133. Native Forests Action Council. 1979b: Submission on the Forest Service management plan proposals for Whirinaki State Forest. In: Submissions on Whirinaki State Forest. New Zealand Forest Service, Wellington. Text 76 p. Appendices 25 p.

[Part of this NFAC submission was included in the compilation of submissions made by the NZFS and annotated in this bibliography as NZFS (1979b). Sections of an earlier but incomplete submission by NFAC are annotated separately as NFAC (1979a) and a further submission is annotated as NFAC (1979c).]

Keywords: management proposals – submission

134. Native Forests Action Council. 1979c: Upper Whirinaki—a proposed addition to the Urewera National Park: a submission to the Urewera National Park Board and National Parks Authority. Native Forests Action Council Bulletin. Native Forests Action Council, Nelson. Text 76 p. Appendices 25 p. 89 references.

This submission deals with the case for adding the southern part of Whirinaki State Forest to the Urewera National Park, emphasising the characteristic features of Whirinaki Forest that are not well represented in the national park, such as dense podocarp forest and volcanic landforms. The bulk of the submission appeared as an earlier submission (NFAC 1979a) opposing the NZFS management proposals for Whirinaki State Forest (see NZFS 1979a). This submission provides additional sections, headed 'Evolution of national park criteria', 'Why national park status?', 'Scenery', 'Recreation', and 'National park criteria'. Five additional appendices include comments on the NZFS's management proposals for Whirinaki State Forest, on hunting and national park status, and on potential effects of the proposed national park addition on the Minginui community.

There is interesting and often debatable comment on many aspects of forest ecology, history and management. The bulletin has many sketch maps and several diagrams of forest profiles. [The wildlife section indicates the paucity of well-sourced knowledge at the time, but several personal communications refer to the presence of the endemic short-tailed bat (*Mystacina tuberculata)* and the long-tailed bat (*Chalinolobus tuberculatus)*. Two native species of lizard are known from the area—the forest gecko (*Hoplodactylus granulatus)* and the green tree gecko (*Naultinus elegans*). There is a comment that 'systematic investigations of the native bats, lizards, land snails etc. have not been conducted, nor are they planned'. There is a section on history, with reference to government confiscation of land in the Whirinaki region (after campaigns against the Hauhau activities). [The optimistic stance expressed in the bulletin, suggesting an increase of tourism and recreation and continued operation of the Minginui Sawmill (cutting exotic species) has not been realised. The list of references includes not only published papers and unpublished reports and seminar proceedings, but also personal communications, extracts from Hansard's letters, oral transcripts, and submissions. [See Stokes et al. (1986) for social aspects of the proposed additions to the Urewera National Park. The case for national park status for part of Whirinaki State Forest was obviated by forest park status for Whirinaki in 1984, and new management policies introduced by DOC, which replaced the NZFS in 1987.]

Keywords: management policies, Minginui Village, national park criteria, tourism, Urewera National Park – proposed addition, wildlife research – future

135. Nevin, D. C. 1985: Whirinaki State Forest Park: archaeological site survey. Unpublished report. Held in National Forest Library ((524.6) 931-17). 50 p.

On a 7-day visit to Whirinaki State Forest Park, 18 archaeological sites were recorded, mainly in areas burnt off for planting in 1985. The bulk of the report consists of site record forms, with some sketch plans and site locations shown on maps with references. The site descriptions cover house floors, terraces, middens, pits and stones. Two sites consist of terraces in the Mangawiri Catchment, 'the only good undefended settlement sites found so far in that area'. Management procedures are recommended, mainly involving demarcation, and leaving the sites and areas close to them unplanted. [See also Millyn & Nevin (1978).]

Keywords: archaeological survey (Whirinaki Forest)

136. Nevin, G. E.; Nevin, D. C. 1980: Traditional history of the Whirinaki Valley. Pp. 73–78 in Orchard, M. J.; Field, D. A.; Ure, J. (Comps) 1981: Whirinaki State Forest Management Plan. New Zealand Forest Service, Wellington.

This paper is included in the 1981 Whirinaki State Forest Management Plan as appendix 5. Its outline is similar to that of an article written for *Pu Kaea* newspaper in December 1995 (Pu Kaea 1995). The original occupants of the Whirinaki River Valley, the Marangaranga, were defeated by invaders from the coast. The descendants of those invaders were the Ngati Manawa and Ngati Whare, who occupy Minginui and the Te Whaiti district at the present day. Battles or skirmishes are related up to the time of Te Turuki (Te Kooti). [The pa sites of Okarea, Te Tapiri and Umurakau are among those described and mapped by Millyn & Nevin (1978).]

Keywords: traditional history – Whirinaki Valley

137. New Zealand Forest Service 1966: Working plan for Whirinaki State Forest 1966–1971. New Zealand Forest Service, Rotorua.

Notes made by A. E. Beveridge about the plan include the following:

Old Maori clearings have reverted to manuka/kamahi, with podocarp regeneration.

A nursery for raising podocarp seedlings, either from seed or transplanted wildlings, existed from 1939 to 1946.

Seedlings planted out on exposed sites failed, but some did better on shaded or sheltered sites; these could not be located when dominated by second growth.

Planting of exotic conifers on cutover sites (fully logged forest), some of which had been invaded by toetoe and other grasses, started in 1945. There was no adequate site preparation until 1960.

Burning replaced machine clearing in 1962.

Podocarp seed stands left from 1950 to 1952 were considered a failure [and were later cleared].

Mortality of totara was observed in the Mangawiri Basin and 'development of a forest sanctuary [of 400 ha] was held in abeyance'. Salvage logging of 'dead and dying totara' continued over 200 ha in the Waione area.

Damage by possums to Douglas fir led to ground and aerial poison application from 1960.

[Scientists and foresters failed to agree on the cause of totara die-back, and the totara/matai stands were clear-felled in the Mangawiri Basin in 1973. For annotations on totara die-back and possum diet, see Beveridge (1967), Mason (1968), Forest Research Institute (1982b), Orchard et al. (1981), and Nugent et al. (1997). For later successful plantings of podocarps on disturbed ground or open sites in the central North Island, see Beveridge et al. (1985), and Beveridge & Bergin (2000). Working plans or management plans for Whirinaki Forest, from the time of the first plan in 1950 up to the time of the 1981 plan annotated in this bibliography (Orchard et al. 1981), are kept in the National Forest Library. Plans prior to 1981 have not been directly consulted recently.]

Keywords: podocarp planting, totara die-back, Whirinaki working plan (1966)

138. New Zealand Forest Service 1977: Management policy for New Zealand's indigenous state forests. New Zealand Forest Service, Wellington. 15 p.

This revised national policy heralded a general cessation of clear-felling. Partial logging would provide a reduced volume of wood from indigenous state forests. The policy supported restocking of some categories of forest using nursery-raised stock or wildings of the dominant species. [There was an attempt to implement these policies in Whirinaki Forest from 1975, following their announcement at the 1975 Forestry Development Conference. Application of the management policy in Whirinaki Forest was made more explicit in the NZFS publication on central North Island indigenous forest policy (NZFS 1978a).]

Keywords: forest management policy – revised

139. New Zealand Forest Service 1978a: Central North Island indigenous forest policy. New Zealand Forest Service, Wellington. 14 p.

General principles of the policy were announced by the Minister of Forests on 7 August 1978. The main prescription for Whirinaki State Forest was that indigenous wood production be reduced from 30 000 m^3/year to 5000 m^3/year over the next 12 years, with substitution by logs of exotic species. A brief historical outline is given of NZFS activities in Whirinaki Forest: control of logging operations from 1938, construction of Minginui Village between 1945 and 1947, and construction of the new Minginui Sawmill in 1977. A public meeting was held at Minginui on 21 June 1977 to discuss the future of Whirinaki Forest, following confrontation between villagers and conservation groups. [Most prescriptions made under this policy were replaced by DOC management policies from 1987, following cessation of all logging of indigenous forest in central North Island Crown forests.]

Keywords: forest management policy – revised

140. New Zealand Forest Service 1978a: Forest types of the upper Whirinaki and Wheao catchments. New Zealand Forest Service (unpublished report). Held in file 31/6, Landcare Research, Hamilton. 5 p.

Keywords: forest types – Whirinaki Catchment

141. New Zealand Forest Service 1978b: Proposed ecological areas in Whirinaki State Forest. Unpublished notes prepared for the Scientific Coordinating Committee Meeting, June 1978. Held in file 31/6, Landcare Research, Hamilton. 8 p.

Keywords: ecological area proposals, Scientific Coordinating Committee

142. New Zealand Forest Service 1979a: Whirinaki State Forest: management plan proposals. Compiled by John Ure, Conservator of Forests. New Zealand Forest Service, Rotorua. 18 p. Appendices, maps.

The intentions of the NZFS are outlined and include continuing with wood production from over 13 500 ha of indigenous forest zoned for this purpose. [These management proposals, issued on 14 May 1979, are presented in a stark and simplistic manner, without any mention of management options or the problems of maintaining the health and vigour of the indigenous forest and its wildlife. The proposals generated a strong reaction from environmentalists, who found little to please them in the prescriptions for continuing wood production. Rotorua Conservancy, NZFS, produced a final management plan in 1981, with 133 pages of text and appendices. See Orchard et al. (1981), also NZFS (1979b) covering submissions on the proposals. While the prescriptions and some information in these proposals are obsolete, like those in the full 1981 management plan, some historical facts may be of general interest.]

Historical events described in the report include:

1932: Whirinaki State Forest gazetted, shortly after logging of Maori land had commenced in the valley.

1938: Start of NZFS logging scheme, with the objective [never realised] of 'introducing silvicultural treatment to encourage regeneration or facilitate re-establishment of indigenous species'.

1945: Minginui Forest Village established. Start of planting exotic species, notably Douglas fir, on clear-felled land and sites of partially logged forest [without site preparation until 1960]. Planting was also done on land with a cover of bracken fern and scrub. By 1978, 3500 ha of radiata pine and Douglas fir had been established. Mention is made of disappointing results from the earlier planting of indigenous tree species on clear-felled and partially cutover areas (pre-1945). [Site preparation, using methods such as tractor clearing, root-raking or burning, was introduced later. Some residual indigenous trees were left after exotic conifers were harvested, possibly adding to a podocarp seed source. There was some podocarp regeneration in thinned exotic stands in later years.]

1950: First management plan for Whirinaki Forest with a policy of 'sustained log output' to ensure perpetuation of the Minginui Village community.

1974: Introduction of helicopter support for the recovery of deer carcasses and live deer.

1975: Cessation of clear-felling of indigenous forest and first operational partial-logging [in Mangawiri Basin] ostensibly under new government-supported policy for managing indigenous forest. [See Herbert (1979).]

1977: Minginui Sawmills completed a new mill to cut both indigenous and exotic species by 1981.

The proposals place some emphasis on recreation, completion of a track network, and hut replacement. It was proposed to plant exotic species on remaining 'idle' shrublands within or adjacent to Whirinaki Forest [potential sites for restoration of indigenous forest]. An appendix, listing 18 recreation and amenity areas, includes 'Pigeon Camp', a site of prolific podocarp regeneration beneath kamahi poles in an enclave of dense podocarp forest. Maps show proposed management zones in Whirinaki, and vegetation classes. The public were invited to comment on the management proposals for Whirinaki Forest by 17 August 1979, 3 months after they were issued.

[The news media reported on the proposals. Intense public debate followed, receiving inspiration from a seminar held earlier at Taupo, in March 1978, to discuss the future of the west Taupo forests (see Pureora bibliography, items 185–187). The archives of Forest Research contain newspaper clippings presenting views for and against the NZFS proposals for management of Whirinaki Forest, as announced on 14 May 1979. Many of the letters appeared in the *Rotorua Daily Post*, with others in the *New Zealand Herald* and *New Zealand Listener*, given interest was widespread in New Zealand. See Roche (1990), and NFAC (1979a, b, c). There were also radio interviews. (e.g. Young 1979). A greater collection of news media items covering the NZFS Rotorua Conservancy are contained in the Auckland Regional Office of the National Archives of New Zealand (see reference file A1017, for Rotorua Forest Conservancy up to 1987). Items previously held in the Minginui (Forest) District Office, including newspaper clippings, are now held at the Rangitaiki Area Office of DOC.]

Keywords: forest management history, management plan proposals, management zones, news media reports, recreation and amenity, vegetation classes

143. New Zealand Forest Service 1979b: Submissions on Whirinaki State Forest Management Plan Proposals. New Zealand Forest Service, Rotorua. Text and appendices 76 p.

This document was compiled as a result of an invitation to the public from the Conservator of Forests, Rotorua, to comment on outline management plan proposals for Whirinaki State Forest, distributed for public comment in May 1979 (NZFS 1979a). A completed management plan was subsequently issued by the NZFS in 1981 (Orchard et al. 1981). The NZFS proposals allowed for continuation of a low level of production from the podocarps of the indigenous forest of Whirinaki, by selective logging and salvage of windfalls. This was in line with a revised government policy for central North Island indigenous forest (NZFS 1978a).

The introductory section to the assessment of submissions in this document is anonymous, but was written by a forester of the NZFS. A submission from the New Zealand Institute of Foresters supported, with some reservations, the thrust of the NZFS management proposals. Their submission is included as an appendix in the 1981 management plan. It was also published separately in the *New Zealand Journal of Forestry* (see New Zealand Institute of Foresters 1980). Views opposing those of the NZFS are represented by the environmental groups ECO and the NFAC, who call for immediate cessation of all logging in the indigenous forest of Whirinaki. Their views were later largely reflected in the book by Morton et al. (1984), entitled *To save a forest: Whirinaki*.

Excerpts from submissions either for or against the NZFS proposals are given (18 p.); they are sometimes bitter and controversial. Much controversy was centred on the proposals to start partial logging in dense podocarp forest, particularly within the Tauranga Stream Basin (Tauranga Basin Ecological Area), known as 'Hunting Block 10'. Views for and against a suggestion to include 30 000 ha of Whirinaki Forest in the Urewera National Park are presented. Concerns were expressed about the retention of Minginui Village and the lifestyle of the people of the Whirinaki Valley, based on continuation of employment in the Minginui Sawmill, tourism and recreational activities. [The Minginui Sawmill, built in 1977, closed in 1988 after a short period of cutting logs from exotic plantations. The Whirinaki Forest Park was established in 1984 and no part of Whirinaki State Forest was added to the Urewera National Park (see Field & Garratt 1979).]

Keywords: environmentalist view, management proposal – submissions, production forestry views

144. New Zealand Forest Service 1984a: Reserves in Whirinaki Forest Park. New Zealand Forest Service, Rotorua. 4 p.

This pamphlet emphasises the NZFS's concept of multiple use in a forest park: recreation, protection forest, ecological areas and other reserves, management to maintain natural areas through protection from fire and animal damage, and management for continuing low-level production of native timber. [After the special caucus committee visit to Whirinaki Forest Park on 5 October 1984, all logging of standing timber was to cease, but salvage of windfallen logs continued until 1987 when the NZFS was disestablished and management of all Crown forests was taken over by DOC.]

The pamphlet has a colour cover-photograph of dense kahikatea forest by the Arahaki Lagoon in the Oriuwaka Ecological Area. Other colour photographs show rimu with understorey tawa, the Taho (Taahau) frost flat with monoao, and the forest edge in the Otupaka Ecological Area. There is also a map of Whirinaki–Urewera forest-classes, showing the location of the forest sanctuary and the five ecological areas in Whirinaki Forest Park. Features of the ecological areas are outlined. The pamphlet was reprinted by DOC in 1989, excluding any mention of wood harvesting which had ceased by then.

Keywords: ecological areas, protection forest, recreation, Whirinaki Forest Park reserves

145. New Zealand Forest Service 1984b: Production from Whirinaki Forest Park. New Zealand Forest Service, Rotorua. 4 p. Colour photographs.

A pamphlet written in popular style, supporting some continuing wood production through selective logging over 12 000 ha of indigenous forest zoned for this purpose in the 1981 management plan (Orchard et al.1981). Logging would mainly involve salvaging podocarp windfalls, with the possibility of log removal by helicopter. The pamphlet outlines how canopy gaps made by logging had been planted for several years with nursery-raised podocarp seedlings—the seedlings raised from seed collected in the forest (mainly rimu and kahikatea). [Until nursery-raised seedlings became available, wilding podocarp seedlings were removed from forest ecotones and transplanted directly to canopy gaps, roadsides and skid-site margins (see Orchard et al. 1981, pp. 28–31).] It is also explained that small numbers of totara logs may be removed under strictly controlled conditions for 'special Maori cultural orders'—mainly carving.

At the time the pamphlet was written there were 4000 ha of exotic conifer plantations and 2900 ha of scrubland in Whirinaki Forest Park. [Planting of cleared scrubland sites with radiata pine and Douglas fir started in the 1940s and continued on land cleared after logging of all merchantable native trees. Further felling of native trees in the park was proscribed after the meeting of a special caucus committee of the Labour Government who visited the park in October 1984 (see NZFS 1984c). Salvage logging of windfalls continued until 1987.]

Keywords: podocarp windfall salvaging, wood production – indigenous

146. New Zealand Forest Service 1984c: Special Caucus Committee visit to Whirinaki Forest Park, Friday 5th October 1984. New Zealand Forest Service, Wellington. Text 21 p. 4 enclosed brochures.

The text, entitled 'Whirinaki: an exercise in forest conservation', presents the NZFS case for continued management of the forest for production of podocarp wood at the level of 5000 m^3 per annum [previously 30 000 m^3 per annum], mainly through salvaging of wind-fallen podocarps. Written in a popular promotional style, presumably by NZFS Rotorua Conservancy staff, there is a brief background account of Whirinaki Forest and reduction in indigenous forest operations generally. The decline of a veteran element in podocarp-dominanted forests is emphasised, together with the lack of developing podocarp regeneration within the old-growth forest, though it is recognised that there could be replacement of present stands in a cyclical pattern over the long term [or after catastrophic canopy opening]. The likely impact of logging cessation on local employment and the Minginui Village is outlined. Some development of tourism is envisaged. Enclosures include brochures entitled 'Whirinaki Forest Park', 'Production from Whirinaki Forest Park', 'Reserves in Whirinaki Forest Park', and 'The Maori of Whirinaki Forest Park', and a leaflet 'Whirinaki State Forest: A management study in dense podocarp forest'. These items are listed separately in this bibliography (NZFS 1984e, b, a, d respectively; FRI 1984). All of this material was published in 1984, the same year as publication of the book *To save a forest: Whirinaki*, by Morton et al. (1984).

After field visits and discussion with caucus committee members, David Butcher, MP, announced the Labour Government's decision that all felling should cease immediately in Whirinaki Forest Park. [From perspective gained over the 20 years since this controversy, it may be seen that opposing accounts were partisan and non-objective and should now be read very critically as presenting an historical debate on the preferred management option for Whirinaki Forest.]

Keywords: forest management – multiple use, logging cessation

147. New Zealand Forest Service 1984d: The Maori of Whirinaki Forest Park. New Zealand Forest Service, Rotorua. 4 p. 7 colour photographs.

The close bonds of the Tuhoe people and Whirinaki Forest are emphasised. At the time of publication, Maori bushmen were still involved in selective logging in the indigenous forest and working in the local sawmill. Traditional tribal foods and medicinal herbs are sought in addition to hunting of deer and pig and trapping of possums for fur. Totara wood is used for building of meeting houses and carving and weaving skills, using flax and fibres of other indigenous plants, are maintained. The traditions and history of ancestors are revered, together with the traces of early inhabitation.

[In the 1970s and 1980s, Whirinaki, like Pureora, was at the centre of a national debate over the continued logging of indigenous forest, especially in the North Island. In 1984 the matter was about to be resolved, and the language and views of this pamphlet were coloured by the emotional issues of the time, when further employment in the Minginui Village and Whirinaki Valley (population 500) was at stake. Felling of trees in indigenous forest in Whirinaki ceased in late 1984, the sawmill built in Minginui in 1977 to cut both indigenous and exotic logs was soon closed (in 1988), and local employment fell to a low level for some years.]

In the late 1970s, two activities by Maori employees of the NZFS which took place, referred to in this pamphlet, were collection of indigenous tree seed (mainly rimu and kahikatea, to be raised in a local nursery) and plantings by the Rotorua Forest Conservancy of wildings (removed from scrub) in open areas such as road margins, logging-skid margins, and forest canopy gaps. [No recent assessment has been made of these plantings. Restoration planting of nursery-raised podocarp seedlings in areas of badly planted exotic trees, such as the Mangawiri Basin (cleared of a dense totara/matai forest and planted with Douglas fir and radiata pine), was possible by 1985, but not undertaken (though a Rotorua forester agreed that it should be done). The salvage of fallen totara for Maori carving or other traditional uses is a further matter to be considered. This brochure was reprinted with some changes by DOC, in 1989.]

Keywords: forestry employment, Maori tribal history – Whirinaki, podocarp planting, totara salvage

148. New Zealand Forest Service 1984e: Whirinaki Forest Park. New Zealand Forest Service, Rotorua. 4 p. Map and colour photographs.

This is the first of four illustrated brochures on Whirinaki Forest Park produced by the NZFS in 1984 in response to the controversy on future management of the Park. This issue has a cover photograph of two rimu trees over a typical understorey of tawa, a map of the park, and a photograph of the Whirinaki Recreation Camp beside a strip of podocarp forest. The text briefly outlines recreational pursuits. It also presents a view of multiple-use management that includes a low level of timber production from the indigenous forest.

[This brochure was reprinted by DOC in 1989 with changes to text and photographs, emphasising recreation and outdoor pursuits and excluding mention of wood harvesting which, for other than traditional cultural purposes, is prevented by law. The extent of Whirinaki Forest Park in 1989 was 54 000 ha (excluding plantations of exotic conifers).]

Keywords: management – multiple-use, recreation, Whirinaki Forest Park

149. New Zealand Forest Service 1985: Tramping and walking in Whirinaki Forest Park. New Zealand Forest Service, Rotorua. 14 p. Illustrated booklet.

Administrative details are now out of date, but this is a useful account of both long and short walks in the park, with details of routes, terrain, features of the landscape, and walking times. Tracks, huts, and stream catchments are shown on a full A4-sized map of the park. Camp and hut sites include the Whirinaki Recreation Camp and the Forest Users Camp (defunct in 2003), a short distance from Minginui Village. The use of heavy machines and logging trucks in the area traversed by the short walks was soon discontinued, except within the 7000 ha of exotic forest then within park boundaries. The hunting areas, known as 'Blocks 1–14', had many roads and both old and new logging tracks. The finest forest sites to visit were considered to be the dense podocarp forest of the Oriuwaka Ecological Area and podocarp/tawa forest in the Fort Road Recreation Reserve within 'Hunting Block 10' of the Tauranga Stream Basin (Tauranga Basin Ecological Area). This booklet was reprinted and published in 1986 by the NZFS, Rotorua, with slight changes to text and photographs. [A DOC pamphlet published in 1999 has less detail.]

Keywords: huts, recreation, tracks, tramping in park, walking in park

150. New Zealand Institute of Foresters 1980: Submission on the Whirinaki State Forest Management Plan proposals: paper prepared by the Council of the Institute and submitted to the Conservator of Forests, Rotorua, on 6 September 1979. *New Zealand Journal of Forestry 25(1)*: 79–99.

The development of a government management policy for New Zealand's indigenous state forests is outlined. This submission agrees in general with the management plan proposals for Whirinaki, which were developed by the NZFS (NZFS 1979a) to be in line with that policy. However, reservations were expressed about the brevity of the document and the lack of convincing evidence that a sustained yield could be achieved by selection management without taking into account the tawa resource. Reference is made to the first operational partial-logging carried out in 1975 in the Mangawiri Basin, which started only 2 months after a government decision to cease clear-felling

indigenous forest and converting to exotic plantations. That operation resulted in excessive damage to residual trees (Herbert 1979), but led to improved techniques.

Keywords: management proposal – submissions, partial logging

151. New Zealand Native Forest Restoration Trust. 1992: The Living Forests of New Zealand. David Bateman Ltd, Auckland. 274 p.

A popular, wide-ranging account, with text mainly written by trustees of the Native Forest Restoration Trust. Splendidly illustrated with colour photographs of forests, forest plants and birds. There are a number of references to Whirinaki Forest and its podocarp species, and brief sections headed 'Forests of the Urewera' (pp. 78–79) and 'The finest podocarp stands at Whirinaki' (pp. 88–90).

Keywords: dense podocarp forest, ecological values, environmental values, wildlife habitat

152. New Zealand Soil Bureau 1968: Soils of New Zealand. Part 1. *NZ Soil Bureau Bulletin 26(1)*. New Zealand Soil Bureau, Wellington. 286 p.

An account of the yellow-brown pumice soils that cover Whirinaki Forest is included in this bulletin (pp. 50–51). These soils 'are derived from rhyolitic materials (Kaharoa and Taupo ashes) of huge paroxysmal eruptions. Kaharoa ashes were erupted about 1300 A.D. from Mt Tarawera', with one series of showers going in a southeast direction. 'The Taupo ashes were erupted about 131 A.D. [revised date AD 200] from vents in or about Lake Taupo and covered all of the Central Volcanic Region.'

The extent of the soil parent material—the Taupo ash, and, in the northern part of Whirinaki Forest, the younger cover of Kaharoa ash—is shown on a coloured map (fig. 1.2.1, facing p. 8). The extent of yellow-brown pumice soils is shown in a zonal soil map (fig. 3.1.1, facing p. 48). A soil map of the North Island (in a pocket of the bulletin) shows the yellow-brown pumice soils subdivided into the Kaingaroa soils, which occur west of the Wheao River, and the Urewera steepland soils, which occur to the east on the higher altitude slopes of Whirinaki Conservation Park. 'Over most of the area covered by yellow-brown pumice soils the soil-forming deposits consist of silty ash over sandy ash, over gravelly sand or gravel' (p. 50).

Keywords: Kaharoa ash, soil map, soils – yellow-brown pumice, Taupo ash, Taupo Eruption

153. Nicholls, J. L. 1966: Map sheet N104 Maungataniwha. New Zealand Forest Service type map, series 2, scale 1:63 360. Ecological survey of New Zealand's indigenous forests. Forest Research Institute, Rotorua.

This map of forest types covers the southern part of Whirinaki Forest, bounded in the east by part of the Urewera National Park, and in the west by scrub, Kaingaroa Forest and farmland. Boundaries of Whirinaki State Forest are not marked on the map. The text accompanying the map gives accounts of forest types, physiography, soils, climate, animals and history. Text is organised under

headings that were used again for map sheet N95, Te Whaiti, which bounds this one to the north (see Nicholls 1969).

Red deer were liberated from 1899 in adjacent districts, and possums from 1898 (cf. Pracy 1962). The author suggests that the 'ragged, scrub-bordered edges and the scattered patches of forest in the west show that a complete forest cover may have been whittled back by burning in Polynesian times'. Advanced growth is said to be very rare in 'merchantable' virgin forest with large podocarps.

The forest types used in the vegetation mapping follow those described by McKelvey & Nicholls (1957) and Nicholls (1969). The main forest types within the southern part of Whirinaki Forest, as shown on the map sheet, are those of pure beech (in forest class K), and scattered rimu and beech at higher altitudes and on steep terrain (in forest class I). The less widespread forest types mapped have scattered podocarps and hardwoods (in forest class M). At lower altitudes there are dense podocarps (in forest class L).

Keywords: forest history, forest type descriptions, forest type map, physiography, soils

154. Nicholls, J. L. 1969: Map sheet N95 Te Whaiti. New Zealand Forest Service type map, series 2, scale 1:63 360. Ecological survey of New Zealand's indigenous forests. Forest Research Institute, Rotorua.

This map shows distribution of forest types in the northern part of Whirinaki Forest and the western part of Urewera National Park. Tenure boundaries are not marked. The southern part of Whirinaki Forest is covered by map sheet N104, Maungataniwha (see Nicholls 1966). The accompanying text for this map, covering the forest types, physiography, soils, climate, wild animals, and history, is taken directly from Nicholls (1966); it is the best concise account of the forest tract and has been used again by later writers, including the NZFS (e.g. Orchard et al. 1981).

Soils under the Whirinaki indigenous forest, west and south of Minginui, are derived 'from ash erupted from the Taupo district c. 1500 BC and AD 150' (revised date AD 200). Red deer were freed in 1919 and 1921 at Te Whaiti. Possums were freed at Te Whaiti in 1917. It is suggested that the scrub-bordered western forest margins and scrub in the Wheao Valley may have resulted from burning in Polynesian times and that the large clearing between Te Whaiti and Minginui and smaller ones elsewhere were made mainly in pre-European times. Logging began in the early 1930s 'and for several years was confined to felling of totara over relatively small areas in the Whirinaki Valley'. West of Minginui heavily timbered forest has been logged since 1938 and, together with ancient forest clearings [in scrub or secondary forest], has been cleared and planted with exotic forest.

Mapping was based on aerial photographs taken in 1945–46. The forest types used in the vegetation mapping follow those described by McKelvey & Nicholls (1957). The main forest types within the northern part of Whirinaki Forest, as shown on the map sheet, are those of dense podocarp (forest types L1 and L2), and scattered podocarp with rimu/matai–tawa–kamahi (forest type M2). Some of the less widespread forest types mapped include those with a tawa-

dominated canopy (in forest class N); they are either the result of crown fires removing most podocarps many years ago, or logging in recent times. Tawa–kamahi (forest type N1) is found mainly along the forest edges west of Te Whaiti and Minginui. Hardwood low forest, with tawa seldom present (forest class P) is of particular historical and ecological interest as it contains pockets of sapling and pole podocarps resulting from fire. Kamahi–rewarewa (forest type P1) occurs in pockets 'at the western forest margin and near ancient clearings south and south-west of Minginui, apparently regrowth since burning of forest in Polynesian times'.

[The presence of dense podocarp forest (type L), along the western boundary of the park, passing into a belt of scrub (type R1) before the exotic plantations of Kaingaroa Forest, does suggest that the dense podocarp forests in this area were the result of Polynesian fires (see Cameron 1960a, 1961), but further evidence is needed. In the description of forest types there are references to rata, mostly standing dead or dying (in forest types D1 and M3), and to totara (in forest type L1) and Halls totara (in forest type M1), also in a similar condition. There is no mention of decline of kamahi.]

Keywords: forest history, forest-type descriptions, forest-type map, physiography, soils

155. Nicholls, J. L. 1974: Urewera forest class map. New Zealand Forest Service Mapping Series 6, Sheet 1, 1:250 000, 2nd edn. Includes explanatory notes.

[Held at Landcare Research, Hamilton. See map in NZFS (1984a), with location of ecological areas and forest sanctuary.]

Keywords: forest class map (Urewera)

156. Nicholls, J. L. 1976: A revised classification of the North Island indigenous forests. *New Zealand Journal of Forestry 21(1)*: 105–132.

A schedule of forest classes containing nearly 200 forest types is given in this revision of the 1957 provisional classification (McKelvey & Nicholls 1957). Some forest types that occur in the southern Urewera district are described as follows (abbreviated):

L5: Abundant rimu with frequent miro, matai and tawa. Occurs at 450–600 m altitude in Whirinaki Forest, on the eastern margin of the central rhyolite plateau.

M3: A forest type grouped in the rimu–matai hardwoods class, occurring in the southern Urewera Ranges.

M4: Rimu, miro, matai, kahikatea. The distribution is as for M3, but generally on easier terrain under 550 m altitude (the M class is distinguished by the presence of matai, totara or kahikatea.

I15: Red beech with kamahi and tawari. This forest type is in the rimu–general hardwoods beeches class.

I25: Red beech, kamahi, podocarps. Occurs in the upper Whirinaki Valley.

J3: Abundant red beech with occasional miro and Hall's totara. It is in the highlands–hardwood beeches class. Occurrs locally at over 800 m in the southern Urewera district.

J5: Red beech, silver beech with toatoa, kamahi, tawari. Occurs at 900–1000 m altitude.

K1: Red beech, with shrubby kamahi, tawari, *Quintinia*. It is in the beeches class.

[The forest classes are described in a more recent publication by Nicholls & Herbert (1995).]

Keywords: forest classes, forest classification – North Island, forest types

157. Nicholls, J. L. 1978: The forest pattern in the Urewera region. Forest Research Institute unpublished report to the Scientific Coordinating Committee. Held in file 31/6, Landcare Research, Hamilton. 3 p.

Keywords: forest pattern – Urewera Forests, Scientific Coordinating Committee

158. Nicholls, J. L. 1979a: Proposed Tauranga Stream Ecological Area in Whirinaki State Forest 58. Unpublished file note. Held in file 31/6, Landcare Research, Hamilton. 4 p.

Keywords: Tauranga Basin Ecological Area

159. Nicholls, J. L. 1979b: Species succession in podocarp–tawa forest at Pureora and Whirinaki. Unpublished file note. Held in file 31/6, Landcare Research, Hamilton. 5 p.

Keywords: succession – podocarp/tawa forest

160. Nicholls, J. L. 1985: Revised zoning of Whirinaki State Forest Park. Unpublished file note. Held in file 31/6, Landcare Research, Hamilton. 2 p. Maps.

Keywords: zoning of Whirinaki Forest

161. Nicholls, J. L. 1986: A descriptive overview of the central North Island volcanic upland. Pp. 2–17 in Veale, B.; Innes, J. (Eds): Ecological research in the central North Island Volcanic Plateau region. Proceedings of a New Zealand Forest Service workshop, Pureora, November 20–23 1985. Forest Research Institute, Rotorua.

This paper was a keynote address at the NZFS workshop. It gives an outline of the geology, physiography and volcanicity of the region, illustrated by colour maps of geology, landforms, topsoil-forming tephra, forest classes and land use in the years 1840 and 1985. Whirinaki Forest is situated at the eastern edge of the volcanic upland, where the ignimbrite meets the greywacke hills of the Urewera National Park. An account is given of the volcanicity of the region over the last 20 000 years. In Whirinaki Forest, yellow-brown pumice soils have been derived mainly from Taupo tephra which erupted from the Taupo caldera (the eruption centre). The Taupo Eruption culminated in four eruptions centred on the Horomatangi Reef in Lake Taupo about AD 130 [the revised date for the Taupo Eruption is AD 200]. The last two events were the eruption of the Taupo lapilli, followed by the powerful eruption of Taupo pumice as a ground flow

extending 80 km from the caldera, and capped by fine ash airfall. A pre-existing forest was almost totally incinerated near source, and towards the perimeter of the flow, blasted down. There is no evidence of forest destruction from airfall of the Kaharoa lapilli, which erupted from the Okataina volcanic centre about 1000 years later, in AD 1280 [revised date is AD 1314]. Topsoils formed from the Kaharoa tephra are shown on a map extending east of the middle reaches of the Rangitaiki River to the Urewera Ranges [Whirinaki Forest was likely to have received light ashfall].

Keywords: forest classes, geology, Kaharoa ash, land use changes, landforms, soils, Taupo tephra, volcanic plateau – central North Island, volcanicity

162. Nicholls, J. L. 1990: The indigenous plant communities of the Kaingaroa Ecological District. *Rotorua Botanical Society Newsletter 20*: 28–46.

The natural vegetation of the 250 000 ha ignimbrite Kaingaroa Plateau has undergone immense changes since the arrival of humans. The original forest cover was largely destroyed by early Maori fires, and the succeeding tussock grassland, scrub, fernland and heathland has mostly been replaced in the past century by exotic conifer plantations and pasture. Only 2% of the plateau remains under indigenous vegetation. Some 29 significant areas are listed and described, with reference to published and unpublished material for the five bioclimatic zones in which they occur. Over half are in the 'Upper Rangitaiki' zone, at the southern end of the plateau. (MCS)

[At the time of writing, many of these significant areas had been botanised only superficially or not at all, and several wetlands had recently been lost to land development for forestry and agriculture.]

[An example of successful establishment of podocarps on a harsh Kaingaroa site where the microclimate was improved by an unthrifty, thin canopy of *Pinus ponderosa* in 'Compartment 1071', Kaingaroa Forest, was described in 1987 by G. Pardy, in Forest Research Institute Project Record 1820. In 1999, plots on a 12 ha site 'underplanted' in 1961 were visited. A summary of observations has been published in Beveridge & Bergin (2000, p.55, trial 7a). Rimu, kahikatea and totara were up to 10 m in height and had a closed canopy which had suppressed dense blackberry (Beveridge, A. E., pers.obs.).]

Keywords: Kaingaroa Plateau – vegetation – fire impact

163. Nicholls, J. L. 1994: Otupaka revisited: 15 May 1994. *Rotorua Botanical Society Newsletter 30*: 6–9.

The objective of the visit was to find further taxa to add to a previously published list for the Taho (Taahau) frost flat (Nicholls & Smale 1991). Appendices include a species list for 18 May 1991, with a further seven species recorded on 15 May 1994.

Keywords: frost flats – Taho (Taahau) species list

164. Nicholls, J. L.; Herbert, J. W. 1995: A condensed classification of the native forests of New Zealand. Pp. 2–5 in Hammond, D. (Ed.): Forestry Handbook, 3rd Edn. New Zealand Institute of Forestry, Christchurch.

The forest classes and forest types that occur in the southern Urewera district, which includes Whirinaki Forest, were described by Nicholls (1976). There are references to dying northern rata and kamahi in several forest classes in the Urewera district and other areas of the North Island.

Keywords: forest classes, forest classification, forest types, kamahi decline, rata decline

165. Nicholls, J. L.; Smale, M. C. 1991: Otupaka field trip: 18 May 1991. *Rotorua Botanical Society Newsletter 23*: 10–13.

Describes vegetation of the Taho (Taahau) frost flat within the Otupaka Ecological Area. A provisional species list is given, which includes 50 indigenous and adventive species typical of a 'standard frost flat' (cf. Smale 1990a, b), and similar to the smaller Waione stream flat flora described by Cameron (1988). Fire swept the flats and surrounding scrub-covered hills about 55 years previously, and dense monoao (*Dracophyllum subulatum)* is now the dominant cover. The ecology and management of larger frost flats in the central North Island were described in Smale (1990a, b).

Keywords: frost flat – Taho (Taahau) species list, Otupaka Ecological Area

166. Norton, D. A.; Herbert, J. W.; Beveridge, A. E. 1988: The ecology of *Dacrydium cupressinum*: a review. *New Zealand Journal of Botany 26*: 27–62.

Some of the complex problems of forest regeneration, forest pattern, forest structure, and the establishment and population dynamics of dense podocarp and podocarp/broadleaved (hardwood) forests are discussed, particularly where rimu is dominant. One section deals with dense rimu forests in the central North Island (pp. 51–53), and specific reference is made to Whirinaki Forest. A number of the papers quoted in this review are included in the current bibliography (viz. Cameron 1954, 1960b; Beveridge 1964, 1973; McKelvey 1955, 1973a and b; Katz 1980a, b; Herbert 1986a and b in Pureora bibliography items 119 and 120; Smale et al. 1985, 1988).

The authors of the review conclude that the dense rimu forests of Whirinaki (and west Taupo) are not even-aged, nor do they represent the first podocarp generation since the Taupo Eruption of c. AD 130 [revised date AD 200]. However, they are too old (with trees aged up to 800 years or more) to have resulted from Polynesian burning. Earlier hypotheses on podocarp succession and supposed regeneration failure [as in old-growth forest in Whirinaki where there is a 'regeneration gap'] are reviewed, and the authors conclude that recent climate change need not be invoked as a cause of this apparent failure. Disturbance is a key factor in forest replacement. A mosaic structure resulting from cycling of the main tree species has been suggested for Whirinaki (Cameron 1954) and demonstrated in west Taupo forests (Beveridge 1973). Podocarps can be maintained at a site through a growth cycle starting in gaps, the gaps caused either by slow death or windthrow of single trees or groups of trees, or by widespread forest destruction.

[It is difficult to demonstrate the gap growth cycle in Whirinaki Forest (see Ogden & Stewart 1995), but pole podocarps develop after fires, with long succession through a canopy of kamahi or kanuka. Substantial canopy opening

of the dense, rimu-dominant forest at the margin of Mangawiri Basin is the result of a heavy partial-logging in 1975, followed by windfall and collapse of pioneer wineberry. There is evidence that a new generation of forest with podocarps has been initiated there, after nearly 30 years since it was disturbed. Small podocarp seedlings of the five species are locally abundant (Beveridge, A. E. 2004, pers. obs., 2 February), but an objective regeneration survey is required to present the situation fully.]

Keywords: forest cycles, forest pattern, forest regeneration-disturbances, forest structure, rimu ecology, rimu growth, rimu-dominant forest (origin/development)

167. Nugent, G.; Fraser, K. W.; Sweetapple, A. J. 1997: Comparison of red deer and possum diets and impacts in podocarp–hardwood forest, Waihaha Catchment, Pureora Conservation Park. *Science for Conservation 50*: 1–61.

These studies, in a west Taupo forest, have some relevance for the Urewera tract and Whirinaki Forest; this paper is also annotated as item 201 in the Pureora bibliography. In particular, a red deer population of approximately 6 individuals/km^2 was sufficient to deplete much of the understorey and result is a high consumption of litterfall. Possum density was approximately 3 individuals/ha. Foliage of Hall's totara, many of which had crown die-back, was the main food of the possum. Kamahi was the only species with foliage important to both possums and deer. [Older kamahi in Whirinaki Forest show crown decline, and so do totara, Hall's totara and northern rata.]

Keywords: Hall's totara die-back, kamahi – decline, possum and deer diet

168. Numata, M. 2001: Analysis of possum damage found in the leaf litter of northern rata (*Metrosideros robusta*) as a potential index of relative possum density. Department of Conservation, Murupara (unpublished report). 50 p. (Text 12 p. Tables and graphs 38 p.)

This is a detailed account of monthly collections and data analysis of litterfall from March 1994 to May 2000, using funnel traps placed initially beneath 9 large rata trees and later beneath 38 trees in areas that had 1080 possum control operations, or no such control. A map shows location of sampled trees in Whirinaki Forest Sanctuary and forest to the south, within Whirinaki Forest Park. The objectives were firstly to determine any effect of a 1080 poison operation carried out in August 1999 by means of an assessment of possum-damaged leaves in litterfall collections, and secondly 'to assess if possum damage found in leaf litter can be a measure of possum density' (i.e. assessing if the methodology actually works in achieving the primary objective). Rata leaves in litter collections were sorted into three categories: possum damaged, insect damaged and undamaged. A constraint on the methodolgy was the difficulty in distinguishing between possum damage and insect damage. It was concluded that the total number of leaves in litterfall may be used as a measure of rata canopy condition.

Data for monthly litter collections from each tree are given in histograms. Main leaf-fall from rata occurs most regularly from December to March, with a

constant seasonal pattern. The method of using numbers of possum-damaged leaves may not be sensitive enough to record the relatively small recovery of rata crowns following the 1998 poisoning operation, which reduced the possum population. This report is one of a series concerned with measuring the decline of crown condition of rata in Whirinaki Forest Park, and the degree of recovery after the reduction of possum populations. An appendix contains data on total monthly litterfall of tawa and kamahi from traps placed beneath rata trees. [See Hosking (1994, 2002, 2003), de Monchy (1999a, b), Hosking & Numata (2001), and Lander & Warne (2001a, b, c). The annotation for Hosking (2003) comments on the overall project.] (BRC)

Keywords: litterfall index, possum density, possum populations, rata litterfall, rata – possum damage

169. Ogden, J.; Stewart, G. H. 1995: Community dynamics of the New Zealand conifers. Pp. 81–119 in Enright, N. J.; Hill, R. S. (Eds): Ecology of the southern conifers. Melbourne University Press, Melbourne.

In a section on 'dense podocarps in central North Island', successional processes and regeneration systems in forest affected by the Taupo Eruption are discussed and presented in a diagram (pp. 114–119 and fig. 5.11). Similarities in age structures are indicated for west Taupo and Whirinaki forests, where the dense stands occur mainly on deep pumice soils. Different degrees of shade tolerance are shown by the different species of podocarp, influencing the sequence of establishment after catastrophic disturbances.

[Smaller-scale disturbances have occurred in Whirinaki Forest since the Taupo Eruption: possible lightning fires or severe storms on rare occasions before human settlement; Polynesian fires since settlement in the 13th or 14th century; and forest clearing mainly during the early 19th century. The later cleared areas, where not subjected to repeated fires, may now be occupied by kamahi and kanuka with podocarp regeneration. In some west Taupo forests, on sites inimical to tawa (too cold or drought-prone), cyclic regeneration of dense podocarp forest is well documented. In Whirinaki Forest, podocarp regeneration at an early stage is occurring in the totara–matai–kahikatea stands (forest class L of Nicholl (1976)) selectively logged for totara (Gamble 1979). In the gap regeneration cycle discussed in this paper (fig. 5.11, pattern c, occurring in the Waipapa Ecologial Area of Pureora Forest Park), kamahi acts as a nurse for podocarps and has an epiphytic origin on fallen logs and tree fern stems —sometimes developing massive stems before succumbing to slow die-back. This gap regeneration can also occur in Tihoi Forest, west Taupo, with die-back of other large hardwoods (hinau, maire, *Griselinia*). However, it has only rarely been recorded in Whirinaki Forest, where large, solitary kamahi have often suffered die-back and mortality, and young epiphytic kamahi (which are subject to browsing) are not prominent on tree fern stems or logs, as they are in parts of Pureora Forest Park. See Norton et al. (1988) for ecology of rimu.]

Keywords: dense podocarp forest, forest clearings, forest pattern, regeneration – natural, succession, Taupo Eruption

170. Orchard, M. J.; Field, D. A.; Ure, J. (Comps) 1981: Whirinaki State Forest Management Plan. New Zealand Forest Service, Wellington. Text 57 p. Appendices 76 p. 21 appendices. 3 maps of vegetation types and management zones, 20 references.

[This plan was approved by the Minister of Forests on 10 August 1981 and was to operate until 1990. It was the last management plan for Whirinaki to be written by staff of the NZFS, which was disestablished in 1987 and replaced by DOC with new management policies and objectives. With a change of government in 1984, the Labour Party decided that all logging in indigenous forests should cease in the same year, and that Whirinaki Forest Park should be established, covering the 60 900 ha of the former state forest (exotic plantations were excluded later). Salvage operations to extract windfallen podocarps continued until the demise of the NZFS in 1987. This 1981 plan was prepared after outline management proposals had been distributed by the NZFS, Rotorua Forest Conservancy, in 1979. Those proposals had been the subject of fierce debate between environmental interests and others interested in some continuation of wood production from the indigenous forest of Whirinaki. Separate annotations are given in this bibliography for the management proposals document, and also a report analysing submissions received on those proposals (NZFS 1979a, b respectively). The 1981 management plan gives little expression to the views of those who opposed the NZFS proposals. Those proposals had tried to reflect government forest policy of the time. Government policy had been revised in 1975, 1977, and 1978, with the most current revision allowing controlled selective logging of podocarp and podocarp/tawa forests, with rapidly diminishing wood production (see NZFS 1977, 1978a).]

Although most of the objectives and some of the discussion contained in the 1981 management plan are now obsolete, it remains a useful historical document on the controversies and attitudes of the late 1970s and early 1980s. The text contains summaries of facets of the forest history, milling, recreational activities (mostly hunting and fishing), control of wild animals, and their impact on vegetation. The many appendices give information on most of these topics. The appendices also include accounts of the Maori history of the Whirinaki Valley, and the results of a 1978 survey on population and employment in the Whirinaki Valley (where Minginui Village was built in 1945). The total population of Whirinaki Valley was 472, according to a 1981 survey. There is descriptive material on forest types, ecological areas, topography, geology, soils, climate, vegetation and wildlife, and some background to forestry activities.

The Forest Service commenced logging in 1938 to remove all merchantable trees from the indigenous forest. From 1945 they were converting both logged forest and scrub areas to plantations of mainly radiata pine and Douglas fir (total plantation area in 1979 was 3900 ha). This continued until 1975, when a policy of controlled selective logging was introduced. A total of 2200 ha was managed in this way, up to the time of the management plan in 1981. [The first operational selective logging in dense podocarp forest of the Mangawiri Catchment in 1975 resulted in excessive damage and windfall (Herbert 1979), leading to the establishment of a trial in 1979 (Okurapoto trail) to demonstrate a much higher degree of control and lower intensity of logging.]

A characteristic feature of the text is the brief and sometimes dismissive coverage of broad and significant topics. However, useful points have been made as follows:

Totara die-back and mortality

Reference is made to widespread die-back and death of totara, the cause not known (pp. 17, 47). Many totara were dead or dying from the 1960s (or possibly earlier). One of the few areas of live totara was said to be the Tauranga Basin Ecological Area (p. 25). No seed from large totara in old-growth forest had been found locally since the 1960s (p. 30). All totara, both dead and alive, were reserved for marae construction, carving, and other Maori cultural requirements (p. 36). Notes by John Nicholls refer to a shallow basin of the forest sanctuary where 'a former concentration of totara was felled for post timber many years ago…'. A scattering of living totara remained in the vicinity (appendix 21, p. 136). In the Otupaka Ecological Area, totara regeneration was advancing into fire-induced manuka on ridges. Some totara poles were 'moribund. Abundant huge old totara in a small matai stand above the Wheao river (type L1) are all standing dead'. In the Tauranga Basin, live totara were locally frequent in forest type P5, but in type Y totara was heavily worked, logging having started many years ago. Further comment is made on felling or salvaging totara and the relatively slow loss of totara in the valley through natural mortality [Totara die-back was at that stage not attributed to possum browsing, see Beveridge (1967), Mason (1968).]

Fire-induced scrub and podocarp regeneration

It is noted that 'Whirinaki has had a long history of lightning fires in the podocarp–hardwood forests'. Other fires have been made by man, some in the Tuwatawata Ecological Area above the Minginui Stream, which have been ascribed to hunters (pp. 17–18). J. L. Nicholls notes that clearings were made in pre-European times, and pioneer successional stands of kanuka and kamahi have been overtaken by abundant podocarp regeneration, up to the size of poles or small trees. Other instances of podocarp (and sometimes beech) regeneration in scrub, resulting from fires or old Maori clearings, are recorded in the Oriuwaka and Otupaka ecological areas (pp. 136–139).

Impact of browsing animals

Red deer populations were at their highest level 'around 1958–1962' prior to an increase in recreational hunting and the use of helicopters for recovery.

Decline of podocarps and lack of developing regeneration

This topic is referred to briefly (pp. 9–10). [Scientists do not agree that the forests themselves are dying, though older podocarp cohorts may be in decline. Podocarps have regenerated in old clearings, fire-induced scrub, and on disturbed ground. At the margins of the Mangawiri Basin, heavy partial-logging in 1975 of a rimu-dominant stand, followed by windfall and windbreak and collapse of pioneer wineberry, has resulted in substantial canopy opening and initiation of podocarp regeneration (Beveridge, A. E. 2004, pers. obs., 2 February)].

Research

Most topics referred to (pp. 47–51) have been covered in annotations of individual papers either in this or the Pureora bibliography.

Research topics covered, with relevant papers to refer to, include:

- Growth of podocarp pole stands on sites of old Maori clearings or pa sites in Whirinaki Forest (Cameron 1960b; Katz 1980b).
- Totara die-back (Beveridge 1967; Forest Research Institute 1982b). Also comments on totara in Mangawiri Basin in annotation on Morton et al. (1984).
- Selection management trials in Whirinaki—1961 trial in podocarp/tawa forest and 1979 trial in dense podocarp forest at Okurapoto (Forest Research Institute 1984; Smale et al. 1985, 1987, 1998; Steward 1998).

Indigenous forest management and silviculture

This section (pp. 28–37) describes a programme of podocarp seed collection and planting out of disturbed sites with nursery-raised seedlings or podocarp wildings. The programme was started in the mid-1970s and had achieved some success by 1981—planted seedlings were generally free from animal browsing and up to 2.5 m in height (p. 48). [Podocarp seedlings planted in groups by roadsides and logging skids should still be recognisable as different from natural seedlings regenerating on similar sites. Further assessments of these should be of scientific value in view of the controversy about lack of developing regeneration at Whirinaki within undisturbed forest. Dense patches of rimu seedlings, probably resulting from the heavy 1978 seedfall, occur on loose pumice sand beside Okurapoto Road.

Description of ecological areas and forest sanctuary

Detailed notes are given (appendix 21) on the five ecological areas and the sanctuary. They were written by J L Nicholls for the Scientific Coordinating Committee [see NZFS (1984a) for accounts of reserves and map locations].

[Previous working plans for Whirinaki Forest are located in the National Forestry Library, Rotorua. The first working plan was prepared in 1950. Early correspondence on investigations of the indigenous Whirinaki Forest is retained in the archives of the Indigenous Forest Management Group (Forest Research, Rotorua), see Forest Research (2004). The Rotorua Conservancy files of conservation and historical interest, now in Auckland Regional Archives of Archives New Zealand, have been examined, and copies made of relevant items for storage at the Bay of Plenty Conservancy Office of DOC.]

Keywords: animal control, forest ecology, forest management history, forest policy, forest types, indigenous forest management, introduced animal impact, management plan (Whirinaki Forest 1981), Maori occupation, podocarp planting, recreation, seed collection, selection management trials, selective logging, totara mortality

171. Orwin, J. 1974: Annotated bibliography on the ecology of New Zealand indigenous forest and scrub 1929–1970. *New Zealand Journal of Botany 12(1)*: 45–113.

Of all the items in the bibliography with direct relevance to Whirinaki Forest, only six have annotations: Cameron (1954, 1960b, 1963), Grant (1963) and McKelvey (1955, 1959). Some of these papers discuss problems of podocarp regeneration and climate change. They are all included in the current bibliography, and annotated further with reference to later studies and views. The other item is a thesis by Robbins (1962) on patterns in podocarp/broadleaf

forests, mainly based on studies in the central North Island. Robbins, R.G. 1962: The podocarp-broadleaf forests of New Zealand. *Transactions of the Royal Society of New Zealand (Botany) 1*: 33–75.

Keywords: bibliography – forest ecology

172. Ots, A. 1990: Whirinaki: paid conservation workers versus volunteers. *Evening Post*, 18 July: 9.

An account of problems encountered by DOC in attempting to use volunteers, such as young backpackers, to work in the forest in return for staying free at a new Whirinaki accommodation centre established by DOC. The DOC scheme, designed to get volunteers helping with jobs such as track maintenance under the supervision of DOC staff, was opposed by the New Zealand Workers Union and the Minginui Village Council. There was a severe unemployment problem in Minginui. Shortage of funds had led to curtailment of DOC staff and wage-workers at Minginui. This situation was highlighted by the difficulties a conservation officer was experiencing being solely responsible for goat control in Whirinaki Forest Park and adjoining forests, also by washouts occurring on closed forest roads.

Keywords: conservation work

173. Owen, K. L. 1992: A blue duck survey of the upper Whirinaki River, Bay of Plenty. *Bay of Plenty Conservancy Technical Report Series 11*. Department of Conservation, Rotorua. 7 p. 9 references.

A walk-through survey along a 21 km section of the upper Whirinaki River, above the Whirinaki Falls, was made on 20–21 March 1991, after the breeding season. The objective was to determine the status of the blue duck population on this part of the river—one of the three largest blue duck populations in the Bay of Plenty Conservancy. A total of 19 blue duck were found, including seven pairs. This was a larger number of sightings than expected. The forest of the upper Whirinaki Catchment consists of podocarp/hardwood, podocarp/beech, and beech associations, and is at altitudes between 440 m and 820 m. The survey area and bird sighting locations are shown on a map.

Details of blue duck records in the Whirinaki Catchment from 1974 to 1990, and from the 1991 survey, are given in appendices. Recommendations are made for further monitoring of the Whirinaki River blue duck population during the 1993 breeding season. It was recommended that further surveys be carried out in the adjacent upper catchments of the Waipunga and Te Hoe rivers.

Keywords: blue duck populations

174. Pardy, G. F. 1984: Impact of selective logging in podocarp/tawa forest; 1961 Whirinaki management trial. Project Record 557. Forest Research Institute, Rotorua (unpublished report). R316.

This is a thorough and detailed report of mortality, decline of vigour, and mode of tree death of podocarps and tawa. Assessments were made in 1974 and 1983, 13 and 22 years after controlled selective logging in 1961 removed around 40% of the merchantable volume in two treatment blocks, leaving an unlogged

control block. Comparisons of tree losses are made between logged blocks and the control. Losses were found to be similar for each of the three 8 ha blocks, amounting to 11–15% of trees over a period of 22 years lost through windthrow, stem snapping and standing death. A total of 18–26% of merchantable volume (mainly podocarps) was lost over the 24 years since timber cruising in 1959. Net decrement in volume was estimated to be 0.7–1.0 m^3/ha/year. [The trial is located near South Road. Initially with unlogged surrounds, it is now surrounded by exotic conifer plantations.]

The forest type of medium-density podocarps (56 trees/ha) and tawa (52 trees/ha) consisted of large, dominant rimu, averaging 100–112 cm diameter, together with defective, large-stemmed matai, fewer miro and large kahikatea, over abundant tawa and occasional rewarewa. A high incidence of defect in rimu and matai assessed at cruising in 1959 was confirmed in subsequent windthrow assessments, with additional 'hidden' defect consisting largely of rots in stem butts and root plates. Results of tree losses and mode of death for each block and tree species are tabulated within the text or appendices. Of the 95 trees lost over the 24 ha trial area, direct wind impact snapped the stems of 60% and uprooted 2%, while 15% died standing, the remainder being hit by falling trees. A further 17 'cull' trees (too defective to fell) were lost, and 10 trees were classed as moribund or severely damaged in 1983. It was concluded that this type of selection logging did not affect the stability of residual trees, as there was a comparable decline of podocarps in the control block over a period of 24 years. [See also Smale et al. (1985, 1987, 1998).]

There is a summary of growth and survival of rimu and kahikatea seedlings planted in logged gaps 1 year after logging, and later in gaps cut in dense wineberry regrowth. The planting produced poor results in each case where seedlings were exposed to browsing. Seedlings in the early plantings showed better growth in wire mesh exclosures, and seedlings outside exclosures were severely browsed in the first two winters, but 'showed a good capacity to recover'. [See Smale et al. (1987), and Steward & Pardy (1989).] Ground disturbed by logging was rapidly invaded by wineberry with a dense ground cover of *Uncinia*, *Microlaena* and *Blechnum fluviatile*. Sparse podocarp regeneration tended to occur around stumps or later under thinning wineberry. Few podocarp seedlings exceeded 50 cm in height over the 22 years since logging. [See Veale (1986) for a regeneration survey.]

Keywords: browsing of planted podocarps, exclosures, management trial, podocarp mortality, podocarp stability, podocarp/tawa forest, regeneration – natural, selection – logging impact, windthrow losses, wineberry regrowth

175. Paul, W. 2002: North Island Kaka at Whirinaki. Environmental Education Resource 1. Department of Conservation, Rotorua (unpublished report). 53 p.

A basic introduction designed for teachers to plan experiential learning activities, focussing on North Island kaka or other forest birds, for 8- to 10-year-old pupils. This is one of six Bay of Plenty Conservancy 'Super site' environmental education resource kits. It contains a resource list of written and electronic material, such as website addresses, books, CD-ROMs and videos. [It is currently being updated in an electronic format (i.e. CD-ROM, website).] (BRC)

Keywords: education, kaka

176. Powlesland, R. G.; Stringer, I. A. N.; Chatterley, D. I. (in press): Impacts of an aerial 1080 operation using carrot baits on invertebrates in artificial refuges in Whirinaki Forest Park, 1998–2002. *New Zealand Journal of Ecology*.

Keywords: 1080 – impact on invertebrates, Whirinaki Forest Park

177. Powlesland, R. G.; Wills, D. E.; August, A. C. L.; August, C. K. 2003: Effects of a 1080 operation on kaka and kereru survival and nesting success, Whirinaki Forest Park. *New Zealand Journal of Ecology 27*: 125–137. 57 references.

This large study extended over four breeding seasons—from October 1998 to June 2002—and involved capturing in mist nets, radio-tagging and monitoring 61 adult kaka and 74 kereru in two study areas. In one of the areas the populations of mammalian predators, namely possums, rats and mustelids, had been assessed before and after an aerial 1080 poison operation in May 2000. Screened carrot baits had been spread evenly by helicopter over the area, which consisted of 1750 ha in and near the Otupaka Ecological Area, at an altitude of 600–900 m. The untreated control area consisted of 3000 ha at an altitude of 495–600 m. Both study areas were covered by dense podocarp and podocarp/hardwood forest with a tawa subcanopy at lower altitude, and beeches at higher altitude.

The poison operation was aimed at reducing possum populations previously assessed by trapping. Before the poison operation, possum population indices 'were moderately high and similar in the two study areas, at 27–33 captures per 100 trap nights. A month after the poison drop there were 4.4 captures per 100 trap nights in the treated block, an 86% reduction, and there was then a gradual increase to 9.5 captures per 100 trap nights some 21 months after poisoning. In the year to February 2002, possum numbers in the untreated area declined from 30.8 captures per 100 trap nights to 11.5 captures per 100 trap nights, so 'that there was no significant difference in trap-catch rate between the two study areas'. The decline of the possum population in the untreated area was thought to have occurred because of possums being trapped for their fur in the Oriuwaka Ecological Area.

Rat population indices were assessed from monitoring of tracking tunnels, and, except for 1 month, were similar seasonally in the two study areas before the poison operation. After the poison operation there was an immediate reduction in the percentage of tracked tunnels in the treated area from 43% to 5%, with reinvasion 9 months later, while remaining at 11% or less for the first 21 months. Mustelid populations remained low at less than 10% in the two study areas, although it is known that stoats may be killed by secondary poisoning. Population indices for predators are shown by figures with bar graphs.

All radio-tagged kaka and kereru in the treated area survived the poisoning operation during the first fortnight. Data combining figures for treated and untreated areas on nesting, mortality and fledgling survival are presented in tables for the four nesting seasons monitored. 'No radio-tagged kereru and too few radio-tagged kaka bred in either study area during the 2000/01 nesting

season to show whether reduced rat and possum populations would enable the birds to nest more successfully.' There were marked fluctuations in breeding and success rates over the four seasons. Most radio-tagged female kaka nested in the 1998/99 and 2001/02 breeding seasons with none or few in the other two seasons. No radio-tagged kereru nested in the 1999/00 and 2000/01 seasons, with 50–60% nesting in the other two seasons. No radio-tagged adult male kaka were found dead during the project, but six females were. In contrast, there was high mortality of radio-tagged adult kereru.

Possums and stoats were identified as the main predators of the eggs, chicks, fledglings and adults of both kaka and kereru (kaka females only), but not all predators could be identified. Poachers apparently shot one kaka, and four kereru and falcons were found eating one kaka and two kereru. The role of ship rats in causing bird mortality could not be determined. Past work on predators and use of toxic baits are discussed, and both rat populations and breeding success of kaka and kereru are thought to be related to fruit abundance—especially of podocarps. Most female kaka nested in years of abundant fruit crops of kahikatea in 1998 and rimu in 2001. [Another heavy fruiting of kahikatea occurred during 2004.]

[Kaka in Pureora Forest have been observed cracking both green and ripe miro fruits crosswise in order to extract seed contents, the pulp being discarded (Beveridge 1964). Thus, kaka are likely to feed on the seed contents of miro when fruits are still green in summer, and continue to do so when seed is ripe in autumn; ripe miro fruits have been seen in tree crowns at Pureora as late as September (Beveridge, A. E., pers. obs.). Because large kahikatea can bear heavy seed crops at 2–3 year intervals, attracting many kereru (Beveridge 1973), there appears to be a case for planting large kahikatea seedlings at the margins of indigenous forest fragments, adjacent to previously logged areas, especially on river flats and in basins such as the Mangawiri. Saplings as tall as 3 m, with strong root systems, have been successfully planted on open sites in deep pumice at roadsides in Tihoi Forest, west Taupo. Kahikatea, rimu and totara have all succeeded after planting on sites cleared and burned at Pureora, with microclimate improved by a thin canopy of declining eucalypts. At 20 years after planting, larger, bushy trees up to 7 m tall were producing sound seed with fleshy receptacles.]

The role of possums as predators is discussed. 'Video footage was obtained of a possum eating a brood of kaka fledglings.' Kereru are thought to be vulnerable to feral cats and stoats when, becoming thirsty after feeding on miro berries, they drink water at ground level. They are also vulnerable when feeding on fruits of low shrubs. It was concluded that both kereru and kaka populations are in decline at Whirinaki. A recommendation was a 'repeat study of an aerial 1080 operation over a large area (5000+ ha) just prior to mast fruiting of a podocarp species to assess the toxin-related mortality of kereru, and to better determine the benefits of such operations to kaka and kereru breeding survival'. [See also Moorhouse et al. (2003), Hill (2003), and Powlesland et al. (in press).] Data on the breeding biology of kaka and kereru have been collected, including some from Whirinaki Forest, and are to be given in further published papers.

Keywords: 1080 impact on predators, birds, kaka – nesting, kaka – radio-tagging, kaka – survival, kereru – nesting, kereru – radio-tagging, kereru – survival, possum populations, predators of kaka, predators of kereru, predator control

178. Pracy, L. T. 1962: Introduction and liberation of the opossum (*Trichosurus vulpecula*) into New Zealand. New Zealand Forest Service Bulletin. New Zealand Forest Service, Wellington. 28 p.

The only references to liberation points for possums near Whirinaki Forest are Galatea, in 1916, and Te Whaiti, in 1917 (p. 17).

Keywords: possums – liberation points

179. Pu Kaea 1995: Ngati Whare iwi claims. *Pu Kaea*, December: 16–19.

A National Library Index New Zealand abstract: 'Gives the history of Ngati Whare and Ngati Manawa and the Whirinaki Forest. Backgrounds the Ngati Whare Iwi Claims Committee which was formed specifically to process research and present land claims to the Waitangi Tribunal with funding from the Crown Rental Trust.' The full historical account is 'the story of a forest people in the Whirinaki Basin—an important centre of continuous human occupation for at least 300 years and evidence exists of earlier centuries of habitation'. Reference is made to the rich food resources of the forest, where kaka, kereru, tui, weka, kiwi and kakapo were the principal bird species sought [see Best (1942)]. A staple food was fern root, 'cultivated in clearings created in the forest and maintained by shifting cultivation'. It is noted that many small patches cleared for gardens are now covered in scrubland and regenerating podocarp forest.

A provisional list of dates, which is open to revision (see below), includes the following:

1150: Arrival of Toi people (Marangaranga) who lived in the forest like their descendants who included the Whirinaki Valley in their tribal area.

1350: Mataatua canoe landed at Whakatane [about the time of the Kaharoa ashfall, now dated 1314, which spread over the northern fringe of Whirinaki Forest, and beneath which no artefacts have yet been found].

1620: Defeat of Marangaranga by coastal tribes who occupied the Whirinaki area as Ngati Whare and Ngati Manawa, later under the Tuhoe tribal umbrella. The founder of Ngati Whare settled at Minginui after the defeat of the Marangaranga. Ngati Apa occupied the Mangawiri Basin about 1780 when there was a Tuhoe raid in their support.

1865: A battle was fought at Te Tapiri, 3 years before Te Turuki (Te Kooti) arrived in the area. [The battle was between Hauhau and 'Queenites', see annotations for Nevin & Nevin (1980) and the Historic Places Trust (1988).]

[The general outline of events in this account appeared in Nevin & Nevin (1980), and was included in the Whirinaki State Forest Management Plan (Orchard et al. 1981, appendix 5). See also Hutton & Neumann (2001). In a letter to the *New Zealand Herald* in December 2003 D. J. Lowe, Associate-Professor of Earth Sciences, Geology Department, University of Waikato, wrote: 'Compelling and widely-published scientific research shows that the earliest Polynesian settlement of New Zealand happened around 1300AD, or a few decades before…']

Keywords: historic places in forest, Maori tribal history – Whirinaki, Maori land rights

180. Pu Kaea 2001: World great walk. *Pu Kaea*, February: 5.

Describes 'Whirinaki Escape', 1-day interpreted walks through the Whirinaki Forest, initiated by the Taputu-Matekuare whanau whose ancestors lived in the forests of Whirinaki and the Urewera Ranges. The chairperson of Te Mauku Trust emphasises the spiritual, cultural, ecological and botanical significance of Whirinaki Forest and the region. [See also Te Karere Maori (2001).]

Keywords: ecotourism, tourism – cultural

181. Pullar, W. A.; Birrell, K. S. 1973: Age and distribution of late Quaternary pyroclastic and associated cover deposits of the Rotorua and Taupo area, North Island, New Zealand. Soil Survey Report 1. Department of Scientific and Industrial Research, Wellington.

The 15 cm isopach for Kaharoa ash from the Okataina Volcanic Centre extends south and west from Murupara and Te Whaiti, and appears to be marginal to the northern fringe of Whirinaki Forest.

Keywords: Kaharoa ash, soil survey (Taupo ashes)

182. Rijkse, W. C. 1988: Soil map of Kaingaroa, Waimihia, Waipunga and Whirinaki. Landcare Research, Hamilton (unpublished map).

A soil map transparency, scale 1:100 000. [An unpublished map, held at Landcare Research library. Available from Environment Bay of Plenty, Whakatane.]

Keywords: soil map, Whirinaki Forest soil map

183. Roche, M. 1990: History of New Zealand forestry. New Zealand Forest Corporation Ltd in association with GP Print Ltd, 466 p.

In this detailed, fully referenced and annotated work, there are brief mentions of Minginui Village and Whirinaki Forest, including the 1978 conflict between Minginui residents and visiting environmental groups (pp. 425–427). In the chapter 'Environmental awakening' there is an account of events that lead to that situation and finally the demise in April 1987 of the NZFS, with its policy of 'multiple use' or 'balanced use' of indigenous forests. It explains the administrative restructuring which split former NZFS functions among the new organisations of DOC, the Department of Survey and Lands Information and the Forestry Corporation. The process that led to this outcome was initiated by the environmentalists' challenge to NZFS management policies from the 1970s. Whirinaki Forest was at the centre of this debate from 1978, following the west Taupo seminar on management of some central North Island indigenous forests. The new directions for indigenous forest management, evolving in the mid-1980s, were influenced not only by views of the environmentalists, but also by the Treasury and the deregulation policies of the Government, resulting in strong politicisation of the issues. The book deals with the emergence of a conservation ethic in the 19th century and changes in the concept of 'conservation of indigenous forests' over the next 100 years. In the 1950s there were misunderstandings or lack of knowledge over the status of the podocarp

forest, its capacity to regenerate, and the possibility of sustained yield management. That partly explains the clear-felling of podocarp forest in Whirinaki until 1975, and a further decade of selective logging with the aim of perpetuating the forest while maintaining a low level of wood production. [See Hutton & Neumann (2001).]

Keywords: environmental issues, forest policy, history – forest management

184. Royal Forest and Bird Protection Society 1980: Policy for New Zealand's remaining indigenous forest. *Forest and Bird*. Supplement for November 1980, 13(8). Wellington.

This supplement gives the society's policy for all New Zealand's indigenous forest. The only specific mention of Whirinaki Forest is the caption for the colour illustration of virgin 'mixed' podocarp forest at Whirinaki [podocarps with subcanopy tawa] with the comment that 'this type of forest is of such conservation importance, and so limited in extent nationally, that it should be logged no further'. [Felling of trees in partial logging of this forest type ceased at Whirinaki in the early 1980s.]

Keywords: conservation areas and values, forest policy – indigenous

185. Royal Forest and Bird Protection Society 1980: Research group progressing with study of kokako. *Forest and Bird 12(7)*: 7–10.

Apart from research on kokako in three central North Island forests, this article refers briefly to work on bird populations and the impact of selective logging in two areas of Whirinaki Forest. One aim was to set up a series of tracking tunnels to give data on rodent and mustelid populations in Whirinaki Forest.

[Pureora studies went ahead, with subsequent publication of results, but the Forest Bird Research Group of the New Zealand Wildlife Service did not appear to have established parallel trials in Whirinaki Forest during its activities from 1978 to 1981. See Crawley (1981), Harrison & Saunders (1981), and Leathwick (1981) for work of the Forest Bird Research Group from 1978 to 1981, also items under the keyword 'predators' in the Pureora bibliography.]

Keywords: bird populations, predator trials, selective-logging impact

186. Royal Forest and Bird Protection Society 1985: The price of preservation. *Forest and Bird 16(1)*: 14.

At the end of a visit to New Zealand, during which he visited Whirinaki Forest and promoted tourism as a means of preserving forest of high heritage value, renowned botanist David Bellamy emphasised that 'environmental interpretation' was required 'to explain the value of heritage sites'. Such sites require skilled management. Whirinaki Forest should be a 'world heritage' site.

Keywords: conservation, environmental interpretation, heritage value, tourism – forest

187. Ruzich, P. 1996: North Island brown kiwi survey Oriuwaka/Te Kohu ecological areas. Department of Conservation, Murupara (unpublished report). 12 p.

No positive kiwi calls were recorded in or near the Oriuwaka Ecological Area, or in the Te Kohu Ecological Area, during night surveys between 11 and 20 September 1996. Listening stations are marked on maps. A possible kiwi call was recorded in each of the ecological areas, but calls could not be confirmed. Two dogs were seen on the survey, one unattended, and there was evidence of dogs lost by pig hunters. Monitoring of dog movements was recommended with the aim of excluding them from ecological areas. See Wills (1996) for a report on kiwi populations recorded in the Tuwatawata Ecological Area.

Keywords: dogs (risk to kiwi), kiwi survey, Oriuwaka Ecological Area – kiwi survey, Te Kohu Ecological Area – kiwi survey

188. St Paul, R. 1977: A bushman's seventeen years of noting birds. *Notornis 22*: 122–130; *Notornis 24*: 20–30.

Edited summaries of St Paul's observations of forest birds from 1946 to 1961 [15 years, despite the title], covering podocarp forests of Whirinaki Forest and the predominant beech forests of the Huiarau Range. As well as the results of bird counts in various localities, there are notes on behaviour, seasonal movements, food sources and nesting habits. These notes are based on classified summarised notes that appeared in *Notornis* over this period. Extracts seen cover tui, bellbird, New Zealand pigeon, North Island kaka and yellow-crowned parakeet (red-crowned parakeet not seen). The author feared that continued milling of podocarps would break the seasonal food cycle of fruit-eating birds from February to August. However, the diversity of food items taken by the forest birds is emphasised. Nectar feeders may gather in the groves of flowering kowhai near the Whirinaki River. Bellbirds and tui may hawk for insects and feed on cicadas during January, though their main food is a wide range of berries. Seasonal concentrations of bellbirds, tui, and pigeons occurred on heavily fruiting podocarps.

Keywords: forest birds, forest birds – habits, forest birds – numbers, forest birds – seasonal movement

189. Saunders, A. 1984: Bush milling and aerial timber extraction trials: Whirinaki Forest. New Zealand Wildlife Service, Rotorua. Text 14 p.

This trial was carried out in mid-July 1984 to investigate the likely impacts of bush-milling and aerial timber extraction on wildlife in an 18 ha site of 'Hunting Block 10', in the northwestern part of Whirinaki Forest. The site was in the Waione Catchment, mainly in virgin podocarp forest dominated by matai or rimu, on broad ridges at approximately 620 m altitude. Logs or flitches, 3–4 m long, were extracted from nine rimu and matai—either windfalls or damaged trees. These trees were some of the many in central North Island forests that were either hit directly by the Cyclone Bernie storm of Easter 1982, or fell over the following 2 years.

One objective of the study had been to provide guidelines for future aerial timber-extraction trials or operations. Only general observations could be made of the impacts of this trial on wildlife, such as those caused by loud noise, strong downdraught from helicopter rotors, and occasional dragging of logs through canopy trees and understorey vegetation. Bush-milling, to cross-cut

logs and prepare flitches of sound heartwood from some of them, involved clearing vegetation for a metre each side of logs. It was not possible to observe responses by forest birds to log extraction. In an intensive study of birds from 1978 to 1981 in unlogged forest and selectively logged forest in Whirinaki (Crawley 1981; Harrison & Saunders 1981), it was observed that birds made little use of windfallen trees, although they formed part of the habitat of robins, pied tits and fantails. Dead or moribund standing trees, and those with stem or branch rots, are most valuable as sites for hole-nesting birds such as kaka, parakeets, and riflemen [insects in rotting wood are, of course, an important item in the diet of kaka]. It was suggested that the greatest impact of aerial logging is likely to be on nesting birds, with destruction of nests, so one recommendation was that no aerial log extraction be done in the main nesting season, from September to February. It was conclued that any dead or damaged standing trees should not be felled.

Preparatory work for this trial was done by the NZFS (Rotorua Conservancy), and their account is included in appendices to this report. In an area of 80 ha around the trial site, there were 0.5 'merchantable' windfalls and 2.2 'unmerchantable' windfalls per hectare of podocarp windfall (fallen during from Cyclone Bernie or over the following 2 years). One of the NZFS staff, J Bathgate, considers that podocarps are declining in these forest types, and notes that scouting for salvage of windfalls occurred two to three times a year over the whole forest. [Salvage operations ceased with the disestablishment of the NZFS in 1987.] Copies of 47 photographs of bush-milling and aerial extraction are contained in an appendix. There is mention of a similar salvage operation in the Old Fort Road Recreation Area.

Keywords: bush-milling windfalls, helicopter salvage logging, logging impact on birds

190. Shaw, W. B. n.d. (1989): Guidelines for salvage of totara for traditional Maori cultural uses. Whirinaki Forest Park Advisory Committee minutes (unpublished note). 2 p.

The Whirinaki Forest Park Advisory Committee was established in 1985, with Professor John Morton as the first chairperson, replaced by Willie Shaw from 1987 to 1990. This document suggests guidelines that could be used to assess requests for salvaging totara for Maori uses.

[Minutes of the advisory committee should be with NZFS Rotorua Conservancy files in the Auckland Regional Office of National Archives. Wood from windfallen totara remains in the Mangawiri Basin, both in areas cleared in 1973 and marginal areas of continuing windfall (Beveridge, A. E. 2004, pers. obs., 2 February).]

Keywords: totara – Maori cultural use, totara salvage

191. Shaw, W. B. 1983a: Tropical cyclones: determinants of pattern and structure in New Zealand's indigenous forests. *Pacific Science 37(4)*: 405–414.

This paper was included as item 230 in the Pureora bibliography. It covers the occurrence of five tropical cyclones in New Zealand over the previous 50 years,

mainly in the North Island, and comments on their impact and significance for indigenous forests. Different degrees of damage are recorded in Urewera National Park from Cyclone Bernie in April 1982. Moderately severe damage was caused in the dense podocarp and podocarp/tawa forest types in the Whirinaki Valley, with blowdown or breakage of stems and crowns of large podocarps, either singly or in groups. [Studies in the Okurapoto Basin showed that a substantial proportion of old podocarp trees had various degrees of rot in roots, stem butts, stems and larger branches. Stability of trees in the Okurapoto trial, including unlogged controls, has been followed from the start of selection logging in 1979 to the present time (see Steward 1998). Healthy trees with sound stems could be hit by other falling trees. Detailed reports on windthrow and damage from Cyclone Bernie in Whirinaki Forest are contained in the NZFS (Rotorua Conservancy) files, now in Auckland Regional Archives.]

Keywords: Cyclone Bernie, forest composition – storm impact, forest pattern – storm impact, forest structure – storm impact, Okurapoto trial – wind damage, tropical cyclones (impact on forest), wind damage – Whirinaki Valley

192. Shaw, W. B. 1983b: The impact of tropical Cyclone Bernie on the forests of Urewera National Park, North Island, New Zealand. *New Zealand Journal of Ecology 6*: 155–156.

Whirinaki Forest was among the many forests of the central and eastern parts of the North Island that were damaged by this cyclone on 9 and 10 April 1982. In the Urewera National Park the winds were generally southerly and accompanied by heavy rain. The damage pattern was irregular, affected by topography. Canopy gaps were created in most forest types and it was thought that the impact of this event 'will be reflected in the regeneration pattern for a very long time'. Initial damage could lead to increased mortality and die-back at a later stage, because the forest becomes more prone to damage by other injurious agents and further storms. It was concluded: 'These events are potentially major determinants of pattern and structure in forests through large parts or all of New Zealand.'

In Whirinaki Forest, windthrow and damage of podocarps in two dense podocarp stands were assessed following the Easter storm. In the Mangawiri Basin, a rimu-dominant forest that had been subject to heavy operational partial-logging from 1975 suffered extensive damage. In the Okurapoto Basin, a controlled selection-logging trial at a low intensity, conducted in 1979, resulted in comparable levels of windthrow and damage in logged blocks and an unlogged control block. Monitoring has been done over a period of 25 years. [See also Grant (1963) for suggested occurrence of catastrophic storms, and Steward (1998) for windthrow damage and other mortality of podocarps in the Okurapoto trial.]

Keywords: Cyclone Bernie, wind damage – Whirinaki Valley

193. Shaw, W. B. 1988: Kaikawaka at Taho frost flat, Whirinaki Forest Park. *Rotorua Botanical Society Newsletter 15*: 22–23.

A partially charred log of kaikawaka (*Libocedrus bidwillii*) was found at the Taho (Taahau) frost flat in the Otupaka Ecological Area in April 1988. Kaikawaka does not now occur in the Whirinaki Valley. The current distribution

of kaikawaka in the central North Island is discussed. It is suggested that the Taho log, with mainly unburned wood and bark, may have been charred by the pumice flow of the Taupo Eruption in AD 130 [revised to AD 200], which could have caused 'local extinction of kaikawaka within its sphere of major vegetation devastation'.

Keywords: kaikawaka – Taho frost flat, Otupaka Ecological Area

194. Shaw, W. B. 1997: Whirinaki Conservation Park ecological areas: extract from some descriptive accounts, and a selected bibliography. Wildland Consultants Ltd unpublished report for Department of Conservation, Murupara. 18 p.

The main text of this report contains the condensed accounts of five ecological areas in Whirinaki Forest Park that are described in the NZFS pamphlet 'Reserves in Whirinaki Forest Park' (see NZFS 1984a). However, those brief descriptions are extended here to include file notes by J L Nicholls and the extensions that he envisaged, as shown on copies of two forest-type maps (Nicholls 1966, 1969). Useful references are given to papers that provide background or describe particular features of the ecological areas that make them 'representative examples of the outstanding forest system found in the Whirinaki Valley'. The papers are listed under the headings 'Geology', 'Physiography', 'Soils', 'Vegetation', 'Flora' and 'Fauna'.

The forest types of the five ecological areas are given. The vegetation is mainly mixed podocarp forest, some areas with an element of tawa or beech. Te Kohu Ecological Area has a variety of forest types at higher altitudes, including almost pure red beech. A history of fire is evident in several forest and/or scrub assemblages: scrubland with regenerating patches of podocarps; podocarp–kamahi–rewarewa forest in the Oriuwaka Ecological Area; and dense regenerating rimu with other podocarps in successional stands of kanuka and kamahi in the Tuwatawata Ecological Area. The 160 ha Whirinaki Forest Sanctuary established in 1971 consists of dense rimu-dominant podocarp forest on an old river terrace, and in places small understorey tawa 'is affected by and recovers from episodic frost damage'. [This area was included in a broader study of tawa die-back in Whirinaki Forest undertaken by the Forest Research Institute in the late 1970s. See Mackenzie & Gadgil (1973) on tawa die-back.]

The bulk of this report consists of background information collected for a 1996/97 funding bid for possum control, to stop decline of forest canopy condition, including the mature totara of the lower Whirinaki Catchment. [In view of the widespread die-back of totara of all ages in Whirinaki, strongly evident in the 1960s and subject to wider study by the Forest Research Institute, the 1985 references in this report to living large totara—in the Tauranga Basin Ecological Area (Tauranga Stream Ecological Area) and a basin in the Tuwatawata Ecological Area—are significant. The references and selected bibliography for items relevant to Whirinaki Conservation Park, totalling 98 papers, unpublished reports and file notes, are very useful and many have been annotated in the present bibliography.]

Keywords: bibliography, ecological areas, forest sanctuary – Tuwatawata Ecological Area, forest types – descriptions, totara die-back, Whirinaki Conservation Park

195. Shaw, W. B.; Smale, M. C. 1988: Notes on a remnant of monoao shrubland on the Kaingaroa Plateau. *Rotorua Botanical Society Newsletter 14*: 23–25.

Describes the Waimarama block—a 175 ha triangle of land bordering State Highway 5 (Taupo–Napier Road), the Rangitaiki River, and the former Waimihia State Forest. At the time it was unallocated Crown land [subsequently placed in DOC stewardship]. It contains a typical range of frost flat communities: monoao shrubland, monoao scrub, and adventive grassland supporting hard/fescue tussock (*Festuca novae-zelandiae*) at its northern limit. (MCS)

[Although supporting similar plant communities to Rangitaiki Conservation Area, the substrate is flow-tephra rather than the water-sorted pumice at Rangitaiki. The belt of self-sown lodgepole pine (*Pinus contorta*) beside the highway has since been removed.]

Keywords: monoao shrubland – Kaingaroa Plateau

196. Shaw, W. B.; Thompson, K.; Steward, G. A. 1990: Bibliography for Te Urewera National Park. *Science and Research Series 30*. Department of Conservation, Wellington. 91 p.

Out of a total of 920 titles under 15 subject headings, about 10% have direct or general relevance to Whirinaki Forest Park, particularly those under the headings of 'Botany', 'Geology', 'Soils', 'Introduced animals', and 'Proposed reserves'. In the 'History' section, the works of Elsdon Best are listed, and there are a number of items on aspects of the culture of the Tuhoe people. Brief annotations are given in the Urewera bibliography for some of the items. A number of fuller annotations are given in the current bibliography of Whirinaki Forest Park.

Keywords: bibliography – Urewera National Park

197. Smale, M. C. 1989: Frost flats of the central North Island. *Rotorua Botanical Society Newsletter 17*: 9–11.

Largely a popularised, condensed summary of material presented by Smale (1990b) on the ecology of monoao (*Dracophyllum subulatum*) on frost flats at Rangitaiki and Pureora, but with additional observations. Salient points about the flora are described, along with the regeneration mechanism of monoao after fire (cohort establishment, the density and thus the later dynamics of the monoao stand depending on the scale of the burn and the harshness of the site). The future of frost flats depends on future fire frequency, the harshness (climate, soil) of the site, and the presence of some aggressive weeds. (MCS)

[Since the article was written, all first-growth compartments in Kaingaroa Forest, which includes the former Waimihia State Forest, have been felled. Modern forestry practices have indeed largely eliminated frost flat vegetation, including monoao, which had survived in some unsuccessful original plantings (late 1920s – early 1930s) on colder sites, particularly at the southern end of the Kaingaroa Plateau. Thus, the range of monoao and its associates, and the extent of frost flats, has continued to shrink.]

Keywords: frost flat vegetation, monoao heathland

198. Smale, M. C. 1990a: Ecology and management of frost flat heathland. *What's New in Forest Research 187*. Forest Research Institute, Rotorua. 4 p. 4 colour photographs.

One of two study areas was the Rangitaiki Conservation Area, an example of an extreme frost flat site, at 740 m altitude. There are similarities between this site and the smaller Waione and Otupaka frost flats in Whirinaki Forest Park. All are dominated by monoao (*Dracophyllum subulatum)*, on infertile, water-sorted pumice soils. [Annotations for comparable Pureora frost flats are given as items 235 and 236 in the Pureora bibliography.]

Keywords: frost flat heathland – ecology

199. Smale, M. C. 1990b: Ecology of *Dracophyllum*-dominant heathland on frost flats at Rangitaiki and north Pureora, central North Island. *New Zealand Journal of Botany 28*: 225–228.

These large areas of frost flats are distant from Whirinaki, but the vegetation is, however, comparable with that on the small areas of frost flats at Waione and Otupaka in Whirinaki Forest or its margins. [See Cameron (1987, 1988), Shaw (1988), and Smale (1989).]

Keywords: frost flat vegetation

200. Smale, M. C.; Bergin, D. O.; Gordon, A. D.; Pardy, G. F.; Steward, G. A. 1985: Selective logging of dense podocarp forest at Whirinaki: early effects. *New Zealand Journal of Forestry Science 15(1)*: 36–58.

A detailed account of the immediate and early impact of selection logging in the Okurapoto trial, which was established in 1979 by removing 9–15% of the merchantable volume. Different tree-selection criteria were used, making canopy gaps of difference sizes. Logging-induced damage to residual trees was categorised, also degrees of ground disturbance. Tree losses during the first 3 years after logging, which included losses attributed to the impact of Cyclone Bernie in April 1982, were comparable in the unlogged control and two treatment blocks where groups of trees or individuals had been removed. The rate of loss was around 1.1 trees/ha/annum. In a third treatment block, where 'unstable' trees had been removed, the loss was 0.43 trees/ha/annum. Death of trees while standing was rare [cf. higher rate of 34% mortality assessed by Steward (1998)]; most mortality occurred through uprooting of trees or snapping of stems. Most podocarps consisted of mature or senescent trees, with many rimu and matai showing some degree of rot in stems. Mean annual diameter increments were obtained by means of dendrometer bands attached to stems. Gross annual volume increment was calculated at around 0.9 m^3/ha/annum, but due to mortality of trees, all blocks, including the control showed a net volume decrement. A regeneration survey (Bergin 1982) showed that there were 23 000 seedlings/ha of podocarps and tawa in the unlogged control block, but that 60% of podocarps were mainly under 10 cm in height and considered ephemeral. Groups of podocarps were planted in canopy gaps.

[Data presented in this paper provide a baseline for determining trends in tree stability, growth and regeneration, and the trial has continued to be monitored over 25 years from the time of establishment, see Steward (1998).]

Keywords: dense podocarp forest – tree selection criteria, logging impact, regeneration survey – podocarps/tawa, selection management trials – Okurapoto, volume decrement, windthrow

201. Smale, M. C.; Beveridge, A. E.; Herbert, J. W. 1998: Selection silviculture trials in North Island native forests: impacts on the residual forest and their implications for sustainable forest management. *New Zealand Forestry 43(3)*: 19–30.

Two of the five trials reviewed are within Whirinaki Forest, one in podocarp/tawa forest near South Road, established in 1959 and selectively logged in 1961, the other in dense, rimu-dominant forest with subcanopy tawa, established in the Okurapoto Basin in 1979. This paper reviews the results of these trials, as well as three trials established in Pureora Forest. The trials established in 1959/1961 in Whirinaki and Pureora were in comparable forest types subjected to different degrees of animal impact. See items 238 and 239 of the Pureora bibliography for coverage of the Pureora trial in podocarp/tawa forest. The objective of all trials was to provide an alternative to destructive, uncontrolled logging, followed by clearing and conversion to exotic conifer plantations or pasture. At Whirinaki, areas of logged indigenous forest and scrub were converted to exotic conifers until 1975 (see NZFS 1977, 1978a for revisions of indigenous forest policy). In the trial areas, podocarp trees were left in a relatively stable condition, while enabling natural regeneration to proceed, supplemented by planting of podocarp seedlings in canopy gaps. The results were reviewed in terms of the impact of logging on soil and forest, with insights into stand structure, growth rates, stability and health of residual trees, forest regeneration and successional trends after logging. (AEB & MCS)

[The NZFS envisaged investigations into possible sustained yield production in Whirinaki Forest from the inception of its logging scheme in 1938, but beyond leaving scattered small blocks of unlogged indigenous forest as a future seed source, no practical measures and little research was carried out over the following 20 years. The 1959/1961 trial near South Road has become an island of indigenous forest, with a surround of unlogged forest, within a large area of radiata pine and Douglas fir. The Okurapoto trial was planned in 1978, at the request of the Rotorua Conservancy, NZFS, as a joint Forest Research Institute/conservancy experiment. It was an attempt at selection management, adopting the best practices then known in order to limit the impact of logging on soil and vegetation, and maintain stability of residual podocarps known to include a senescent element. At Okurapoto, logging was done at a lower intensity than that applied to other trials or operational partial-logging in central North Island forests. The first operational partial-logging in Whirinaki Forest was intended to reflect the revised indigenous forest policy, declared in 1975; it was carried out by Rotorua Conservancy in the same year in rimu-dominant forest of the Mangawiri Basin. Assessment of the impact on the forest was made 3 years later, and showed a high level of damage and subsequent windthrow (Herbert 1979). For the Okurapoto trial, see early accounts by Forest Research Institute (1984), Smale et al. (1985, 1988), Bergin (1982), and for a regeneration survey see Veale (1984). For the last assessment of windfall and tree mortality see Steward (1998). For the 1961 trial see Pardy (1984), Smale et al. (1987), and, specifically for the growth of planted podocarps, see Steward & Pardy (1989).]

One of the most significant results from all five trials was that sustained yield management of podocarps was unlikely to be attained, because there was a net volume loss in the logged forest (and also in unlogged controls). However, a small sustained yield of tawa was a possibility. In both the Whirinaki trial areas, natural regeneration of podocarps was sparse before logging, except for small, ephemeral seedlings. Few of the seedlings had grown above 1–2 m in height in the 40 or 20 years since logging commenced at the South Road and Okurapoto trial areas respectively [see also Gamble (1979)]. Planted podocarps in the Whirinaki trials had been retarded in growth due to competition from wineberry in logged gaps, or by browsing by possums and deer at times of peak animal populations. [In 2004 rimu and kahikatea planted in 1979 in the Okurapoto trial had grown to 6–7 m in height, but many stems had subsequently broken off at 1–2 m by collapsing of taller pioneer wineberry laden with vine tangles (Steward, G., pers. comm.).] At Pureora, the forest type in the 1961 trial area had changed through extensive colonisation by rimu of logging track margins and other sites of disturbed soil, particularly after collapse of pioneer wineberry.

[MCS: This is a concise overview of the five sustainable management (selective logging) trials established by the Forest Research Institute and NZFS in native forests of the central North Island between 1959 and 1979. Two of the five trials are in Whirinaki Forest Park. The earliest was established in 1959 in rimu–matai/tawa–kamahi forest in the Okahu Stream (harvested blocks) and Oriuwaka (control block) catchments and involved the removal in 1961 of 35–40% of merchantable volume. The article covers the social, political, ecological and silvicultural background of the trials; summarises the impacts on the residual forest in terms of (residual) tree condition, ground condition, (residual) forest stability, productivity, structure and composition, regeneration of major canopy species, forest recovery and weed incursion; and also discusses the implications of these impacts for sustainable forest management. See also Smale et al. (1985; 1987), and Steward (1998).]

Keywords: growth rates – podocarps, logging impact, regeneration, selection management trials, tree mortality, tree stand stability, vegetation regrowth, vegetation sustained yield – negative

202. Smale, M. C.; Beveridge, A. E.; Pardy, G. F.; Steward, G. A. 1987: Selective logging in podocarp/tawa forest at Pureora and Whirinaki. *New Zealand Journal of Forestry Science 17(1)*: 29–50.

A selective-logging trial was established in podocarp/tawa forest at Whirinaki in 1959/1961, with a comparable trial in Pureora Forest. The Pureora trial was annotated as item 239 in the Pureora bibliography. The current annotation covers the Whirinaki trial, at 600 m altitude, by South Road. The trial comprised a forest block selectively logged to remove 40% of the merchantable trees (mainly groups of podocarps with a few tawa), and an unlogged control block. The trial was assessed 22 years after logging to determine changes in structure, tree stability, growth increment, regeneration of tree species, and changes in ground vegetation.

Mortality of merchantable trees occurred at similar rates in both logged and unlogged blocks, 'suggesting that logging has not adversely affected stability'.

Most trees died through windthrow or snapping of stems, with fewer trees dying standing. The mortality assessment was done in 1983, a year after the impact of Cyclone Bernie. Mortality rates were highest in rimu, at around 2% of residual trees/annum. The substantial natural defect (rots of root-butts and stems) occurring in old podocarps appeared to be a major factor predisposing trees to die through windfall or collapse of stems. It was concluded that 'if current mortality rates at Whirinaki continue, most existing podocarp trees are likely to die within the next century'.

The Pureora and Whirinaki trial sites were both in a forest type widespread in the central North Island at the time of trial initiation in 1959, that being rimu/matai/tawa/kamahi on yellow-brown pumice soils derived from rhyolitic Taupo pumice. Assessments indicated similar forest changes and trends for both study areas, except that podocarp regeneration, particularly rimu, was much more abundant both before logging and 20 years later at Pureora [with rimu saplings along extraction tracks and in logged gaps]. Natural podocarp regeneration has remained sparse and poorly developed at Whirinaki. The impact of browsing by deer and possums was apparent many years earlier in Whirinaki and influenced regrowth after logging. However, dense wineberry colonised logging-disturbed soil in both study areas, and tawa advanced growth and regeneration have persisted and developed. [See Pardy (1984).]

Keywords: forest structure and changes, growth increment, podocarp/tawa forest, regeneration – tree species, regrowth, regrowth after logging, selective-logging trial, tree mortality, tree stability, windthrow, wineberry regrowth

203. Smith, A. N. H.; Westbrooke, I. 2004: Changes in bird conspicuousness at Pureora Forest. *Notornis 51*: 21–25.

The studies of 5-minute bird counts made in Pureora and Whirinaki forests by the Wildlife Service's Forest Bird Research Group from 1978 to 1981 (Harrison & Saunders 1981) are referred to in this paper as 'historical bird count surveys' which are valuable 'for assessing long-term changes in bird populations'. The current paper is concerned with changes in bird conspicuousness on one site of the historical survey in Pureora Forest, compared with two similar sites in Whirinaki Forest in a 1997–98 study. The discussion of results leads to the conclusion that 'a repetition of 5-minute bird counts at the [two] historical sites in Whirinaki Forest Park would afford a comparison of the Pureora trends with an area that has had very limited pest control'.

Keywords: bird population reassessment, 5-minute bird counts – Pureora Forest, Whirinaki – bird conspicuousness

204. Smith, H. 1996: Whirinaki Forest Park hut user survey: November 1993–November 1995. Department of Conservation, Rotorua. Text 6 p. Appendices, map.

A survey of the use of eight huts in Whirinaki Forest Park covering the period November 1993 – November 1995. Information was from hut logbooks. Data on day-trippers and those intending to use huts were collected from intentions books at road-ends. The survey results illustrate visitor use and type of activity on the track system. Results are shown in bar charts in an appendix, giving use of each hut for each year of the survey. The main recreational activities in the

park were tramping and walking, followed by hunting, with only a few visiting the park to go fishing.

A map shows locations of huts and tracks that were used by visitor groups all the year round, with November to February the busiest time. School visits were made mainly to the Mangamate and Central Whirinaki huts, most often in November, December and February. The Central Whirinaki Hut had the greatest use, averaging 880 visits/year over the 2-year survey period. DOC staff may stay at a hut for a month or more while carrying out hut and track maintenance, or survey work. It was estimated that only 50% of visitors sign the visitors' books at huts and road-ends. Earlier hut-user surveys in Whirinaki were those by F. Fitzpatrick for the period August 1987 – August 1988, and by Halliday for August 1986 – August 1987 [not seen].

Keywords: hunting, hut use, recreation, tramping

205. Stark, F. 1984: Botanic man meets Minginui. *New Zealand Listener*, 10 November: 20–24.

A vivid, illustrated, day-by-day account of a visit by Dr David Bellamy to Minginui Village and Whirinaki Forest, between 11 and 18 September 1984. Dr Bellamy was the guest of the Whirinaki Forest Promotion Trust for his fortnight in New Zealand. The trust generally supported the views of conservationists, calling for immediate cessation of logging. They were in confrontation with Minginui villagers, the official policy of the NZFS, and those in favour of continued wood production from the indigenous forest. The trust was publishing the book *To save a forest: Whirinaki* (Morton et al.1984) in the same month. They had also arranged for a television documentary to be made, fronted by Dr Bellamy, who managed to accompany the film crew on time despite obstacles put in their way [see DOC n.d.]. The Forest Service took Bellamy on a helicopter trip to see the forest. They viewed the damage caused by Cyclone Bernie in Easter 1982, in unlogged podocarp and podocarp/tawa forest; selectively logged forest after salvaging of 'dead and dying podocarps'; and beech forest (with an extensive blowdown). He later refuted official Forest Service views, and quoted Forest Research Institute scientists as saying that the podocarp forests were not dying. Bellamy thought that Whirinaki Forest would become highly valued for tourism. His arrival in the forest came 'only days after an announcement by the government that logging should stop by the end of the year'. [See NZFS (1984c).]

Keywords: conservation issues, David Bellamy visits, logging cessation

206. Steward, G. A. 1988: Forest Research Institute Records on past silvicultural practices in New Zealand native forests. Project Record 2084. Forest Research Institute, Rotorua (unpublished report). 88 p.

This catalogue of seven Forest Research Institute files on indigenous forest (with a base number of '28' for 'indigenous forest management') covers the period 1950 to 1986, and has some 50 references to Whirinaki Forest, including reports, file notes, letters and diary notes. While many items refer to selection management trials, with studies of tree stability and mortality, there are many others on forest succession, regeneration and general ecology of the dense

podocarp and podocarp/tawa forests. A report by A J McGuire, dated 1 January 1956, contains information from the NZFS's Rotorua Conservancy records on an indigenous nursery and establishment of indigenous species at Te Whaiti from 1938 to 1945. [Investigations into indigenous forest were resumed at Whirinaki from the 1960s to about 1985, and included proposals for restoration of totara-dominant forest in the Mangawiri Basin, where totara/matai forest had been cleared and converted to plantations of exotics in 1973.] There are references to the first working plan for Whirinaki in 1950. A report by R. Y. Collins, dated 14 August 1978, is one of the few records of widespread conservancy planting of podocarps which took place from 1977 in selectively logged forest and by roads and skid sites in Whirinaki. [See also Forest Research Archives (2003).]

Keywords: forest ecology, indigenous forest management, nursery practice, restoration planting, silvicultural records, species lists, seed collection

207. Steward, G. A. 1998: Windfall and mortality within the Okurapoto dense podocarp selection logging trial, Whirinaki Forest Park. Forest Research, Rotorua (unpublished report). 11p.

This assessment was carried out in 1998, 19 years after selection logging, using three tree- selection criteria in three separate blocks, to remove 9–15% of the merchantable volume. A fourth block of unlogged forest was the control. No significant differences in tree mortality rates were identified between treatment blocks, or between treatment blocks and the control. Total tree loss over 19 years was 0.47 trees/ha/annum over the 40 ha of the whole trial area, the majority of losses being of rimu and matai. In the first 4 years of the trial (1979–83), tree mortality was twice as high, at 0.93 trees/ha/annum (Cyclone Bernie had struck the area in 1982). Over the last 15 years (1983–98), windthrow was the main cause of death. Roughly equal numbers of trees were lost through uprooting or snapping of stems (windbreak), considered a direct or primary result of wind impact while further trees were lost as a result of being struck by other falling trees, considered a secondary result. A high figure of 34% of mortality resulted from death of standing trees [GAS: but this could not be directly related to logging].

Logging-trial treatments are detailed in the report, also losses in stem volume since 1983, amounting to 1.5 m^3/ha/annum for merchantable trees. Many matai had defective stems caused by rot, and such trees accounted for 61% of matai mortality. Overall, 81% of windfallen trees fell towards the northwest quarter, suggesting impact from southeast winds (as in Cyclone Bernie). In this very tall, dense podocarp forest, with some rimu reaching 55–60 m in height, and with a density of 120–140 stems/ha, small gaps such as those made by felling single trees soon closed, and groups of planted podocarp seedlings [and small natural seedlings] became smothered by tree ferns and ground ferns. Within larger clearings made by felling groups of 10–12 trees in the 'Group Selection' block, a dense growth of wineberry soon overtook planted seedlings. [Their ultimate survival and growth requires further assessment. See Bergin (1988), and Steward & Pardy (1989).]

The author concludes that 'the removal of 9–15% of the merchantable volume from the three logging treatments in this trial does not appear to have

influenced the short to medium term stability of this forest at Okurapoto, when compared to mortality in similar unlogged forest. While tree losses were high in all blocks assessed, there is evidence of a natural decline in tree health of older trees.' [See earlier reports on tree mortality and windfall in Okurapoto trial in Smale et al. (1985, 1987, 1998)].

Keywords: Okurapoto trial, selection management – dense podocarp forest, tree mortality, volume loss, windfall

208. Steward, G. A.; Pardy, G. F. 1989: Group planting of rimu and kahikatea in gaps 15 years after selective logging, Whirinaki Forest Park. Project Record 2274. Forest Research Institute, Rotorua (unpublished report). 12 p.

At the 1961 trial site near South Road, two attempts were made to establish rimu and kahikatea seedlings in dense, 6–8 m tall wineberry regrowth—first at 15 and then 19 years after selective logging removed 40% of the merchantable volume. Results are given for survival and height growth of the seedlings. Both attempts failed in terms of survival rate and lack of vigorous growth of the podocarp seedlings. A high percentage mortality of 50–60% was ascribed to a number of factors: crushing of seedlings by windthrown canopy trees; vigorous competition from a dense growth of ferns, sedges and bush oat grass (*Microlaena*); shading by and collapsing of wineberry beneath vine tangles marginal to cut gaps; and localised pig rooting on moist ground. Poor growth of the surviving planted podocarps was ascribed to deer and possum browsing of leaders and branch tips, and competition from ground vegetation and overtopping vegetation, with additional shade from residual canopy trees of tawa [including expanding crowns] and podocarps.

In 1976, 15 years after partial logging, gaps 2 m and 4 m wide were cut in wineberry regrowth before planting clusters of five seedlings per gap. The original gaps were widened to 6–8 m in 1980, 19 years after partial logging, for further planting of larger rimu and kahikatea seedlings. All planted seedlings were released from competing vegetation several times, by slasher cutting or chemical spraying. Mean annual height growth in 1987, 11 and 7 years after planting, was around 4 cm for rimu and 10 cm for kahikatea. Better survival (90–95%) and height increment (16–20 cm annually) were obtained by planting larger gaps in freshly logged dense podocarp forest at the Okurapoto trial site, before invasion of wineberry (Bergin 1988).

[The frequent dense ground cover of *Uncinia* spp. and *Microlaena* in virgin podocarp and podocarp/tawa forest at Whirinaki appears to have been induced by browsing of deer, released in the vicinity of Whirinaki Forest about 100 years ago. This ground cover is invigorated in gaps cut by logging, or in gaps cut in invading wineberry. Together with ground ferns and tree ferns, these species offer severe competition to small, naturally regenerated and also planted podocarp seedlings. Thus, planting of freshly disturbed ground with large seedlings, before invasion of ground cover, has allowed the podocarps to gain some early height growth, although they are later overtopped by shrub hardwoods. An additional problem at Whirinaki has been the browsing of both rimu and kahikatea seedlings by deer and possums. This has been demonstrated in the same area of the currently reported trial, where nursery-raised rimu and

kahikatea planted in canopy gaps in 1961 were reduced to stubs outside exclosures during the first two winters, but continued to grow well inside netted exclosures. (See Forest Research Institute sample plot R with 1963 photographs.]

Keywords: group planting – rimu/kahikatea, selective-logging gaps, wineberry regrowth

209. Steward, G. A.; Pardy, G. F. 1990: The effects of roading on the stability of dense podocarp forest, Whirinaki Forest. Project Record 2458. Forest Research Institute, Rotorua (unpublished report). 16 p.

Three different types of road were constructed through dense podocarp forest in 1978. They were all adjacent to four blocks of the Okurapoto selection management trial. An arterial road averaged 10–12 m wide, including batters. There were two types of secondary road, each 4–5 m wide. One had logging slash buried beneath the road centre; slash from the other road was bulldozed into surrounding forest. The effects of construction of these roads on the residual forest were assessed over 10 years, at 2-year intervals. The study area consisted of three sample strips along each of the three road types. In total they covered an area of 1.8 ha. The degree of disturbance to residual trees along road margins was categorised according to amount of lateral-root severance, root-plate compaction, crown damage from felling, stem damage, accumulation of debris (soil and slash) at the base of trees, and crown health.

For the three road types, deterioration in tree health and windfall rates of marginal trees in residual forest of the study areas was similar to that in the adjoining Okurapoto trial, with between 0.9 and 1.6 windthrown trees/ha/year. The forest of the study area immediately after logging contained 111 podocarps/ha (of which 57 trees/ha were matai and 31 trees/ha were rimu) and 22 hardwoods/ha (mainly tawa). A survey of defects in residual trees before roading, mainly of stem and butt rot, showed that natural decay in matai and rimu was high, with 45% of matai and 23% of rimu having some defect.

The arterial road resulted in significantly more damage to residual forest along the road margins than either of the two types of secondary road. Among the primary windfalls (not hit by other falling trees) associated with the roads presence, matai with snapped stems was more frequent than uprooted trees, and usually associated with stem or butt rot. Rimu was uprooted as often as snapped, while tawa was always entirely uprooted.

The secondary roads caused little canopy disturbance, with tree crowns often overhanging the road. Seedling regeneration had generally been sparse, but where windfall had created a gap in dense wineberry, an abundance of newly germinated podocarp seedlings was found in a carpet of moss and lichens. In contrast, the arterial road resulted in a considerable canopy gap, estimated to amount to 12 ha of forest along 10 km of road. The larger of the roadside batters, however, had been invaded by dense wineberry. After 10 years this was thinning out over a mass of newly germinated seedlings of podocarps, mainly less than 10 cm in height. [After 20 years, some of these rimu seedlings have become well-established saplings. They can be distinguished from rimu that has been planted at the roadside, not only by their density, but also because they are

randomly arranged, contrasting with the planted rimu which are in groups of three to five. Patches of very dense rimu seedlings have survived after germinating in pumice sand near seed trees that had heavy seed crops in 1978.] Eleven years after roading construction the shrub–hardwood vegetation alongside arterial road margins had encroached towards the road centre. [Species that were scarce in unlogged old-growth podocarp forest, such as fuchsia, kamahi, and *Coprosma* spp., appeared on road margins.]

[GAS: Totara planted along the road margin have generally survived for the last 25 years, but are damaged by defoliating insects and suppressed by regrowth.]

Keywords: mortality of roadside trees, Okurapoto trial, podocarp forest, regrowth, roading impact – on residual trees, tree damage, windthrow

210. Steward, G. A.; Shaw, W. B.; Krogh, L. 1987: Catalogue of Forest Research Institute records on Protected Natural Areas, Vol. 1. Forest Research Institute, Rotorua. 145 p.

References relevant to Whirinaki Forest are those under the keyword 'Whirinaki State Forest Park' (34 items), and those in the sections dealing with proposals and extensions for Otupaka, Oriuwaka, Te Hoe, Tuwatawata and Waione ecological areas. Other keywords, including 'forest types', 'frost flats', 'Rotorua (NZFS) Conservancy', and 'scientific reserves', refer to Whirinaki Forest. Many of these items were written by J. L. Nicholls and J. W. Herbert over the period 1965–86, including some in file 31/6 with titles listed in the current bibliography. [Photocopies are available from Landcare Research, Private Bag 3127, Hamilton.] Volume 2 of this catalogue, by Steward & Shaw (1988), contains few direct references to Whirinaki, except for the Hautapu Bog (item 46), and reservation in the Whirinaki Ecological District (item 61). There are a number of references to Urewera National Park, including a list of vascular plants on Mount Maungataniwha (item 61).

Keywords: catalogue of records, ecological areas, frost flats, podocarp forest, protected natural areas, scientific reserves, scientific values, species lists, Whirinaki forest types

211. Stokes, E.; Milroy, J. W.; Melbourne, H. 1986: Te Urewera-Nga iwi Te Whenua Te Ngahere. Land and forests of Te Urewera. University of Waikato, Hamilton. 370 p. Photographs, statistical data, figures, maps, 160 references.

The text and bibliography cover aspects of 'social, economic, cultural and historical dimensions of Te Urewera communities'. Over 3000 people, predominantly Maori, live in Te Urewera communities, among which one of the largest in recent times has been the Minginui Forest Village [now considerably reduced in population since the demise of the NZFS in 1987 and the closure of Minginui Sawmills in 1988]. The authors state that 'there is some difference in perceptions of Te Urewera by Tuhoe people and those of the general public' and that the Tuhoe 'still see themselves as an integral part of the forest environment of Te Urewera' which is their ancestral land. An account of Te Whaiti-Minginui community of the Whirinaki Valley (population 490 in a 1984 survey) is given (pp. 226–258).

Following a brief historical summary of earlier Maori occupation and timber milling from the 1920s, most of this account deals with 'the battle of Whirinaki'—the confrontation of villagers with 'the greenies' who wanted to stop the logging of indigenous forest in Whirinaki State Forest. Much of the detail is from articles in the *New Zealand Herald* and the *Waikato Times* during the period 1978–84. Early inspiration was gained by a party of Minginui villagers who attended a seminar organised by ECO in Taupo, on Queen's Birthday weekend 1978, to discuss the future of west Taupo forests. A planned field trip to Whirinaki Forest by bus-loads of conservationists was prevented by villagers blocking the roads. Further confrontations were made by infiltration at meetings of the Royal Forest and Bird Protection Society at several venues, with a final episode in September 1984 when David Bellamy visited the forest (see Stark 1984).

Bibliographical references in the publication that are listed in the current bibliography on Whirinaki Forest include the following: Best (1942), on Maori relations with Urewera Forest; Millyn & Nevin (1978) and Nevin (1980, 1985), on archaeological site survey and history; NZFS (1984), on milling history and Minginui Village description; Field & Garrett (1979) and NFAC (1979), on national park values. There are references to Minginui Village in other sections of the publication, and interesting discussions on Maori activities and viewpoints under headings such as 'Historic places' and 'Wahi tapu' (pp. 331–343), noting the 'rich traditions of Maori occupation relevant to the Whirinaki Valley, as well as other Urewera communities'. A comment is made that 'some very deep thinking is required to evaluate the most appropriate ways to interpret Maori and Pakeha history of Te Urewera'. The sections 'Maori culture and tradition' and 'Traditional uses of forest resources' (pp. 352–366) describe activities such as eel fishing, hunting and trapping, tourism, and marae visits. In 1984 'local people, not just at Minginui, have felt considerable anger and frustration that outside groups, particularly the Royal Forest and Bird Protection Society and Native Forests Action Council, have appeared to have had so much influence' [in matters of forest policy and forest management].

An account of the Tangata Whenua (pp. 10–21) refers to the occupation of areas by aboriginal Polynesians (Te Timia Toi) before arrival of the Mataatua canoe and other canoes in the Bay of Plenty. The important Tuhoe ancestor was Tuhoe Potiki, the product of a marriage between Mataatua immigrant and aboriginal Tangata Whenua 'whose descendants moved south into Te Urewera and to Te Whaiti-nui a toi' [in the Whirinaki Valley]. 'The occupation of the tangata whenua would be in its nature more that of a nomad people than that of fixed permanent homes' (p. 16). Before the introduction of kumara, people lived largely as hunters and gatherers of products of the forest. [See Cameron (1960, 1961) for the possibility of early Tangata Whenua fires affecting the margins of Whirinaki Forest and possibly leading to initiation of dense podocarp stands in the valleys of the Mangawiri Stream and Whirinaki River.] The kiore [*Rattus exulans*] was said to be replaced by introduced rats [mainly *Rattus rattus*, the ship rat in the forest] from about 1838, with potatoes being cultivated from about this time. The native kokopu were said to have disappeared from the Whirinaki and other rivers after introduction of trout in the early 1900s. [No kokopu and only two species of eel were found in a recent survey of the Whirinaki and its tributaries, see Young (2000). See also Hutton & Neumann (2001) for the history of Minginui Forest Village.]

Keywords: Maori occupation and forest living, Urewera – forest, Urewera – history, Urewera – land, Urewera – people

212. Te Karere Maori 2001: Whirinaki Forest, one of the world's great rainforests. *Te Karere 201(1)*. 4 p.

A new tourism venture, the 'Whirinaki Escape', was launched in 2000 'as a means of developing social and economic opportunities for local Maori'. Te Mauku Trust conducts 1-day interpreted walks in the forest 'with flora and fauna interpretation, tribal history and traditional stories'. [See also Pu Kaea (2001).]

Keywords: forest walks, Maori tribal history – Whirinaki, tourism venture

213. Thompson, B. N. 1964: Quaternary volcanism of the central North Island. *New Zealand Journal of Geology and Geophysics 7(1)*: 45–66.

This is a broad account of the main rock types of the Central Volcanic Region. Where Whirinaki is situated, the ignimbrite of the Kaingaroa Plateau abuts on the greywacke hills of the Huiarau Range, as shown on a coloured geological map. The Taupo fault zone extends along the Whirinaki Valley.

Keywords: greywacke, ignimbrite, map – geological/central North Island, volcanism – central North Island

214. Thomson, C.; Challies, C. N. 1988: Diet of feral pigs in the podocarp/tawa forests of the Urewera Ranges. *New Zealand Journal of Ecology 11*: 73–78.

[Although this paper is concerned with pig diet in the northern Urewera, the diet of pigs in a comparable forest type in Whirinaki Forest is likely to be similar, including many of the same food items. This is a valuable contribution to the small amount of knowledge recorded on the impact of pigs in podocarp/tawa forests of the central North Island, where 'pigs periodically reach high numbers and then decline again naturally'.] The authors suggest that these fluctuations may be linked to the availability of tawa and hinau fruit which, together with supplejack fruit and some miro, made up one-third of the pigs' diet. Foods were itemised from samples of the stomach contents of 104 feral pigs, shot in the Urewera Ranges between December 1982 and June 1985. Tables give data for items of plant and animal material, sampled annually and by season. Browsing and grazing accounted for 17.6% of the annual diet, ground foraging 51.8%, and rooting 30.6%. Plant material made up 71.9% of the annual diet, and apart from fruits, major plant foods were roots of supplejack, the fronds and starchy contents of tree ferns (*Cyathea* spp.), and bracken rhizomes. Leaves of tawari were frequently browsed, but comprised only 1% of the annual diet. Animal material made up the other 28.1% of the annual diet, the main animal foods eaten being earthworms and possum carcasses, with a small component of insects.

[In Whirinaki Forest extensive pig rooting is commonly seen in moist areas by streams and on river terraces, sometimes uprooting newly planted podocarp seedlings and destroying small natural podocarp and broadleaved seedlings (Beveridge, A. E., pers. obs.).] Large hinau trees are less common in Whirinaki

Forest than in either the northern Urewera forests sampled or the west Taupo forests. In Whirinaki Forest there are occasional heavy crops of matai and miro. Possums destroy much developing tawa fruit in tree crowns and eat seed of mature fruit on the ground. Many archaeological sites have been disturbed by pigs, which may uproot artefacts (e.g. Millyn & Nevin 1978). Terrestrial orchids (*Dactylanthus*) and king fern (*Marattia* spp.) may be threatened by pigs (e.g. Beadel 1992). [In Pureora Forest, signs of pig forage beneath tawa and hinau trees were commonly seen during early autumn seedfall, and stomach contents of a pig shot in May were full of matai and hinau seed (mainly crushed), with some fungi (Beveridge, A. E. 1964, pers. obs.).] A result of pig presence is pig hunting with dogs which may become lost and kill kiwis (recently recorded in Urewera National Park) and possibly be a threat to blue duck. [Although foraging for food usually causes only local disturbance of the forest floor, pigs can consume quantities of tawa, hinau, miro and matai fruits (e.g. Beveridge 1964; Jane 1978a).]

Keywords: pig damage, pig diet

215. Townsend, A. J.; Beadel, S. M. 1997: Rangitaiki weed inventory. Wildland Consultants Ltd unpublished report for Department of Conservation, Murupara. 314 p. 33 references.

This large document includes, in standardised form, the results of an inventory carried out in 1997 in 22 'pest plant management units' on the western side of Whirinaki Forest Park. Some units were outside the park, but within its proximity. Each management unit has an A4-sized map (scale 1:50 000) showing location of any infestation of 'ecological weeds'—those that pose a threat to the botanical integrity of protected areas. For each invasive plant species there is a colour aerial photograph showing location of an infestation, in addition to notes of its extent, vegetation types present, and conservation values threatened. Priorities for weed control in each management unit are given in three categories at the end of the document (pp. 298–301). 'Category 1' priority applies to small infestations requiring early control and action to prevent spread; seven species in this category include, for example, black wattle, privet and heather. 'Category 2' covers larger infestations, or widely spread invasive species, requiring urgent action but possibly taking long periods to control, for example *Pinus contorta* and willows (*Salix fragilis*, *S. cinerea).* 'Category 3' covers widespread species 'generally of limited ecological threat, and tend to be a lower priority for control', for example broom, gorse, Spanish heath, *Hieracium* (control may be required on important frost flats such as Taho). Appendices contain recording forms and a list of adventive species in management units, giving both scientific and popular names. Within Whirinaki Forest Park most weed infestations appear to be associated with disturbed ground (roadsides, logging tracks), hut sites, shrubland, scrub and frost flats, while the willows threaten the whole riverine system. All the exotic conifers have spread to some extent from plantations.

Keywords: conservation areas and values, invasive weeds, maps – weed infestations, pest plant management unit, weed control priorities, weed inventory

216. Van Dongen, Y. 1989: Minginui's last stand. *New Zealand Geographic 2*: 70–85.

This illustrated account of a big army exercise pitted against a mock rebel uprising in Minginui Village offers reflection on the long occupation of the region by Maori, and also the current way of life, attitudes, problems and plans for the future of the villagers. These plans include schemes to promote tourism and education, with appreciation of Whirinaki Forest Park, its history and recreational pursuits available. Army personnel make friends in the village and suggest the possibility of army recruitment to ease current unemployment.

Keywords: Minginui Village, village lifestyle and opportunities

217. Veale, B. J. 1986: Natural regeneration in selectively-logged management trials in podocarp forests of the central North Island. Project Record 1170. Forest Research Institute, Rotorua (unpublished report). 25 p.

The report describes regeneration surveys carried out in the area of the 1961 selection management trial in Whirinaki Forest. It also describes regeneration surveys in two west Taupo forests (see annotation for this report in Pureora bibliography, item 260). This annotation refers only to the surveys in the Whirinaki trial, where logging removed 40% of the merchantable volume, mainly podocarps. Regeneration surveys of podocarp and tawa were carried out before logging, in 1961, and after logging, in 1973 and 1984. The surveys of 1973 and 1984 used different sampling methods. Data for the 1961 survey could not be found, but notes from the 1973 survey indicated that in 1961 there were only rare established podocarp seedlings over 15 cm tall, but abundant tawa in all size classes. A sampling of regeneration over 24 ha before logging recorded only one rimu and five kahikatea seedlings over 15 cm tall in 1200 plots of 2×2 m^2. The 1984 survey indicated an increase in podocarp seedlings to around 400/ha in both control and logged blocks in a size class that ranged from 15 cm in height to 5 cm diameter, but all were under 50 cm in height. These seedlings tended to be grouped around stumps of trees felled in 1961, or at gap margins. Miro and kahikatea over 15 cm in height were more common than rimu or matai. Tawa seedlings and saplings were abundant in both logged blocks and the control block, with 5000–6000 stems/ha up to 3 m in height.

[Thus, despite considerable opening of the canopy, initially by logging and subsequently by windthrow or mortality of podocarp trees, there was no vigorous development of podocarp regeneration over a period of 23 years. This situation contrasts strongly with that in the parallel trial in the same type of podocarp forest at Pureora, where podocarp regeneration was much more abundant and well developed. Although little incidence of browsing damage to small, natural podocarp seedlings was recorded in the Whirinaki study area in 1984, severe damage to seedlings of rimu and kahikatea planted in 1961 occurred in two subsequent winters, and removal of palatable shrubs at peak browsing periods has induced a dense growth of sedges and ferns. A note by John Innes to the Forest Bird Research Group in 1981 refers to sampling the 1961 trial by the 'point height intercept' method. Wineberry and the fern *Blechnum fluviatile* 'were almost entirely dominant on old skid tracks and other disturbed areas 20 years after logging. Other species were present in such

areas as scattered, hedged low seedlings, but their progression through to taller height classes appeared to be hindered by browsing pressure.' See Pardy (1984), and Smale et al. (1998).]

Keywords: natural regeneration survey (podocarps/tawa), selectively logged forest

218. Waitangi Tribunal 1993: Te Ikawhenua: Energy Assets. Report Wai 212. Brooker & Friends Ltd, Wellington. 79 p.

The original 1991 claim ('the substantive claim') concerned the loss of traditional food, namely eels, by the Maori who had lived by the Rangitaiki and Wheao rivers, this loss being caused by the construction of the Aniwhenua Dam (completed in 1980) and the Wheao Dam (completed in 1984). Two of the tribes who claimed ownership of these rivers were the Ngati Whare and Ngati Manawa, some of whom still lived in the Whirinaki Valley, as their ancestors had for centuries. This claim included part of the catchment of the Whirinaki and Wheao rivers now within Whirinaki Forest Park (see p. viii for location map). Construction of the two dams blocked the migratory routes for eels to and from the sea. Historic sites by the rivers, or in their catchments, were described by claimants and included Te Tapiri Pa (now a fire lookout in the Whirinaki Forest Park). [At the time this report was published, the substantive claim had not been heard and determined (p. 45), but see Waitangi Tribunal (1998).]

Keywords: dam construction (Aniwhenua/Wheao), eel fisheries – Whirinaki River, Waitangi Tribunal, Wheao River

219. Waitangi Tribunal. 1998: Waitangi Tribunal releases Te Ika Whenua rivers report. Media release, 22 September.

The recommendations of this report include 'establishment of a regime of management and control of the Te Ika Whenua rivers, recognising the tino rangatiratanga of the Te Runanga o Te Ikawhenua over the waterways'—the waterways being the middle reaches of the Rangitaiki, Wheao and Whirinaki rivers, and their tributaries. [For a description of the original claim, 'Wai 212', see the annotation for Waitangi Tribunal (1993).]

Keywords: Waitangi Tribunal – Whirinaki, Wheao River

220. Walker, G. 1980: The Taupo pumice: product of the most powerful known (ultraplinian) eruption. *Journal of Volcanology and Geothermal Research 8*: 69–94.

A highly technical paper on the nature of the Taupo pumice, erupted from a centre east of Lake Taupo about AD 130. [The Concise Oxford Dictionary (10th edition) states that 'plinian' refers to the 'type of volcanic eruption in which a narrow stream of gas and ash is violently erupted from a vent to a height of several miles (as with the eruption of Vesuvius in A.D. 79)'.] The Taupo plinial pumice, known as the Taupo lapilli member of the Taupo pumice formation, was very widely dispersed, and was 24 km^3 in volume. The eruptive column must have exceeded 50 km in height, and a very mobile pyroclastic flow followed its collapse. The pyroclastic sequence resulting from the Taupo Eruption of c. AD 131 [revised to AD 200] is given, with the Taupo lapilli

member being followed by a rhyolitic block bed and upper Taupo pumice, together forming the Taupo ignimbrite.

[Pyroclastic material from the Taupo Eruption reached the area now covered by Whirinaki Forest. A section through the volcanic layers exposed in a road cutting by the Okurapoto trials of 1979 was studied by Alan Pullar, Bill Cotching and Neil Kennedy, accompanied by the principal author of the current bibliography (AEB). The deposits were described, and their boundaries marked on photographs. The resulting report, with photographs, are held by Landcare Research.]

Keywords: Taupo Eruption, Taupo pumice

221. Wardle, P. 1966: Biological flora of New Zealand 1: *Weinmannia racemosa* Linn.f. (Cunoniaceae) Kamahi. *New Zealand Journal of Botany 4(1)*: 114–131.

This paper, annotated as item 266 in the Pureora bibliography, gives a general account of the ecology of kamahi, but several aspects have significant relevance for Whirinaki Forest. 'The abundance of *W. racemosa* on infertile soils derived from volcanic ash in the Rotorua–Taupo district is probably related to the high water-holding capacity of these soils' (Will & Stone 1964, unpubl. report). Kamahi is susceptible to summer drought. Leaves of kamahi are a preferred food for both possums and deer, but it was recognised that the death and die-back of kamahi, widespread in mid-altitude North Island forests, including Whirinaki Forest, may have complex causes.

[In Whirinaki Forest, deer browsing has prevented kamahi from developing as terrestrial seedlings or epiphytes on rotting logs, while a combination of climatic factors and possum browsing may lead to the general lack of epiphytic kamahi on tree fern stems and logs. In the wetter forest of Pureora, epiphytic kamahi were common before the impact of possums in the 1970s. Old kamahi in Whirinaki Forest have shown crown die-back for many years.]

Keywords: kamahi die-back, kamahi ecology, kamahi – preferred food – possum and deer, kamahi – successional

222. Webb, B. 1989: Gone bush, back in five days. *Evening Post*, 25 October: 31–32.

This account includes an appreciation of a 3-day guided tramping trip in Whirinaki Forest Park, along a well-maintained track through beech and podocarp forest, with comfortable tent accommodation and a final night spent on the Murumurunga Marae of the Ngati Whare people.

Keywords: tourism, tramping

223. Wildland Consultants Ltd. 2000: Strategic plan for (*Pinus*) *contorta* management in the upper Rangitaiki and Waipunga catchments, Central North Island. Unpublished report for Rangitaiki Contorta Coordinating Committee, Department of Conservation, Murupara.

The spread of *Pinus contorta* is shown on coloured maps—the maps are the result of a survey of some 250 000 ha. Control measures are recommended in a

strategic plan, and methods of *P. contorta* removal are given in an appendix. The report is relevant to Whirinaki Forest Park as there are many infestations within the northern part of the park. Mainly these are small, and on disturbed sites and in open or low vegetation, such as the manuka–monoao scrub of frost flats (Taho and Waione sites). The infested sites within different management units of the park were described by Townsend & Beadel (1997) in their Rangitaiki weed inventory, but this report has an appendix giving more details of the nature and density of *P. contorta* invasion. Buffer zones 1 km or 2 km wide are recommended around areas of high conservation value, and to the west of the park. The ecology of *P. contorta* is outlined. It is intolerant of shade, but tolerant of drought and frost. It cannot invade a dense shrub layer, dense grass, or indigenous forest with a closed canopy, but colonises roadsides and canopy gaps, and low, open scrub, also bog margins and streamsides. *P. contorta* produces seed when 5–8 years old, but spread from trees usually takes place after 10–15 years. Seed can be blown up to 40 km. Areas where *P. contorta* control is of high priority include several management units in Whirinaki Forest Park (pp. 24–25). Townsend and Beadel (1997) included the 'Ohu Camp Unit' as a high priority area for *P. contorta* control, though the unit is said to have low botanical conservation values.

[It should be noted that hawthorn, another invasive weed, can induce dense regeneration of podocarps, especially matai, as in the vicinity of the Mangamate Waterfall Camping Area (Beveridge, A. E., pers. obs.).]

Keywords: *Pinus contorta* control, *Pinus contorta* tolerances

224. Wills, D. E. 1996: North Island Brown Kiwi Survey, Whirinaki Forest Park, 15 July – 15 August. Department of Conservation, Murupara (unpublished report). 31 p. (Text 8 p. Appendices and maps 23 p.)

Thirty-one kiwi (19 males and 12 females) were recorded in and near the Tuwatawata Ecological Area during night surveys in July and August 1996. Nine listening stations were used. These were in a possum control area where large northern rata were thought to be declining through possum browsing. Six pairs of kiwi were located within an area of approximately 100 ha. Standard kiwi-call cards were used, recording weather data, and tapes of kiwi calls were played. All kiwi were recorded at 500–750 m altitude. Appendices include tabulated data, and maps show locations of listening stations. A few stations were located on prominent hills in and near the ecological areas of Oriuwaka, Otupaka and Te Kohu, but no kiwi were recorded at those sites. It was recommended that a more intensive kiwi survey be done in the Tuwatawata Ecological Area after the current possum control operation.

Keywords: kiwi survey, Tuwatawata Ecological Area

225. Wilson, C. J.; Ambraseys, N. N.; Bradley, J.; Walker, G. D. 1980: A new date for the Taupo Eruption, New Zealand. *Nature 288*: 252–255.

An article giving a new date of AD 186 for the Taupo Eruption. [MCS: This date has since been revised to AD 200.]

Keywords: Taupo Eruption

226. **Wilson, C. J. N.; Loughton, B. F.; Lloyd, E. F. 1986: Volcanic history and evolution of the Maroa–Taupo area. Pp. 194–223 in Smith, I. F. M. (Ed.): Late Cenozoic volcanism in New Zealand.** ***Journal of the Royal Society of New Zealand, Bulletin 23*****, Wellington.**

Keywords: volcanism central North Island

227. **Wilson, C. J.; Walker, G. P. 1985: The Taupo Eruption, New Zealand. Part 1. General aspects.** ***Philosophical Transactions of the Royal Society of London 314*****: 199–228.**

This is a detailed and highly technical account of the different eruptive events and the nature of the eruptive material emanating from a vent in Lake Taupo during the Taupo Eruption of c. AD 186 [revised date AD 200]. The authors write that the Taupo Eruption was one of the largest explosive eruptions in the world in the past 7000 years, and generated a great variety of pyroclastic deposits, including pumice falls, ash falls, and several ignimbrite flow units. Ash falls reached the Pacific Ocean [and therefore covered Whirinaki Forest and the Urewera tract, with rhyolitic ignimbrite reaching the Whirinaki Valley]. This paper reviews past work, adds new information, and has a long list of references.

Keywords: pyroclastic deposits, Taupo Eruption

228. **Yockney, I. 1998: My first party hunt.** ***New Zealand Wildlife 11(84)*****: 40.**

An account of an Easter hunting trip with the South Auckland Deerstalkers, written by a 14-year-old member of the party. The hunt involved access by helicopter and a stay at the Central Te Hoe Hut.

Keywords: deer hunting trip, hunting

229. **Young, K. 2000: Whirinaki River freshwater fish: distribution and diversity. Department of Conservation, Rotorua (unpublished report). 27 p.**

This survey of freshwater fish in the Whirinaki River and its tributaries focused on the forested part of the catchment, which is mainly within Whirinaki Forest Park. The survey was carried out from November 1999 to February 2000. Only four species of freshwater fish were found—brown trout, rainbow trout and the two native eel species, mainly the long-finned eel, with the short-finned eel being found in only two tributaries. The eels migrate and spawn in the sea when mature. No other indigenous freshwater fish, apart from the eels, were found, although the surveyed waters provide excellent habitat for species such as the galaxiids, koaro and banded kokopu, which normally migrate to the sea to complete their life cycle but occur in some landlocked populations. The author suggests that koaro, banded kokopu, and a non-migratory dwarf galaxiid may be present in the Whirinaki River system. The eels found in the survey were large, over 40 years of age, and in small numbers. They represent populations existing before construction of the Matahina Dam in the early 1960s and the Aniwhenua Dam in the late 1970s. These dams are likely to present barriers to eels and other freshwater species. The Aniwhenua Falls may also restrict access for

indigenous freshwater species to the Whirinaki River system. A few small eels, or elvers, were found, and an elver transfer programme that stocked Lake Aniwhenua 'has had limited success in stocking the Whirinaki River system'.

Keywords: dam impact on eels, eels (dam impact on), Whirinaki – freshwater fish

230. Young, V. 1979: Whirinaki State Forest. Transcript of Radio New Zealand interview with Minister of Forests. Radio New Zealand, National Programme, 27 July 1979.

In this 16-minute interview (with a reporter, who had interviewed the president of the NFAC the previous day) the Minister supported the new indigenous forest management policy that the Government was following. That policy was to cease clear-felling and move to selection logging and sustained yield management, with a much lower production of indigenous timber from over approximately 25% of the total area of Whirinaki Forest. The Minister stated that 'in many ways the forest has a greater chance to survive being properly managed, than being left to nature, because … those older forests in the Whirinaki [will] degenerate, they will lose the podocarp component and they will become hardwood forests of tawa. We believe, by proper management and the planting of native trees in logged areas, we can manage the rimu forest most effectively.'

[There was, and still is, much that is contentious in the Minister's statement. The older podocarp trees are in decline—through rots, windthrow, and storm impact—but the forests do not degenerate and inexorably become forests dominated only by tawa. Changes to forest composition and regeneration potential can be affected by deer and possum browsing. Complex regeneration cycles are not yet fully understood and further investigation is needed on the initiation of dense podocarp forest. The new mill at Minginui closed in 1988 and felling of podocarps ceased in 1984, heralding the establishment of DOC as managers of the forest in 1987.]

Keywords: forest management policy – revised, ministerial interview

3. Acknowledgements

This project was funded through the DOC Science Advice (and Services) Fund, following a recommendation from David Hunt, Technical Support Manager, Bay of Plenty Conservancy, DOC, Rotorua.

We are grateful for the assistance we received from the following persons: Sue Clements of DOC, Rotorua, who assiduously collected papers from the National Library, the National Forest Library, and DOC libraries; Kerry Jones of DOC, Rotorua, for the provision of the Whirinaki Conservation Park map; Paul Cashmore and Keith Owen of DOC, Rotorua, for discussion and reports on threatened plants and birds; Andy Blick of DOC's Rangitaiki Area Office, for the loan of books and reports, and accounts of current activities within Whirinaki Forest; George Pardy of DOC's Rotorua Lakes Area Office, for discussion on possible restoration of indigenous forest in the Mangawiri Basin (cleared and planted with exotic conifers in 1973), and collection of samples of epicormic shoots from the stems of surviving totara with crown die-back (both George Pardy and Andy Blick accompanied the principal author, Tony Beveridge, on two recent visits to Whirinaki Forest); Christine Lee of Forest Research, who typed a substantial number of annotations from handwritten index cards; Toni Wilson of DOC, Rotorua, who completed the typing from cards and amended early drafts; Chris Ecroyd and Elizabeth Miller of the Forest Research herbarium, who made a number of papers available; Peter Gadgil of Forest Research, for discussion on totara mortality; Willie Shaw of Wildland Consultants Ltd, for discussion about animal impact on the forest, the effects of catastrophic disturbance, and forest succession; Ralph Powlesland of DOC, who gave references for recent work on threatened birds; and John Innes of Landcare Research, who helped obtain recent papers on bird research.

4. Index of listed keywords

This index comprises all keywords as listed in the items shown in this bibliography.

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