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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 Forest Research Institute, Rotorua (unpublished).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 Forest Research Institute, Rotorua (unpublished). 16 p. plus tallies and graphs.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

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[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

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[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

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[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

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[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

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