the Opuiaki Ecological Area. However, lizards and frogs are usually quite difficult to find in mainland forests as populations are invariably greatly depleted by the presence of introduced predators. Species known from the surrounding district that are almost certainly present within the area are the Pacific gecko (*Hoplodactylus pacificus*), the copper skink (*Cyclodina aenea*) and the striped skink (*Oligosoma striatum*).

A further six indigenous species have distributions and habitat requirements that suggest they could possibly occur within the area. These include species of conservation interest such as Hochstetter's frog (*Leiopelma hochstetteri*), Archey's frog (*Leiopelma archeyi*) and the striped gecko (*Hoplodactylus stephensi*).

If the proposed mammal control proceeds it is likely to benefit the herpetofauna only if it is continuous and maintained indefinitely.

[The survey was done from 14 to 25 January 2000, using a variety of research techniques in native forest and marginal shrubland. The only species found were the forest gecko and the introduced green and golden bell frog, both

of which were widespread and relatively common. Thirteen specimens of the forest gecko were found in searches at night. The geckos were foraging in the foliage on a number of listed plant species or climbing trunks. Green and golden bell frogs were found up to 2 km within the forest and were breeding in streams and ponds, showing no indication of disease. Introduced frogs within forests are known to be predators of invertebrates and small vertebrates, including native frogs. A herpetological review is given of 16 species known to occur (listed in table) in the study area, the Otanewainuku Ecological District, the Northern Volcanic Plateau Ecological Region, and the Coromandel/Waikato/Western Bay of Plenty. 'The green gecko (*Naultinus elegans*) was recorded from the study area previously'—AEB.]

Keywords: forest gecko, *Hoplodactylus granulatus*, green and golden bell frog, *Litorea aurea,* geckos, skinks, frogs, Mamaku Plateau, Opuiaki Ecological Area

Wilcox, M.D.; Ledgard, N.J. 1983: Provenance variation in the New Zealand species of *Nothofagus*. *New Zealand Journal of Ecology 6*: 19–31.

[From the authors' abstract:]

Provenance variation was studied in the growth and morphology of seedlings of silver beech (*Nothofagus menziesii*), red beech (*N. fusca*), hard beech (*N. truncata*), black beech (*N. solandri:* var. *solandri*), and mountain beech (*N. solandri:* var. *cliffortioides*). Seedlings were grown for 2 years in replicated provenance experiments at Rangiora and Rotorua.

Red beech seemed a comparatively uniform species, with only minor genetic variation apparent in the growth rate and appearance of seedlings from a comprehensive range of provenances. Hybridism with *N. solandri* was prevalent in several seedlots. Hard beech was poorly represented in the study; at Rotorua, the local Mamaku Plateau provenance was the most vigorous, although was the slowest-growing at Rangiora.

[Four species of beech were found on rather restricted sites on the Mamaku Plateau. No seedlots of black beech were collected from isolated northern occurrences, such as the small stand on the Mamaku Plateau. Only a token sample of hard beech was obtained, although the Mamaku provenance was the fastest growing of three provenances grown in Rotorua, with a mean height of 82 cm 2 years after sowing seed. 'Silver beech was shown to be a genetically variable species'. Seedlings of the Mamaku provenance were the fastest growing of 17 provenances tested at Rotorua, with a mean height of 82 cm after 2 years. Mamaku silver beech had 'exceptionally large leaves (17 × 14mm), red beech seemed a comparatively uniform species'. At Rotorua, the local Mamaku provenance was the most vigorous of 17 provenances, seedlings having a mean height of 93 cm after 2 years—AEB.]

Keywords: beech provenances, *Nothofagus* spp., silver beech, *Nothofagus menziesii*, red beech, *Nothofagus fusca*, hard beech, *Nothofagus truncata*, black beech, *Nothofagus solandri* var. *solandri*, mountain beech, *Nothofagus solandri* var. *cliffortioides*, beech—morphology, beech—seedling growth

Wilcox, P.L. 1985: The effect of soil condition, fertiliser and insect damage on *Dacrycarpus dacrydioides* (A. Rich) de Laubenfels seedlings on the southern Mamaku Plateau crest. Unpublished dissertation for degree of Bachelor of Forest Science, University of Canterbury, Christchurch. 73 p. with illustrations (some colour), plus 8 appendices, maps and 26 references.

[An appraisal with statistical analysis of the effect of four fertilisers applied at or near planting time and four different degrees of soil disturbance on height increment of kahikatea seedlings planted in partially-logged forest in Horohoro, SF31. Groups of seedlings were planted on or near logging tracks in 1977, 2 years after the removal of most merchantable podocarps by logging. Soil conditions on planted microsites were assessed as compacted, 'claggy' (churned by tractor), lightly disturbed or undisturbed. The effect of soil condition did not become significant until 3 years after planting. Poorest growth was on compacted soil, which restricted root growth. Best growth was on lightly disturbed soil. Insect damage to kahikatea seedlings was assessed at 8 years after planting. Damage to stems from the ovipositor scars of cicadas was related to the conspicuousness of reproducing adult insects and was considered to be minor. The larvae of the native longhorn borer, *Navomorpha lineata*, caused most damage to the stems of more vigorous kahikatea seedlings, resulting in death of leaders and loss of up to 1 m in height, causing production of epicormic shoots and bushy crowns, although no death of seedlings. Only 46 out of 315 kahikatea seedlings suffered leader damage from this stem borer.

The small increase in growth of kahikatea seedlings as a result of 'magamp' and urea fertiliser applications was not considered significant 'in terms of management'. Damage from cicada and *Navomorpha* is well described and illustrated. See Pardy & Wicken (1988) for performance of cluster-planted kahikatea and rimu over 12 years in this trial in which the survival rate was 89% for rimu and 97% for kahikatea. Rimu seedlings also incur damage from cicadas and *Navomorpha* in well-lit situations, as do totara to a lesser extent.

No assessment of planted podocarp performance has been made since 1988. Brief subsequent inspections have indicated that some of the planted podocarps have emerged from dense toetoe growth along log extraction tracks. No damage by deer browsing on palatable vegetation was observed, although deer were thought to be present in low numbers throughout Horohoro Forest in the 1970s—AEB.]

Keywords: Horohoro Forest, planted podocarps, fertiliser—response, insect damage, *Navomorpha* stem borer, cicada damage—stems, rimu, *Dacrydium cupressinum*, kahikatea, *Dacrycarpus dacrydioides*, soil condition—growth response

Wilke, M. 2002: Post poison operation report for possum and ship rat control in part of Mokaihaha Ecological Area. Rotorua Lakes Area Office, Department of Conservation, Rotorua (unpublished). 28 p.

[There are two reports with different dates, although both are substantially the same. Dates for the reports are 20 September 2001 – 8 October 2001, and 20 September 2001 – 13 October 2001. The reports are written in standard formats, including an operation summary.

Bait stations were placed at 100-m intervals over 848 ha of unlogged forest, mainly north of the Tikitiki Stream. Prefeeding was done with pollard pellets and the poison baits contained 1080 in cereal pellets with cinnamon lure. Targets were reached, with possum numbers reduced to less than 5% and ship rat numbers to less than 1% by 1 November 2001. Possum numbers were monitored by use of leg-hold traps, and were reduced from 44.6% to 1.67% post poisoning. Ship rats were monitored by tracking tunnels and no tracking was recorded after 10 November 2001.

The main aim was to increase the kokako population. The outcome of this work was achieved by finding five pairs of kokako that produced nine nests/eggs, with nine kokako chicks fledged as on 14 February 2002. The reports indicate the high degree of consultation and preparation before the operation could start, and the precautions taken to avoid non-target species. It is recommended in this report that there should be discussion on possible benefits of stoat control in this area, particularly for kaka. It is noted that stoats do not seem to have impacted on kokako in 2001. See Marsh & Blake (1997) for a survey of the kokako population in the Mokaihaha Ecological Area—AEB.]

Keywords: pest control—possum and rat, pest control—monitoring, Mokaihaha Ecological Area, kokako—breeding, *Callaeas cinerea*

Williams, D.S.; Leathwick, J.A. 1994: Remeasurement of ecological transects in some central North Island forests. Forest Research Institute contract report FEW 90/25. Forest Research Institute, Rotorua (unpublished). 19 p. Includes illustrations.

[This report gives results for only one of five ecological transects established in the Kaimai Mamaku Forest Park to follow long-term vegetation trends. This transect (No. 32) is located by the Waiwhakarewarewa Stream in the Opuiaki Ecological Area. The transect was established in rimu-tawari forest in 1960 and was remeasured in 1982. Changes are recorded of basal area and stem density, both by size class. It is concluded that the vegetation was still unaffected by browsing animals. Williams & Leathwick consider that browsing mammals have had little effect on the understorey due to the abundance of palatable plant species in this tier, and that any change so far seen was a result of natural stand processes. The authors also qualify this with the statement that an increase in either possums or deer would rapidly reduce the amount of highly preferred plant species—AEB.]

[This transect and three others on the Mamaku Plateau were remeasured by Landcare Research in 1999—BRC.]

Keywords: forest ecology, monitoring, Kaimai Mamaku Forest Park, vegetation, browsing animals—impacts, Opuiaki Ecological Area

Wills, D.E. 1997: Kokako territory survey: Opuiaki Ecological Area and Woods Mill Block summary report, January and February 1994. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished). 49 p. plus maps.

[During this survey, which was carried out over 2 months, the territories of eight pairs of kokako and three single birds were mapped in the 300 ha of old-growth forest in the Opuiaki Ecological Area, while the territories of only two pairs of kokako and one sub-adult single bird were mapped in the 400 ha of forest heavily logged in the Woods Mill Block from 1933 to 1942. Features of terrain and vegetation are given, and the positions of permanent markers are described for the boundaries of the Opuiaki Block. Mapped territories tended to be clustered in the central part of the Opuiaki Block and towards the western part of the Woods Mill Block, where the old Woods Mill tramway forms the western boundary (see Somervell 2004: 63). The forest of the Opuiaki Block is described as having emergent podocarps or tawa and tanekaha, with tawari, kamahi, matai and supplejack—mostly species that are food sources for kokako, allowing pairs of birds to have relatively small territories. The Woods Mill Block had considerable areas devastated by logging and reverting to tree ferns. The two pairs of kokako and a single bird found were using larger territories in residual forest with fewer mature podocarps but otherwise similar vegetation to that of Opuiaki.

For each kokako territory, the bird characteristics are outlined in terms of song and behaviour, while terrain and the vegetation are described in different tiers. Traps were set at regular intervals for possums and rats, resulting in 14 possums and 1 stoat being caught in the Opuiaki Block over 150 trap nights, and 8 rats being caught over 69 trap nights.

References to the recording of kokako on the north Mamaku Plateau by the Fauna Survey Unit of the Wildlife Service in 1975 and 1982 are made by Owen (1999) and Wallace (1988). This survey report by Wills is part of an ongoing effort to ensure that sustainable populations of kokako will survive on the Mamaku Plateau, at least in the larger forest blocks of the Mokaihaha and Opuiaki Ecological Areas—AEB.]

Keywords:, kokako—survey, kokako—territories, *Callaeas cinerea*, Opuiaki Ecological Area, Woods Mill Block, bird populations, predator control

Wilson, T. 2004: Summary of community surveys undertaken for the Department of Conservation. Bay of Plenty Conservancy, Department of Conservation, Rotorua (unpublished).

[Author's précis:]

The Mamaku community was one of five communities surveyed for their interests in conservation. Questions were posed to elucidate people's perceptions of the value of nature, the environment, historical and cultural importance of their local area.

Keywords: Mamaku, community survey, conservation

Wises 1994: Discover New Zealand: a Wises guide. Wises Publications, Auckland. 569 p.

[An expanded travel directory of New Zealand, containing two paragraphs describing Mamaku (village) and the Mamaku Plateau. It outlines the locality, basic components and history of the area. See Jennings (1994) for a history of the Mamaku settlement—BRC.]

Keywords: Mamaku village, Mamaku Plateau

Wright, K.M. 2000: Stratigraphy, volcanology, petrology and geochemistry of the 7.5 ka Mamaku eruptive episode, Okataina Volcanic Centre, North Island, New Zealand. Held in General Library, University of Auckland, Auckland. 119 p. Includes illustrations (chiefly colour) and maps.

[The Mamaku Eruptive Episode (MME) was centred to the east of Lake Okataina. The eruption occurred within the Haroharo Volcanic Complex, which lies within the Okataina Volcanic Centre, within the Taupo Volcanic Zone, North Island, New Zealand. Some pyroclastic fall would have landed on the Mamaku Plateau—BRC.]

Keywords: Mamaku eruption, geology, Okataina Volcanic Centre, Taupo Volcanic Zone, volcanicity

Young, J.M.; Fletcher, M.J. 1997: International collection of micro-organisms from plants: Catalogue: Accessions 1-12989. Landcare Research, Auckland.

[The only records listed for the Mamaku Plateau are for fungi: Nos 17760 and 11761 for *Giberella tumida* on broom (*Cytisus scoparius*); and No. 5433 for *Hypocria atro-gelatinosa* on *Grifola* Berkeley—BRC.]

Keywords: micro-organisms on plants, fungi

3. Acknowledgements

This project was cooperatively funded through the Tane's Tree Trust (a group dedicated to the restoration and retention of indigenous forest and planting of indigenous trees, also concerned with disseminating knowledge and understanding of forest ecology and indigenous trees) and the Department of Conservation (Science Advice Fund).

We are grateful for the assistance we received from the following persons: DOC Information Resource Centre staff; the National Library; National Forest Library and knowledge advisors; Scion; DOC Bay of Plenty Conservancy staff—Sue Clements for the collection of articles, Dean Strachan for the provision of the maps of the Mamaku Plateau region, and Paul Cashmore, Keith Owen and Simon Smale for discussion on flora, fauna and bird corridors, and helpful comments on this work; George Pardy for reports on planting podocarps in Mamaku Experimental Reserves; Willie Debries for discussion on the history of the area; Greg Steward of Scion for reports and information on Mamaku trials with indigenous species; John Innes of Landcare Research for discussion on predators and birds in indigenous forest; Mike Wilcox for discussion of botanical matters; and Christine Dodunski of Scion, Michael Bergin and Fiona Maguire, who typed a substantial number of annotations from handwritten index cards. This work was improved by the help of the following reviewers: David Field (ex-Bay of Plenty Conservator, DOC, 1987–1997) and Keith Owen.

Index

This index comprises all keywords, authors and serial titles, as listed in the items shown in this bibliography.

F

G

H

I

J

K

L

M

N

O

P

R

S

T

New Zealand Government