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

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CONTENTS

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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

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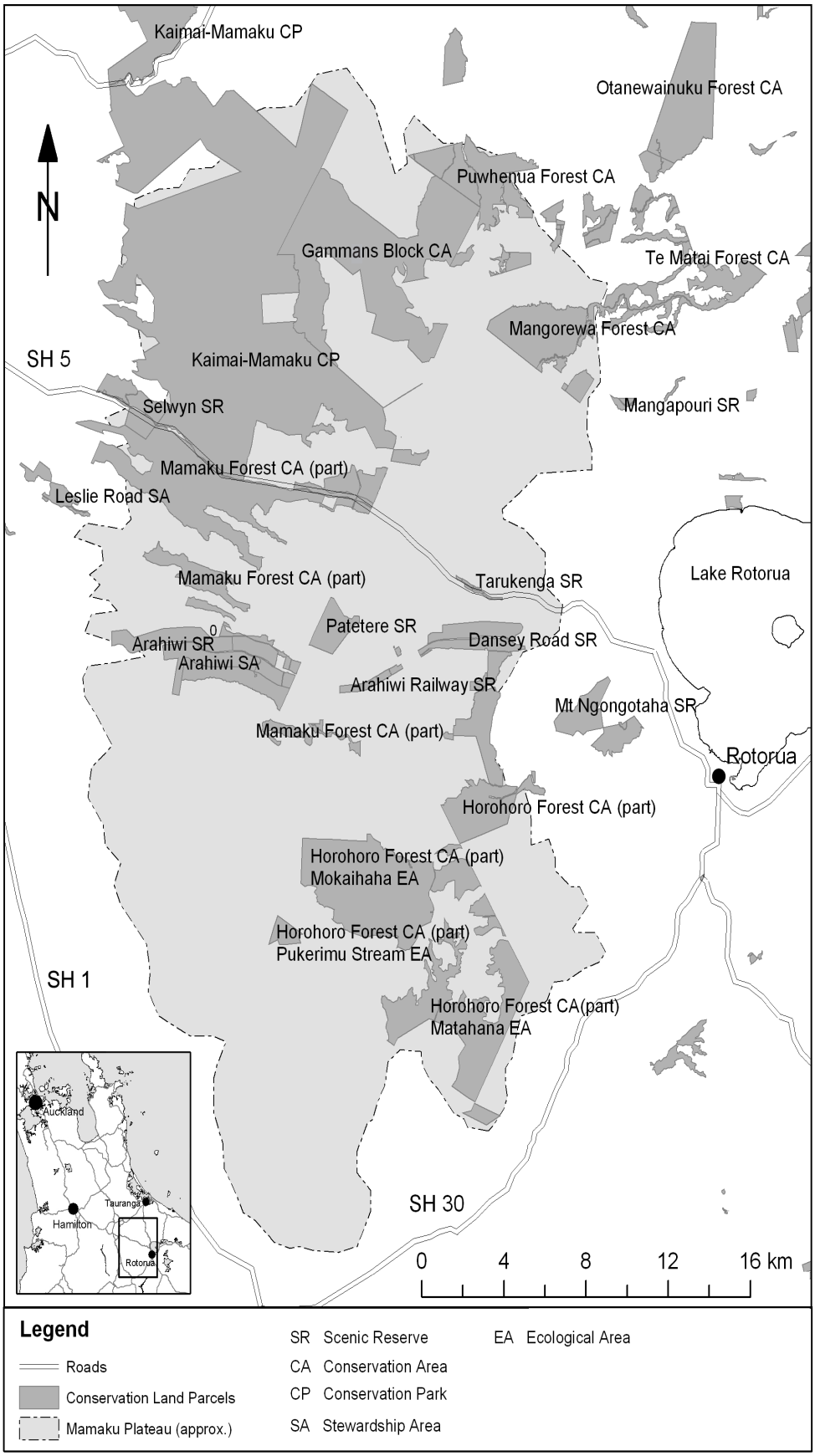
1. Introduction

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.

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[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

Continue to next file: Part 2