

Atiamuri Ecological District

Survey Report for the

Protected Natural Areas Programme

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Abstract

The Atiamuri Ecological District was surveyed for the New Zealand Protected Natural Areas programme to assess the representativeness of existing natural areas and to prioritise new Recommended Areas for Protection. Only 87 of the 158 ecological units identified as contributing to the ecological diversity of the district are represented in the 31 existing protected natural areas dominated by native vegetation or containing geothermal features. Owing to the small size of most protected natural areas, only about 14 units are considered to be adequately represented. As a result all 49 study areas (unprotected remnants) surveyed are classified as Recommended Areas for Protection. These are described in order of importance within three ranked categories, and together comprise approximately 5800 ha, or 2.6% of the total area of the district.

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1. Introduction

The goal of the Protected Natural Areas Programme (PNAP) is to establish a network of reserves which is representative of the full range of New Zealand's natural diversity as embodied in the Reserves Act 1977, Section 3(1)(b). This identifies the need for :

“The preservation of representative samples of all classes of natural ecosystems and landscape which in the aggregate originally gave New Zealand its own recognisable character.”

In order to fulfil these objectives, Atiamuri Ecological District was surveyed by Landcare Research, on contract to the Department of Conservation, as part of an overall strategy to survey the districts of the Central Volcanic Plateau. All the sites described were visited by the author and by Nicholas J. Singers, either together or accompanied by staff of the Department of Conservation or other volunteer helpers (see Acknowledgments). Most of the field work was done over the summer of 1994/1995; some further areas were examined in the spring of 1995. All geothermal areas were visited by the author and by Ashley D. Cody, whose parallel report (Cody 1995) is quoted extensively in those sections referring to geothermal characteristics.

This report commences with outlines of the ecological character of Atiamuri Ecological District and its vegetation and wildlife history, and an explanation of the survey methodology. The following survey results include descriptions of the existing Protected Natural Areas (PNAs), comprising scenic and allied reserves, Queen Elizabeth II National Trust open space covenants, and one area protected as a Maori Land Trust. Opportunities for protection are then discussed, and culminate in the ranking and description of Recommended Areas for Protection (RAPs). Geothermal areas are also shown, ranked separately according to described criteria, to allow further evaluation. Appendices contain vegetation type descriptions, maps of 1840 and present-day vegetation units, species checklists, references, and a glossary of scientific terms.

2. Ecological Character of the Atiamuri Ecological District

2.1 Location and setting

Atiamuri Ecological District, with a total area of some 222 240 ha, is the northern portion of the Central Volcanic Plateau Ecological Region (Fig. 1). It extends from a few kilometres south of Rotorua in the north almost to Lake Taupo in the south, and from the foot of the Kaingaroa escarpment in the east to Lake Maraetai in the west. It lies completely within the catchment of the Waikato River, and the district and catchment boundaries coincide in the north and south.

The district was defined in McEwen (1987) on the basis of its unique geology and topography (landforms), and the transitional vegetation pattern, showing a marked north-to-south change from rimu/tawa-kamahi to dense mixed podocarp forest, with sub-montane to montane podocarp-hardwood stands on the ranges and highest dome tops. Exceptional, very minor areas with hard beech occur on the southern margin of the Mamaku Plateau, just within the Waikato River catchment. Lower ground was predominantly covered by tussock, fern, and manuka scrub before European settlement.

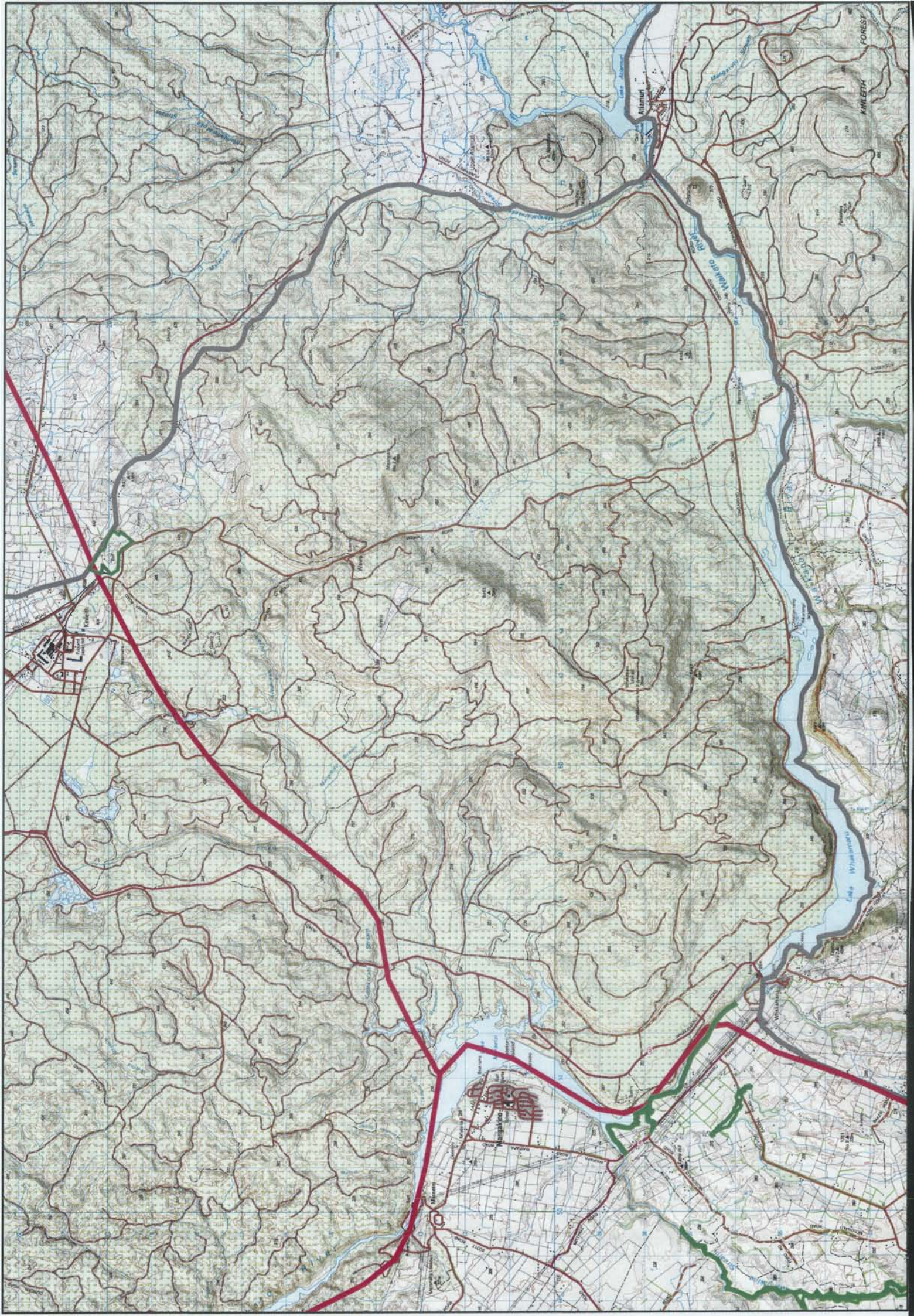
Climatically the district is characterised by warm, sometimes dry summers and cool winters with frequent ground frosts. Annual rainfall is normally between 1100 and 2000 mm, with maxima as high as 2400 mm over the Mamaku Plateau and Paeroa Range. There are frequent valley fogs, and persistent cloud occurs along the higher ground.

The soils throughout are of volcanic origin, predominantly young, coarse-textured volcanic ash soils derived from the Taupo rhyolitic pumice flows and ash falls lying over older silty and sandy, more weathered brown ashes. Leaching effects range from moderate in areas of lower rainfall to severe with higher rainfall, and podsolised soils and podsoles are evident where rimu- dominant forests previously stood. Minor areas of land were farmed from the late 19th century up until ca 1950, but the ease of clearing scrub and fern with bulldozers and tractors then brought about rapid and widespread conversion of the landscape. On the flat to rolling or moderately steep country sheep, cattle, and dairy farms now predominate; steeper land and the easier terrain developed before World War II are extensively planted in exotic forest.

The virgin, dense mixed podocarp forests have long since been logged and widely cleared, leaving only a few small remnants much modified by logging. The sub-montane to montane cloud forest of the Paeroa Range, the Horohoro Dome, and a small remnant adjacent to State Highway 1 near Whakamaru are possibly the only good examples of the original forest composition still extant.

Fig. 1 Atiamuri Ecological District.

2.2 Physiography



2.2.1 Landscape units

Visually the district can be divided into five landscape units (Fig. 2). The level or gently rolling terrain of the alluvial bottomlands, mostly to the north of the Waikato River, and visible along State Highways 5 and 30, is within an altitude range of about 280-450 m. In the eastern quarter are most of the prominent rhyolitic domes that give the district much of its unique character. Generally with maximum altitudes around 800 m, these contain much of the remaining indigenous vegetation of the district. Higher again, to just over 900 m, the tops of the Paeroa Range (a tilted ignimbrite block and abutting hills) and the impressively steep Horohoro Bluff (a rhyolite dome sliced by a major fault) provide the only examples of montane cloud forest in the district. Both these features also have substantial indigenous forest cover.

To the south of the Waikato River, State Highway 1 traverses the deeply dissected tephra deposits of the Taupo eruptions, themselves overlying the tilted Mokau ignimbrite sheet. It was in this environment that the dense mixed podocarp forests of former times grew - home now to an almost equally dense exotic forest that dominates the view from the main road.

Within these landscape units the geothermal areas have great visual impact. From the land system viewpoint, however, they are but small intrusions originating below a major formation. In terms of bioclimatic zones they represent a very small portion of the total land system, and yet by virtue of their subtropical microclimatic effect they support a fern and fern ally assemblage unique on the New Zealand mainland.

At a finer scale than the five landscape units, nine physiographic units can be delineated.

2.2.2 Physiographic units

Rhyolite domes

Visually the most significant feature of the district, these steep-sided, more or less flat-topped domes were formed by the extrusion of rhyolitic magma towards the end of a period of Quaternary volcanic activity. Subsequently they were overlaid with soils derived from ash showers and flows, mainly from the Taupo Volcanic Centre but also, in the north, from sources east and south-east of Rotorua. Originally with a cover of podocarp/(tawa)-kamahi forest, by European times only forest patches remained owing to the widespread and regular burning of fern and scrubland by the local Maori. Within the sub-montane to montane zone (Fig. 3) the forest changes to predominantly hardwoods.

Paeroa Range

A special instance of the previous unit, the Paeroa Range is composed in the north of a tilted block of ignimbrite, sloping to the southeast and heavily faulted along the north-west side, and continuing as a major divide comprising higher-than-usual hills towards the Waikato River. The presence of areas of geothermal activity along the fault scarp, particularly extensive at Te Kopia, has given rise to a range of geothermally altered soils that support a unique and special flora. The range top at 979 m is the highest point of the district.

Alluvial bottomlands

Comprising the farming areas of the Waikite Valley and the Reporoa Plain, these areas have developed from deposition of alluvial material. Impoundment of the Waikato River by ejected material from the 26 500 yr B.P. Taupo eruption caused an extensive shallow lake to form. This deposited poorly water-sorted pumice and silts, which together with vegetative material have formed low-quality peats in some places, with terraces and wave-cut erosion features also visible. On higher ground, non-alluvial terraces with flattish to undulating surfaces were formed by gas-charged clouds of pumice (*nuées ardentes*) from the Taupo eruptions of ca 1850 years B.P. (Vucetich & Wells 1978).

Mokai and Whakamaru ignimbrite plateaus

Along the south-west margin of the district extensive sheets of ignimbrite, tilted gently to the north-east, have been overlayed with deep tephra deposits from the Taupo eruptions. Erosion has cut deeply into these deposits, sometimes right through the ignimbrite, leaving steep-sided narrow gorges with characteristic vertical gully heads. These deep gullies now contain some of the more interesting indigenous flora of the district.

Mamaku plateau

Referred to in earlier times as the Patetere Plateau, this huge series of ignimbrite sheets extends from the Kaimai Range in the north to Tokoroa in the south. Tilting as it does to the south-east, its catchment drains to the Waikato mostly via the Tahunaatara River. The plateau and the dissected south-east margins which are within the Ecological District were completely forest covered until the 1960s, and remain quite largely so.

Hills

Various rolling to steep hills of diverse origin occur widely. Maximum heights are generally 400-500 m a.s.l. North of Lake Ohakuri and between the Paeroa Range and the margin of the Mamaku Plateau is a series of ignimbrite ridges aligned northeast southwest, and freshwater sedimentary rock and interbedded pumice tuffs, separated by long, narrow valleys. In the very north a few sizable rhyolite domes occur, emerging from a dissected fan of rhyolite breccias (unwelded ignimbrite). From about Atiamuri south to Lake Taupo the common major and minor rhyolite domes are surrounded (except on the west) by a rather

jumbled hilly landscape of well dissected associated pumice breccia fans with occasional small, flat valley floors.

Geothermal ecosystems

In the vicinity of geothermal vents a unique environment is created. According to the acidity and temperature of the vent, a sequence of specifically adapted biota will colonise the area. As ground temperatures rise above 30°C approaching the vent, species variation is reduced until finally kanuka (*Kunzea ericoides* var. *microflora*) and mingimingi (*Leucopogon fasciculatus*) are the only shrubs present. Under these shrubs the ferns *Histiopteris incisa*, *Gleichenia dicarpa*, and *Dicranopteris linearis* flourish in company with the clubmoss *Lycopodium cernuum* and a few species of moss. Above about 45°C the mingimingi disappears and the kanuka reduces in height, until as temperatures approach 60°C the ferns alone survive, becoming stunted and decumbent. Mosses and liverworts alone subsist in temperatures from about 85°C to 92°C, above which there are only bare, steaming, hydrothermally altered clays. Wildling pines, usually *Pinus radiata*, sometimes appear in thermal areas, occasionally surviving on the very edge of geothermal vents. Within the outflow of hot springs grow a range of algae; several species of insects are apparently specially adapted to this micro-environment.

Fig. 2 Landscape units.

Fig. 3 Bioclimatic zones.
Lake ecosystems

The string of man-made lakes behind hydro-electric dams on the Waikato River have created a significant aquatic habitat. The riparian strips support a strongly developing and complex flora. Seeds and spores of many species are distributed by river flow, wind movement, the wide range of bird species that feed and nest along the shores, and (unfortunately) the huge influx of people over the summer months, with their boats, vehicles, dogs, and discarded rubbish. The wide range of habitats available, combined with the lowland climate, provide excellent conditions for several invasive plant species. The most visible of these are probably aquatic weeds such as *Lagarosiphon major* and two species of waterlily that foul boat propellers, the abundant blackberry that borders nearly every picnic spot, and huge number of wildling pines that pepper the landscape, many ending up as decaying trunks in adjacent waterways.

Wetland ecosystems

In pre-European times, wetlands would have been both a major part of the environment and a food source of considerable value to Maori. The higher fertility of the peat soils created in the swamp environment induced settlers to drain the easier wetlands and convert them to pasture. Although unfortunately no comparative figures are available, we now know that a total wetland area of only about 1090 ha remains in the whole district (Leathwick *et al.* 1995). Of this total, most is contained within the extensive Kapenga swamp in the very north, the remainder comprising small wetlands mostly retained within the boundaries of exotic forests.

The future security of these latter areas depends entirely on the good will of two major forestry companies, Carter Holt Harvey Ltd and Fletcher Challenge Forests. In recent times there has been an upsurge in awareness of the enormous value of natural wetlands, for maintenance of water quality and provision of habitat for the wide range of plant, bird, and insect species that totally depend on them. Vaile (1939) recorded that before the draining and cultivation of the Reporoa Basin, the Torepatutahi Stream and other watercourses did not vary in flow more than about a foot (40 cm) throughout the year, floods being almost unknown.

River ecosystems

Second only to volcanic influence, the river system is a most important landscape-shaping feature of the district. Soon after leaving Lake Taupo, the Waikato River becomes confined between steep cliffs of silicified sediments before plummeting 20 m over the Huka Falls. For some 6 km downstream, to below the hydro-controlled Aratiatia Rapids, the Department of Conservation maintains a series of walkways and lookout points for the use of the huge tourist traffic through the area. Over many years, and by many well intentioned agencies, a wide range of both indigenous and exotic plant species have been established here. Many are of local provenance and can only enhance the value of the reserve. Others, however, are exotics with a record as serious invasive pests overseas (e.g. *Rhododendron*, especially *R. ponticum* - see Cronk & Fuller 1995), and some are indigenous to other districts of New Zealand (e.g. *Nothofagus fusca* and *N. menziesii*); their establishment threatens the botanical integrity of the local vegetation.

Smaller rivers and streams, many originating as crystal-clear springs from the surrounding hills, feed this Waikato system. The wide range of inhabiting aquatic insects provide a rich food source for the freshwater crayfish, native fishes, and the much sought after rainbow and brown trout that attract visitors from around

the world. Maintenance of water quality is fundamental to the survival of this complex and valuable resource.

2.3 Bioclimatic zones

2.3.1 Lowland

By far the majority of the district lies in this zone, within the altitudinal range of 250-700 m. This is equivalent to the warm temperate zone of Meurk (1984). When native forest was extensive rimu, a tall podocarp, demarcated the upper limit of the zone. The climatic range is such that the middle of the district, near Orakeikorako, is the southern inland boundary of mangeao (*Litsea calicaris*), and similarly appears to be the northern limit of the very hardy *Olearia virgata*, a species represented in only a couple of small 'frost flat' remnants.

2.3.2 Sub-montane - montane

In the sub-montane to montane zone, from 700 m to the highest point of the Paeroa Range at 979 m, the rimu of the lowland zone is replaced by Hall's totara. Equivalent to the cool temperate zone of Meurk (1984), this small area is insufficient to support a true montane vegetation, and consequently typical montane plants appear only sporadically, e.g., *Cordyline indivisa* and *Leptopteris superba*. Severe modification, usually by logging and fire followed by an influx of deer and possums has significantly altered much of this upland forest.

2.4 Climate

In common with most of the eastern part of New Zealand the district depends largely for its rainfall on northerly airstreams, making for considerable seasonal variation. Maximum monthly falls occur during May to August, and driest conditions between November and February. On average there are about 120 rain days per year; total annual rainfalls vary from 1100 mm to 2000 mm over most of the district, with peaks of 2400 mm on the Paeroa Range and the southern Mamaku Plateau (Quayle 1984).

Droughts (defined as 15 days without rain) occur in most years, especially in the Reporoa Basin, and dry spells (defined as 15 days with less than 1 mm on any day) occur on average twice per year.

Thunderstorms are frequent in summer, and hail in winter; both are more likely on higher ground. Snowfalls are infrequent, varying from perhaps one per year in the south of the district to one every three years in the north.

The prevailing windflow is southwesterly, but northeasterly, westerly and southerly winds are also quite common. Spring and summer are the windiest seasons, although the variation is not large, perhaps about 20%. There is some effect from adiabatic 'sea breezes' inland during summer afternoons, but clear nights usually have little or no wind.

The mean daily temperatures recorded at Broadlands, in the Reporoa Basin, vary from 5.9°C in July to 17.5°C in February; sunshine throughout the district is about 1900 hours annually. The severity and frequency of ground frosts vary throughout, ranging from 50 to 100 per year, and are highly dependent on local effects such as cold air 'ponding' and the shelter of exotic plantations.

Fogs are common, particularly the 'steaming fogs' emanating from lakes and rivers, and of course the intense local fogs produced by geothermal features under appropriate conditions.

2.5 Geothermal features

Introduction

The Atiamuri Ecological District, Taupo District, and Tongariro Ecological Region to the south and the Rotorua and Te Teko districts to the north contain nearly all New Zealand's high-temperature, often large geothermal fields (GFs). GFs of this district also contain some of those most severely modified by human activity in New Zealand (Glover 1977; Lloyd 1972).

Most GFs have been studied for geothermal power production potential, and summaries of each field, together with bibliographies of work published, are given by Mongillo & Clelland (1984) and by Cody & Christie (1992). Grange (1937) gives thorough descriptions of many GFs before the widespread impacts of developments since the 1950s.

Types of geothermal feature

Surface geothermal activity can be grouped into four major types according to heating systems, fluid chemistry, and groundwater levels.

- (1.) Deep and largely undiluted geothermal waters, typically depositing sinters around their surface vents and outflows; clear waters, alkaline, often very hot to boiling. The least common geothermal feature.
- (2.) Weaker upflows of geothermal waters, diluted by varying amounts of groundwater mixing, usually warm to hot (rarely boiling), neutral to weakly acidic, sometimes turbid, rarely depositing sinter. May also be further heated by additional steam and gas entering diluted geothermal fluids. Common.
- (3.) Surface groundwaters heated solely by steam and gas, producing very acidic conditions, so that surface materials are actively decomposed. Such features can be boiling, and are typically muddy and turbid owing to breakdown of surrounding ground margins. Common in most geothermal areas.

- (4.) Where little or no groundwater is available, hot, barren, and intensely altered ground results, with any vegetation consequently stressed and modified owing to very acid or leached soils or even absence of soils. These conditions are very common in nearly all GFs, and generally contain individual geothermal features (IGFs) of only local significance. Very rarely an open vent may discharge superheated steam and gases; it is then called a fumarole.

Geysers

These are the most rare and ephemeral of all natural geothermal features worldwide. There has also been an accelerating worldwide trend towards their extinction owing to exploitation of their geothermal reservoirs. In the early 1950s New Zealand had about 180 active geysers, perhaps 170 of them within this district. However, by the early 1980s only about 40 remained of which 30 are in the Atiamuri Ecological District. This wholesale destruction of geysers and alkaline flowing hot springs is well documented for both New Zealand and overseas GFs in numerous scientific publications (Lloyd 1972; Glover 1977; Bryan 1995).

Recent geothermal history

Exploitation of a GF generally involves removal of fluids (i.e. mass), which in turn rapidly reduces pressures within it. An early response is cessation of geyser activity and overflow from alkaline springs, often within a few months or years. Pressure drops of ~0.5-1 bars (or drops of ~5-10 m in water level) are usually sufficient to stop all geysering and most flowing hot spring activity. After several years or decades increased boiling (due to lowered geothermal aquifer pressures) can cause surface areas of hot acid ground, or a great expansion of existing areas (e.g. Karapiti or 'Craters of the Moon'). Lowered pressures also commonly induce violent hydrothermal explosions, as have occurred in recent years at Tauhara and Karapiti (Scott & Cody 1982; Allis 1984; Mongillo & Allis 1988; Bromley & Mongillo 1994) and at Rotorua (Cody & Simpson 1985).

Wairakei, Taupo, Ohaaki-Broadlands, Rotokawa, and Orakeikorako GFs have been greatly altered since the 1950s by a man-made lake flooding Orakeikorako, geothermal power stations destroying all geysers and alkaline flowing springs at Wairakei and Ohaaki, and clearing of indigenous vegetation and drainage severely altering Waikite Valley, Reporoa, and Te Kopia GFs. However, several GFs have undergone only minor modification, and while future exploitation for power production is likely (e.g., at Reporoa, Rotokawa, Mokai, Ngatamariki, Tauhara-Taupo), GFs at Waiotapu, Waimangu, Waikite Valley, and Te Kopia are now relatively secure from geothermal power development (Hunt *et al.* 1994).

Most geothermal areas in the Atiamuri Ecological District are under varying degrees of threat from the usually more insidious effects of ongoing land-use activities such as farming, pine plantation development, and logging. Erosion and lowering of groundwater tables are consequences ultimately adversely modifying hot springs (e.g., Waikite Valley and Reporoa GFs). In the Wairakei GF no alkaline geothermal waters flow out at Karapiti, and of some 240 alkaline hot springs (including 70 geysers) present in Wairakei Geyser Valley in the early 1950s, not one remains today (Glover 1977). Wairakei GF is unique worldwide for the greatest known induced subsidence in any exploited reservoir (including oil, gas, water and geothermal

fields); about 15 m of ground subsidence and an aquifer pressure drop of ~14 bars have occurred since the 1950s (Allis & Barker 1982).

2.6 Soils

The soils of the district are divided into five major classes (Vucetich & Wells 1978). All are derived from volcanic debris, principally from Taupo Pumice in various forms, but some from older Late Pleistocene and Holocene ashes, in places mixed with small amounts of Taupo material.

Yellow-brown pumice soils and related steepland soils

This, the major soil group formed from Taupo Pumice, covers by far the largest land area within the district. Soils range from moderately to excessively drained, and are greatly influenced in their colour and character by the vegetation cover that existed before cultivation. Although these soils have excellent physical properties, for many decades a wasting disease of stock, known as ‘bush sickness’, led to only very limited success of pastoral farming and the widespread alternative of exotic forest plantation. In the 1930s the cause of ‘bush sickness’ was identified as a lack of the trace elements cobalt and selenium, and their addition to general fertilisers made possible the post-World War II conversion of most of the open land to farms.

Yellow-brown loams

These soils derived from Holocene tephra older than the Taupo series occur extensively in the western part of the district, and in pockets around Ngakuru and between Orakeikorako and Maroa. Generally on moderately steep slopes, they are liable to slump locally.

Organic soils

Formed in old swamps and lake beds from water-deposited pumice and decomposed organic materials (flax, rushes, manuka), these poorly drained soils are found extensively in the Reporoa Basin and in depressions and low-lying parts of the Whirinaki and Te Kopia districts.

Soils formed from ejecta from hydrothermal eruptions

Near Rainbow Mountain (Maungakakamea), around the Waiotapu Thermal Area, and in the Wairakei Valley at Taupo are soils derived from hydrothermal activity which generally contain heterogeneous assemblages of weathered rocks in a mud matrix, with little or no fresh pyroclastic material or complex mineral components.

Thermally altered soils

In the vicinity of geothermal activity, parent soil material is subject to decomposition by the action of heat

and water. When acidic vapours are dissolved in water from condensed steam and are deposited on the surrounding cooler terrain, intense leaching of bases, formation of kaolin clays, and deposition of silica take place. The end products are usually fine red or grey clays that support a distinctive but restricted range of vegetation.

2.7 Vegetation history

There are few records of the district in early European times, but two good accounts date from the last quarter of the 19th century. In the first of these, the botanist Thomas Kirk (1872) describes the botany of the most outstanding features of the district, particularly the geothermal areas of the Waikite Valley, Paeroa Range, and Orakeikorako. He apparently did not visit the Wairakei Valley although he was at Taupo, as mention is made of *Cyclosorus interruptus* (as *Nephrodium unitum*) at Waipahihi being at the southern limit of its distribution. Kirk also describes briefly the composition of the podocarp forest at Oruanui and mentions a few species present on the otherwise sparsely vegetated pumice plains he crossed.

In 1882 J.H. Kerry-Nicholls passed through the region on a 600 mile journey on horseback. Starting from Tauranga, travelling down the eastern side of Lake Taupo and around the central volcanoes, he passed around Mt. Ruapehu to the south and returned to the Waikato via the west side of Taupo and then into the Waipa Valley. His is a more readable story, with excellent illustrations, but unfortunately he does not define the places from which he made his quite extensive botanical collection. His description, however, of the track from “Atea-Amuri”, where he and his sole companion crossed the Waikato, to Oruanui - following almost exactly the line of the present State Highway 1 - sums up perfectly the impressions of all the travellers of the period.

“Pumice, pumice, nothing but pumice, rolled away as far as the eye could discern, now stretching out in a broad and flat expanse, now rising in the form of hillocks, now towering high in the shape of conical mountains [*sic*], now winding away in deep ravines - white, bare, and sterile as a boundless desert, save when the stunted tussock grass struggled, as if it were for life, with enormous stones and boulders fashioned from the white, porous rock, or where a crystal stream shaped its devious course beneath a dense growth of broadleaved flax and waving toe-toe grass” (Kerry-Nicholls 1884).

The landscape described by Kerry-Nicholls was an outcome of repeated wildfires during the 600 or so years of Maori occupation until the late 1800s. Frequent mention is made of the effects of these fires, lit to keep tracks open, to promote the growth of bracken fern (*Pteridium esculentum*) for its edible rhizome, or to clear patches of forest for planting after the introduction of the potato (Bidwell 1841; Vaile 1939; Nicholls 1964). The exceptionally violent final phase of the ca AD 180 Taupo eruptions (Wilson 1993) utterly destroyed the indigenous forest of the time over the whole district, except perhaps for patchy survival on high lee slopes towards the northern limits. Clarkson *et al.* (1986) have shown that tall forest had returned to the Hauhangaroa Range, west of Lake Taupo but no further from the eruption source than Maroa and Reporoa, by about 1300 years ago.

Within this landscape the geothermal areas stood out like oases. To the Maori they were congenial living areas warm, although infertile places from which they could hunt for birds or fish in the adjacent rivers, and logically the tracks of the day connected them with their food- gathering areas. These unique habitats, standing in isolation, were colonised first by airborne spores of species adapted to the geothermal environment. A rich flora of primitive spore-bearing plants - algae, lichens, fern allies, and of course the tropical ferns - established readily without the competition of higher plants. In due course seeds of the latter carried by wind, water, and birds established in the humus established by the earlier arrivals, then propagated until restricted by the constraints of temperature, acidity, and soil fertility. A characteristic vegetation pattern evolved in geothermal zones, with a limited range of species, each occupying its own particular niche but always at the mercy of changes in the level of thermal activity. Unfortunately, this well balanced indigenous vegetation has been upset by the recent arrival of two invaders, pines (*Pinus* spp.) and blackberry (*Rubus fruticosus* agg.). Both of these thrive in the poor soils of the district, and are also highly tolerant of elevated ground temperature, pine even more so than blackberry.

The vegetation of the district suffered little from European influence until the turn of the century, although it is interesting to note that by the time of Kirk's visit there was an extensive range of exotic weeds at Rotorua, which he lists, although no mention is made of any weeds within the Atiamuri Ecological District. By the early 1900s the situation had changed considerably. Vaile (1939) lists many introduced plants, but states that in 1908, when there were only two blackberry plants in the district, the fruit was so popular that the owner of one of these distributed it widely so that others could enjoy it.

A reconstruction of the vegetation as at 1840 (Leathwick *et al.* 1995 - see Appendix 8) indicates that approximately 8.9% of the district was in forest, 90% in scrub and fern and tussock, and the remaining 1.1% either aquatic or bare pumice. From that time to the present the combined effects of timber milling, land clearance, drainage, and fires have modified the district so greatly that now less than 7% of that original vegetation remains.

2.8 Wildlife history

Early European accounts of the district record the presence, and use by the Maori, of the native trout (kokopu), the inanga or whitebait (*Galaxias* sp), and eels in the streams and rivers. The freshwater mussel, or kakahi (*Hydrilla* sp), and the koura or freshwater crayfish (*Paranephrops* sp) were also gathered for food. Later the introduced rainbow and brown trout, as well as char, rudd, and goldfish, brought about significant changes to the balance of aquatic animals (McDowall 1990).

An extensive range of bird species was present, and bird snaring areas were important tribal resources, used on a seasonal basis. In the latter part of the nineteenth century game birds such as black swans, geese, quail, and pheasants were introduced, and became popular with Maori as well as Pakeha (Vaile 1939). Shooting became an additional tourist attraction, and was included in advertisements of the district's amenities (Allen 1894).

The native bats were present but rarely seen, and little is known of their distribution, although a large colony of long-tailed bats (*Chalinolobus tuberculatus*) was known to inhabit the cave at Orakeikorako in 1938

(Powell 1951), and this species is still present in the area. Bats were also reported from the Broadlands area by Vaile, although the species was not determined. Recent work on the bat-pollinated root parasite *Dactylanthus taylorii* (Ecroyd 1993, 1995) has raised awareness of the less common short-tailed bat (*Mystacina tuberculata*), and colonies may soon be located with ultrasonic detection equipment.

Brown skinks (*Cyclodon pseudornata*) were originally common (Vaile 1939). However, as throughout mainland New Zealand, the arrival of first the black rat (*Rattus rattus rattus*) and later the Norwegian or brown rat (*Rattus norvegicus*) decimated the population, which appears to have co-existed with the earlier introduced Polynesian rat or kiore (*Rattus exulans*). One recent report of the spotted skink (*Leiopisma infrapunctatum*) from the Wairakei area (Dept of Conservation, SSWI Database), and a 1995 sighting (yet to be confirmed) from the Reporoa district, are the only skink records. Geckos were always uncommon, and there are few modern records, the latest - in 1950 (see McCann 1955 and SSWI database) - being of the green gecko *Naultinus elegans elegans*. As with many uncommon plants and animals, sightings seem to be reported only when observers with specialist knowledge are working in the area.

The arrival of the first settlers brought a wave of mammal introductions. Many became prolific pests, so that by the turn of the century there were feral horses, cattle, dogs, pigs, hares, rabbits, stoats, weasels, cats, and mice (Vaile 1939), all playing an active part in the destruction of indigenous flora and fauna.

More recently, deliberate releases of deer, goats, wallabies, and possums have added to the deterioration of the few native forest remnants. Red deer (*Cervus elaphus*) occur in several isolated pockets, and were encountered during the survey. Local hunting is reasonably effective in keeping their numbers within acceptable levels. A greater threat is the release by disenchanted farmers of domestic goats (*Capra hircus*) into regenerating forest areas; they open up the undergrowth and so facilitate the spread of the Australian brush-tailed possum (*Trichosurus vulpecula*). As well as causing dieback or death of rata (*Metrosideros robusta*), mistletoe (*Ileostylus micranthus*), wood rose (*Dactylanthus taylorii*), and many more common plant species, the possum is a major vector in the spread of bovine tuberculosis.

3. Methodology

3.1 Field survey

The methodology used in the survey follows Myers *et al.* (1987).

Owing to the limited time between the letting of the contract for this survey and the requirement to commence field work during the summer months of 1994/95, the Phase 1 period, defined by Myers *et al.* (1987), was considerably curtailed. The boundaries of the district, and of existing reserves and covenants, were established on maps of the NZMS 260 series provided by the three Department of Conservation

conservancies partly included within the Atiamuri Ecological District. A complete set of relatively recent (March 1993) aerial photographs was supplied, some annotated to suggest areas of interest.

Valuable information in the form of maps and descriptions from earlier surveys was provided from the files of Landcare Research, Hamilton and the New Zealand Forest Research Institute, Rotorua, and thorough searches of the Department of Conservation databases by staff at Rotorua Conservancy office.

It was decided to briefly examine those reserves for which information was already available, both to verify that previous records were still valid and to complete those portions of the field survey report that would not have been considered in the earlier studies. This also meant that rankings obtained for later analysis were in a compatible format, and would be comparable across the whole range of study areas. The minimum study area was considered to be about 10 ha, except for areas of special interest such as geothermal features, wetlands, or 'frost flat' remnants, where much smaller areas were considered.

As geothermal areas are such a feature of the district, Ashley D. Cody (geothermal consultant) contracted to provide a report on these, and to instruct the botanists on the survey team on safety precautions.

Records were obtained from the herbaria of the Forest Research Institute (NZFRI), Landcare Research, Lincoln (CHR), and Waikato University, Hamilton (WAIK) to confirm the locations of rare plants reported from the district and to assist eventual compilation of a district species list.

Initially it was expected that the survey would cover some 50 to 60 areas; in the event 80 study areas were included, although data from some of these is minimal as they are of interest only for geothermal features.

All records from the survey, including field notes and species lists, were entered into a Paradox™ database to facilitate later analysis and compilation of this report.

3.2 Evaluation

Evaluation of data by computer analysis was undertaken to establish a set of ranking values for study areas. Several methods were tried, all giving usable results. However, it was established that a relatively simple calculation obtained by assigning numerical values to the following criteria produced ranking values that were generally in accord with the subjective perceptions of the field team.

(1.) Values relating to 'representativeness' or ecological values (see Myers *et al.* 1987):

- (a) representativeness
- (b) diversity and pattern
- (c) rarity or special features
- (d) naturalness
- (e) long-term viability
- (f) size and shape

- (g) fragility and threat
- (h) buffering and surrounding landscape

These are all positive values, ranked on a Low - Medium - High basis in the field, and therefore scaled 1 - 2 - 3, except for variable (g), for which the scaling must be reversed.

(2.) Values relating to threats or damage from outside influences;

- (a) grazing
- (b) weeds
- (c) wild animals
- (d) drainage
- (e) erosion
- (f) fire
- (g) clearance
- (h) topdressing

In the field, rankings were assigned as Nil-Low-Medium-High, so a scaling of 0-3 gives a value to the negative influences within the study area.

Obviously, summing the factors in group (1) and subtracting the factors in group (2) gives a score which can be used to sort study areas into rankings for evaluation. Initially this was done for all areas together, in order to test the validity of the method. Finally those areas not already protected were considered separately, to facilitate selection of Recommended Areas for Protection.

The final variable brought into the equation was the term 'other values', used by Myers to include such considerations as "landscape, cultural, recreational, educational, economic, historical, spiritual or other values". This variable was included in the final sorted table to alert readers to the existence of factors perhaps not immediately apparent in the choice of areas recommended for protection. The field assessment of Low-Medium-High was numerically scaled 1-3, although the occasional area achieved a symbolic zero.

Finally the rankings were checked to ensure that a representative sample of the ecological units defined were included as Recommended Areas for Protection.

4. Results

4.1 Survey data

The study area field cards, and a full copy of the relevant Paradox database, are lodged at Landcare

Research, Hamilton. A full set of computer-printed duplicates of all study area cards and species lists is held at the Department of Conservation conservancy offices at Turangi and Rotorua.

4.2 Vegetation pattern

The native vegetation of the district has been severely depleted. Analysis of the present-day vegetation cover shows that only 6.9%, or 15 334 hectares of combined forest or scrub and shrublands remain, most of that contained in a few large discrete blocks such as on the Paeroa Range and in the Matahana Ecological Reserve.

These remnants have all been logged for their podocarps, and have thus changed considerably in structure. In some areas, Tumunui Bush for instance, the removal of podocarps was so complete that no seed trees remain and no regeneration of these species has occurred to date. In other areas, such as Tutukau Block, old and defective matai (*Prumnopitys taxifolia*) were not removed and hence supply a prolific seed source, which has altered the balance of regeneration towards a matai-dominated succession.

In most areas where fires followed logging the succession has been towards a rewarewa/kamahi community, which in many places has become static owing to the effects of browsing and grazing. In some blocks there is a complete absence of understorey, with only unpalatable fern species, or at higher levels horopito (*Pseudowintera colorata*), becoming established. In those places where fences are adequate, or the terrain is too steep to allow animals access, there is a lush fern flora and a diverse range of other understorey plants. Good examples are on the Horohoro Bluff in the Rotorua Conservancy and alongside the Mangakowhiriwhiri Stream in the Taupo Conservancy. The latter already shows the value of the goat culling which has been undertaken.

No good examples of the monoao-manuka-fern scrubland that preceded land clearance were found. Small residual patches in a couple of gullies gave some idea of their appearance, but nothing to compare with the horizon-to-horizon effect of “endless” plains that were present even as late as the 1950s. Small remnants of ‘frost flat’ vegetation were found south of the Waikato River; these produced a range of species that previously would have been common but are now rare.

The alluvial plains and terraces of the Reporoa Basin have probably been modified most of all. The extensive scrubland and patches of totara (*Podocarpus totara*) that Vaile (1939) describes are all gone, replaced with exotic grasses and, in untended corners, with blackberry. The present trees are almost entirely exotic, and wildling pines are common. The white-flowered shrub *Olearia virgata*, which Vaile described as common amongst the manuka, has all but disappeared; in fact only a few plants were found in the entire district. Similarly, only a few kowhai (*Sophora tetraptera*) now occur in protected places along waterways. Wetlands in the district are in poor condition, except for those within the exotic forest boundaries where they are protected from grazing animals. One exception is a unique flax swamp off Oruanui Road (study area No. 35), which is in remarkably good condition and deserves total protection. This is the only remaining example of what must have been a very common vegetation type. Although no particularly rare plant species were found, it nevertheless supports a wide variety of bird species and is readily accessible.

The aquatic vegetation of the Waikato River above the hydro lakes is strongly influenced by the daily fluctuations of water flow, under the control of Electricorp (Howard-Williams 1989). The effect of this is a reduction of species to those able to cope with these unnatural conditions. In the lakes themselves a range of predominantly introduced aquatic plants flourish, in some seasons also supporting the recently introduced water-net (*Hydrodictyon reticulatum*), spread by both waterfowl and boats coming from infected areas. The riparian strips contain a vigorously regenerating flora, dominated by kohuhu (*Pittosporum tenuifolium*) and five finger (*Pseudopanax arboreus*), but containing a wealth of other species subject to local influences such as soil type and water table. Unfortunately the presence of spreading wildling pines is a problem; however, the damage caused when they are extracted by contractors appears to far exceed the improvement gained by their removal. Although recognised as being labour-intensive, poisoning or ring-barking and allowing their natural collapse would appear to be a far better solution. Examination of areas along the northern edge of Lake Ohakuri that have recently had pines extracted showed a worrying increase in the number of adventive weeds, especially gorse, Spanish heath, and new pine seedlings. Officers of the Department of Conservation are aware of these problems, and field trials are being carried out to compare the effects of various cutting and poisoning regimes (G. Pardy, pers. comm).

The geothermal vegetation is similarly threatened. In a few areas, such as Te Kopia, parts of Orakeikorako, Waioapu, and Maungakakamea, the thermal vegetation is in excellent condition, subject only to the threats of natural geothermal changes and inadvertent human interference. In other areas, however, there are problems - almost all anthropogenic - with weeds such as blackberry and pines, rubbish dumping, grazing, and probably worst of all the effects of logging. In some places, despite contrary recommendations by botanists over several decades, logging machines continue to devastate the fragile ecology of these unique reserves (Ngatamariki Scenic Reserve, Waihunuhunu covenant area, and others). To the survey team this seemed to be even more unacceptable where it was being carried out with the connivance of the Department of Conservation.

Some geothermal areas have surrounds with little or no floral or faunal value remaining. However, some of these areas are still highly significant to science, and although locally and regionally numerous are nationally rare examples of natural thermal features. Some are significant because of their location relative to geological structures and volcanic centres, yet are surrounded by highly modified vegetation, e.g., Waipupamahana, Horohoro, Atiamuri hot springs, Whangairorohea, Opaheke, and Golden Springs.

Micro-ecosystems within hot spring outflows may be more diverse and rich in species numbers than previously identified. At several sites abundant algal mats in spring outflows have conspicuous and locally abundant populations of flies, with worms or larvae visible. Whether these are merely adventive fauna or local endemics is unknown. Similarly, thermophilic algae and diatoms present in most spring outflows are largely unstudied, and in some places apparently unique forms occur. One example, the spring on Loughnane's farm (Matapan Road, Atiamuri) has a fawn-coloured rubbery growth within the hot outflow zone; and at Ohineariki bath (Mokai) there is a white 'spider web' mass. Some individual samplings have been described from most geothermal features (Cassie-Cooper 1991), but no comprehensive systematic study has yet been made (Cody 1995).

4.3 Flora

4.3.1 General

Approximately 400 native vascular plant species were recorded during the survey. However, owing to the limited time (late November to early March) and the rapid survey techniques, few ephemerals such as ground orchids were seen. To collate a useful district species list, field records of this and previous surveys have been combined with herbarium records from the Forest Research Institute, Waikato University, Auckland Institute and Museum, and Landcare Research, Lincoln, to give a total of 453 species (Appendix 2).

The adventive vascular flora as listed comprises 245 species (Appendix 3), but further species will no doubt be added in future. An effort was made to voucher interesting specimens, but this required considerable time, and much remains to be done.

4.3.2 Rare and endangered plants and distributional limits

(See Cameron *et al.* 1995 for explanations of Threat categories.)

The occurrence of several species of ferns and fern allies of tropical affiliation is noteworthy. Some achieve their southernmost limit between Waikite Valley thermal area and Lake Taupo.

Thelypteris confluens, or marsh fern, occurs in large coastal swamplands in Northland and the Bay of Plenty, and also in Australia and South Africa (Wilson & Given 1989). It is present in small numbers in a few geothermal areas as far south as the Waikite Wildlife Management Area, where it is at its southern limit. Although previously listed as Vulnerable, its status has now been reduced to Rare (Cameron *et al.* 1995), as more locations have been found.

Cyclosorus interruptus, a common Pacific Island species (classified as Rare in New Zealand) present at geothermal sites from Waiotapu to Orakeikorako also occurs at Wairakei and has its southern limit at Taupo Spa (Given 1976).

The thermal sword fern (*Nephrolepis* sp. cf. *cordifolia*) was previously classified as Local but is known to occur in numbers and is no longer listed. It is abundant at Waikite Valley, Waihunuhunu Springs thermal reserve, and Upper Atiamuri thermal area, is present in the Wairakei geothermal field, and reaches its southern limit at the Taupo Spa (Given 1976).

The thermal species of *Christella* (determined by A.C. Davidson, University of Auckland as *Christella dentata* var. *caespitosa*) present also in the Kermadec Islands, is another tropical species. This fern is abundant at several sites from Waikite Valley to Wairakei, and its southern limit is at the Waipahihi Stream just south of the district boundary (Given 1976). Previously listed as Local in the N.Z. Threatened Plant

List, it is now considered Endangered (*Christella dentata* 'N.Z.' - Cameron *et al.* 1995).

Populations of both *Christella* and *Nephrolepis* have been surveyed recently in the Tauhara Geothermal Field by staff of Landcare Research, and indications are that plant numbers have decreased or become extinct in some locations. Although recent unpublished opinions have suggested that the New Zealand taxa may be identical with more widespread common species from the tropical Pacific, they are nonetheless uncommon on the New Zealand mainland. Considering the unstable and changing environment of the thermal areas, and the limited habitat of these species, it is suggested that *Nephrolepis* sp cf. *cordifolia* should continue to be listed as 'Local'. Recommendations have been made for continued monitoring of known populations (Burns *et al.* 1995).

Dicranopteris linearis is another tropical fern previously classified as Rare, but now listed as Local. It is present at several sites in the district and is particularly abundant in the Te Kopia Scenic Reserve. It occurs as far south as the Kiriohineki Stream in the Wairakei thermal area.

Of particular interest is the root parasite *Dactylanthus taylorii*, or wood rose, the only member of an endemic genus. This endangered plant is found at several sites in the district, growing on various host plants from which it extracts its nutrients via a placenta-like attachment to the host root. The plant has been collected in the thousands in the past, for the curious flower-like structure that forms on the host root at the interface with the parasite. The combination of habitat destruction, collection, and browsing by possums seeking the nectar-rich flowers has led to a serious population decline, the plant becoming extinct in many places where it was formerly abundant. *Dactylanthus taylorii* is parasitic on the roots of about 30 species of native hardwood tree and shrub; broadleaf, five finger, kamahi, karamu, kohuhu, lemonwood, mamangi, pate, putaputaweta, and wineberry are all common hosts. Many of these species are seral and are abundant on forest margins; hence one of the most common sites for *Dactylanthus* is in old fire- induced vegetation at the edge of tall forest (Ecroyd 1995).

The endemic climbing fern *Lygodium articulatum* may reach its southern limit in the district, and the small alpine heath *Epacris alpina* reaches its northern limit on Horohoro Bluff.

Also in the district is an unusual fern, pillwort (*Pilularia novae-zelandiae*), a small aquatic plant which occurs in the Waikato River in the vicinity of the Aratiatia Rapids, just outside the reserve area. It is probably quite widespread, but is inconspicuous and easily overlooked.

The fern ally *Lycopodium cernuum*, a clubmoss common in thermal areas, has a discontinuous distribution, reaching as far south as Taupo in the North Island then reappearing in warm coastal parts of the northern South Island. Another fascinating fern ally *Psilotum nudum* is present at several thermal areas as far south as Wairakei, with unconfirmed reports from Tokaanu and Ketetahi Springs (Given 1976). Sharing a somewhat similar distribution is the giant hypolepis, *Hypolepis dicksonioides* which is also present on several Pacific islands (Brownsey & Smith-Dodsworth 1989).

One fern record that has been consistently requoted by various authors is that of *Ophioglossum petiolatum*,

an endangered species. This record has been traced to a voucher at WELT collected by W.R.B. Oliver in 1917 but which has not yet been examined. It is considered doubtful that this species would occur south of the Auckland area (D.R. Given, pers. comm.).

The rush *Fimbristylis velata* (syn. *F. squarrosa*), considered by some to be an introduced species, was first reported by Kirk from Otamakokore. It has been reported by P. de Lange from the Wairakei geothermal area, at probably its present southern limit.

The Atiamuri Ecological District supports an extensive orchid flora, the thermally altered poor soils of the geothermal areas being particularly suited to some of the ground orchids. Worthy of note here are *Calochilus robertsonii* and *C. paludosus*, reported from Te Kopia and Rainbow Mountain Scenic Reserves, *Caladenia iridescens* also from Rainbow Mountain, and two early records from Te Kopia of *Prasophyllum* sp. aff. *patens* and *Pterostylis micromega*. The status of all these species is indicated in Appendix 1. The recent discovery at Te Kopia of the perching orchid *Drymoanthus flavus* brings a new northern limit to its unusual discontinuous distribution (Ecroyd 1994).

Recently two colonies of the indigenous stinging nettle *Urtica linearifolia* were discovered in the district, establishing a new northern limit for this species (Beadel 1995).

Mention has been made of the presence of mangeao (*Litsea calicaris*), a forest tree of predominantly tropical affinities (Australia, Indonesia, New Guinea). It was previously considered to reach its southern limit in the district at Maleme Road and Puaiti scenic reserves and on the Paeroa Range (J. Nicholls pers. comm.). Trees of up to 1.3 m d.b.h. were found in the heavily logged Tutukau Block, 8 km further southwest and across the Waikato River.

4.3.3 Old records and species extinct in the district.

There are records of a few species that have not been seen for many years, or possible misidentifications which are unverifiable unless a voucher can be located. Dobbie (1951) contains an illustration of *Hymenophyllum minimum* (as *Meringium*), giving the location as Atiamuri, near Rotorua. There seems no reason to doubt this record; however the species has not been reported from there in recent years. Similarly Allan (1961) gives a location for *Mazus radicans* as "near Rotorua", and it has been suggested that that record referred to the Kapenga Swamp. It would certainly be an appropriate habitat, and there is little reason to doubt that the species could have occurred there.

Kirk (1872) has several records of species that are no longer present or have yet to be rediscovered. From the Otamakokore Stream in the Waikite Valley he recorded *Gunnera prorepens*, which has not been noted since - hardly surprising, considering the substantial disruption to habitat that has occurred in the meantime. His record of *Raoulia hectori* from the pumice flats of the Mokai area probably referred to a still unnamed species, *Raoulia* sp. aff. *australis* (Druce 1980), that is still found on the Kaingaroa Plateau, and would have been common in similar habitats in earlier times.

Senecio lautus, also described from Mokai, and again not recently recorded, is predominantly a coastal species (Webb *et al.* 1988), yet considering the unusual number of plants of tropical and coastal affinities growing in the geothermal regions there seems little reason to doubt Kirk's record. The small rush *Isolepis aucklandica*, which Kirk located "about one mile east of Otumakokori ; altitude 1,500 feet" would have to have been somewhere on the Paeroa Range. In 1872 that would have been an appropriate location, and it may yet be rediscovered there.

Kirk's record of *Muehlenbeckia axillaris* has not been repeated. However, in 1872 the cold, bare 'frost flats' of the Mokai district would have been a suitable habitat, and the species probably was present but is now extinct in the district.

The northern endemic fern *Asplenium lamprophyllum* was collected by K.W. Allison from the base of the Paeroa Range "near Waiotapu" in 1920 (CHR 290567), but has not been seen recently.

4.4 Wildlife

Birds

Sixty bird species occur permanently or regularly in the Atiamuri Ecological District, and a majority (37 species) are native (Appendix 5). Forty-nine of these species were confirmed during the 1994-95 PNA survey. Other records came from the New Zealand bird distribution atlas (Bull *et al.* 1985), from a 1989 review of wildlife habitats in the Bay of Plenty region (Rasch 1989), or from notebooks of local ornithologists.

The species distribution reflects the habitats available in the district, especially the large areas of pasture and exotic forest, as well as smaller areas of logged native forest. There are also diverse waters and wetlands: some small natural lakes (Ngahewa, Tutaeinanga, Ngapouri), two large impoundments of the Waikato River (Lakes Ohakuri and Whakamaru), the faster-flowing upper section of the Waikato River below Taupo, and some substantial swamps (Kapenga swamp, Bryce Road swamp) and many smaller ones.

The conservation status of bird species in New Zealand is classified on an international (IUCN) basis in Collar *et al.* (1994), nationally in Bell (1986), and prioritised for Department of Conservation action - using criteria of taxonomic distinctiveness, demography, threats, vulnerability, and cultural value - in Molloy & Davis (1990), although the true status of many species, such as kakariki, is still being determined. Nine species present in Atiamuri Ecological District are listed by at least one of these authors, marking them to be of conservation significance.

Dabchicks (endangered, Collar *et al.*; category B, Molloy & Davis; threatened, Bell) occur in small numbers (total about 10) on lakes Ngahewa, Tutaeinanga, and Ngapouri, although virtually absent from the Waikato River, perhaps because it is generally too deep and has too much flow. Bitterns (endangered, Collar *et al.*; categories I and O, Molloy & Davis; threatened, Bell) are rare in the district; one was seen during the survey

in the Waihunuhunu inlet of Lake Ohakuri. Fernbirds (regionally threatened, Bell) are, however, widespread and abundant in their preferred habitats, which include the many small wetlands in gullies of major pine forests. New Zealand's largest tern, the Caspian (categories I and O, Molloy & Davis; threatened, Bell) is a rare visitor to the district, usually in the winter when individuals may be seen roosting beside or feeding on the Waikato River.

Of open-country species, both banded dotterels (category C, Molloy & Davis; threatened, Bell) and New Zealand falcons (category B, Molloy & Davis; threatened, Bell) are rare breeders in the district. Banded dotterels breed on geothermal sinter flats adjacent to Lake Rotokawa, and a falcon pair (or pairs) were seen over several days during this survey, above the Mokai Plateau near Poihipi Road.

Many endangered forest bird species such as kiwi, kaka, and kokako are now absent from the district, probably because there are no large, unlogged and predator-free tracts of primary forest remaining. Kereru (category B, Molloy & Davis) occur in remaining native forest remnants such as Te Kopia Scenic Reserve. One kakariki (category C, Molloy & Davis) was noted in this survey in Waikorapa Bush (U16 013181) between Earthquake Flat Road and Tumunui Bush. There is unlikely to be a viable population there. One North Island robin (regionally threatened, Bell) was noted (U17 784015) near the Hauwai Stream, a tributary of Lake Ohakuri. The record of a rifleman (T17 658878, this survey) adjacent to Poihipi Road is also significant, since this bird is rare in the district (John Innes, pers. comm.).

Amphibians

Two species of introduced Australian frog are present, the golden bell frog (*Litoria aurea*) and the green tree frog (*Litoria raniformis*), but no records exist of any of the indigenous species (SSWI).

Invertebrates

The records of land snails for the Atiamuri Ecological District (Appendix 6) show a restricted species diversity, possibly, as with the reptilian fauna and freshwater fishes, owing to the catastrophic effects of the Taupo eruptions. Many of these land snails (such as the Australasia-wide *Pasmaditta jungermanniae*) have a widespread distribution, and a few are more limited (Pauline Mayhill, pers. comm.). *Mocella accelerata* is not often collected; records show it from the mid north to approximately latitude 38.5 °S. *Fectola mira* is at its southern limit in the district. *Phenacohelix rustictus* has a limited distribution from the Mamaku Plateau to Mt Taranaki (Egmont), with one isolated record from Foxton.

Phrixgnathus brunneus, a central North Island endemic snail, is “very beautiful” (Pauline Mayhill's words) but not common. The paua slug *Schizoglossa novoseelandica* (a slug with an external shell) is found in the central North Island in areas with good rainfall or with moisture throughout the year. Two species of introduced slug were seen but not identified.

5. Opportunities for Protection

5.1 Existing Protected Natural Areas

5.1.1 Representativeness

It becomes immediately apparent when comparing what is known of 1840s vegetation against the current scenario that except in a couple of rare instances, it would be impossible to achieve the suggested figure of 10% representation (Kelly 1980) of any of the formerly common landscape or vegetation types. Approximately 9000 ha, or 4% of the district, is in reserves, protective covenants, or stewardship areas; however, over 6000 ha of this is contained in the Paeroa Range-Te Kopia reserves and the Matahana Ecological Area of the Horohoro Forest. Of the other 3000 ha only a little over 2000 ha has reserve status, the remainder being in landowner covenants of various types. This then means that virtually all study areas would come within the requirement to be recommended for protection, although realistically many of these areas are so degraded that economic and management criteria would place them on a very low priority. This factor has been considered in the ranking of RAPs.

Well represented are mixed podocarp-beech forest of the Mamaku Plateau in the Matahana Ecological Reserve, and geothermal areas, although in some instances modified by tourist facilities. Remnants of the tall rimu-matai and totara forests of the Maroa and Oruanui areas are not present in any of the existing reserves, and the best possibility for preservation apparently depends on the continuing good will of Carter Holt Harvey Ltd regarding the small block off Kemp Road (RAP 2) in the Maroa forest.

Surprising also is that monoao-manuka-bracken scrub and fernlands, which occupied 90% of the district on the arrival of Europeans, could not be found anywhere in an area sufficient to warrant suggestion as an RAP. A small 'frost flat' remnant between the Maroa podocarp stand and SH 1 is probably the best example seen, and thus further enhances the value of RAP 2.

Not one reserve of a forest type is directly accessible to the public anywhere in the district. Both the Maleme Road and Puaiti reserves (Rotorua Conservancy) are reached by unmarked 'rights of way', which are not readily recognisable by visitors, and the Pakuri Scenic Reserve (Taupo Conservancy) can be reached only by crossing private land.

Wetlands are well represented in the study areas, and some are of considerable ecological value. The 10% criterion, if applied, would again mean that all remaining wetlands in the district are worthy of some consideration for protection. Some are of exceptional value and are ranked high in the list of recommended areas.

5.1.2 Security

Although apparently protected under various classifications, some reserves suffer badly from the effects of logging or grazing. Ngatamariki Scenic Reserve, was recommended in previous reports (Ecroyd 1979b) to be retired from logging, but has been cropped and replanted with pines in the immediate vicinity of the springs. This area is of high scientific interest, and is the site of ongoing geothermal studies by the University of Waikato, the Geothermal Institute, and Environment Waikato.

The Waikite Wildlife Management Reserve, although specifically commented on by Irving (1992) regarding stock damage, still has cattle reaching the fragile swamp vegetation, particularly the area in which the rare swamp fern *Thelypteris confluens* was reported. The fern was not found during the present survey.

The Waihunuhunu inlet, although under protective covenant, has had pines felled; it is to be hoped that they will not be replanted here. Owing to its high botanical and geothermal values this area is worthy of a much higher protection status; however, without some protective plantings of native species it is likely that blackberry will encroach rampantly.

5.1.3 Ranking

An approximate ranking of existing Protected Natural Areas within the Atiamuri Ecological District is shown in Table 1. Their locations are shown in Fig. 4, keyed to the ranking number. These rankings were obtained by the same computer evaluation process as described under Methodology (section 3) for RAPs.

Te Kopia Scenic Reserve has been given the top ranking, as it contains a unique assemblage of both botanical and geothermal features and has an altitudinal range exceeding that of any other thermal feature in the district. Similarly, Craters of the Moon and Rainbow Mountain, both thermal areas having different characteristics, are considered well placed at second and third. The Matahana Ecological Reserve in Horohoro Forest is of high value as a former forest on the south-east quarter of the Mamaku Plateau. There are extensive forest reserves in all other parts of the plateau. It is interesting, and reflects well the unique character of this district, that of the first ten protected areas six are geothermal, two forest, one wetland, and one a scenic riverside tourist area.

Table 1 Ranking of Protected Natural Areas

PNA No.	Study No.	Site name
1	23	Te Kopia Scenic Reserve
2	64	Craters of the Moon Scenic Reserve
3	18	Rainbow Mountain Scenic Reserve
4	25	Matahana Ecological Area (Horohoro Forest)
5	63	Upper Kiriohineki Stream Scenic Reserve
6	69	Waihunuhunu Stream covenant
7	7	Red Hills (Orakeikorako) covenant
8	21	Kapenga Swamp lease area
9	24	Paeroa Range
10	68	Huka Falls - Aratiatia Rapids Scenic Reserve
11	80	Waikite Thermal Reserve
12	53	Ivan Swan's Conservation Area
13	19	Maungaongaonga Scenic Reserve
14	62	Puaiti Scenic Reserve
15	16	Maleme Road Scenic Reserve
16	20	Waiotapu Scenic Reserve
17	47	Waipapa Trust Reserve (Maori land)
18	11	Waikite Wildlife Management Reserve
19	48	Tirohanga Scenic Reserve
20	3	Waikorapa Bush covenant
21	51	Kaahu Scenic Reserve
22	2	Tahunaatara Stream margins
23	27	Ngatamariki Scenic Reserve
24	81	Pakuri Scenic Reserve
25	4	Mangatete Stream covenant
26	17	Lake Ngahewa Recreation Reserve
27	5	Lake Ngapouri
28	6	Whirinaki Arm riparian covenant
29	12	Paeroa Scarp Thermal Area
30	14	Otamakokore Stream covenant
31	10	Lake Ohakuri riparian covenant
32	13	Longview Road Thermal Area
33	76	Golden Springs Council Reserve

PNA No. 1

TE KOPIA SCENIC RESERVE

Study area No. 23

Area: 1408 ha

Authority: Department of Conservation

NZMS 260: U17

Grid Ref.: 905057

Aerial photo: 232415

Physiographic unit: Geothermal

Bioclimatic zone: Lowland

Altitudinal range: 400-570 m

Ecological pattern

The area is graded both altitudinally and thermally to produce a unique range of vegetation habitats. Rare ferns and orchids are present within the area of geothermal vegetation.

Seven vegetation types were identified by Burns & Leathwick (1993):

- (1.) Prostrate kanuka / *Campylopus* moss shrubland on heated soils;
- (2.) Prostrate kanuka - mingimingi shrubland on slightly cooler ground;
- (3.) (Pine) /mingimingi - manuka scrub, common on hillslopes;
- (4.) Manuka - kamahi / *Cyathodes juniperina* scrub on slightly warm soils of colluvial toeslopes;
- (5.) Kamahi - fivefinger forest on the edges of the geothermal area;
- (6.) Bracken - baumea fern-reedland in old explosion crater;
- (7.) Manuka - makomako / *Hypolepis ambigua* fernland on warm soils of alluvial fan.

Description

This is a unique geothermal area, extending from the alluvial fan and wetlands at the scarp base, through heated shrublands on the face, containing weakly flowing hot neutral springs and mud geysers, to further areas of altered soils and hot water occurrences along the escarpment top. High on the scarp is the large Te Kopia fumarole, unchanged since Hochstetter's description 135 years ago, and the largest fumarole remaining on the New Zealand mainland. Surrounding the reserve is a buffer of secondary rewarewa/kamahi forest. The reserve is generally unmodified and contains few tracks.

The area has been comprehensively studied by botanists (Clarkson 1984; Burns & Leathwick 1993), and these authors give detailed analysis of the vegetation and ecology of the reserve. The geology too has been frequently examined, beginning with Hochstetter (1864) to Grange (1937), continuing through the period of geothermal power investigation of the 1960s, Healy (1974), Lloyd (1984), and culminating recently in a study of increased ground heating after a series of earthquake swarms in November 1993 (MacKenzie *et al.* 1994). Owing to temperature inversions and poor ground permeability the geothermal field is unlikely to be utilised for power generation. Deer, pigs, and possums are present throughout the adjoining forest, the first two frequently using warm mud pools in the reserve for wallows. Some duck shooting is done in wetlands below the reserve.

Significance

One of the largest New Zealand populations of the thermal fern *Dicranopteris linearis*, and the orchids *Calochilus robertsonii* and *Drymoanthus flavus* ('spotted leaf') occur here (Humphries & Ecroyd 1990; Ecroyd 1994). The reserve contains an excellent example of thermal vegetation, in an area normally undisturbed by tourist or other human incursion. Present legal protection appears to be adequate. In view of the unique values of this area the highest possible priority for protection should be maintained.

PNA No. 2 KARAPITI (CRATERS OF THE MOON)

Study area No. 64 Area: 36 ha

Authority: Department of Conservation

NZMS 260: U18 Grid Ref.: 772795 Aerial photo: 232171

Physiographic unit: Geothermal

Bioclimatic zone: Lowland Altitudinal range: 400-545 m

Ecological pattern

An active steamfield with fumaroles, explosion craters, collapse pits, and blowouts, formed mostly since the 1950s when the Wairakei Power Station was constructed. A well developed vegetation zonation reflects different levels of thermal flux. Clarkson (1989) defined five vegetation types:

- (1.) Bare ground with temperatures up to 97°C;
- (2.) Geothermal vegetation, ferns/moss, and lichen field with temperatures of 55-70°C;
- (3.) Prostrate kanuka shrubland and scrub with temperatures below 55°C;
- (4.) Exotic plantation/native broadleaved regeneration;
- (5.) Recently felled plantation areas with abundant introduced weeds.

Description

A central steamfield of about 4 ha is surrounded by low ridges. To the south is the deeply gorged Waipouwerawera Stream, and to the north the Wairakei golf course. The geothermal vegetation has many rare and unusual vegetation types, well documented by Given (1980, 1981, 1989) and Clarkson (1989). The majority of the Karapiti Block which contains the geothermal area is planted in exotic pines, mostly *Pinus radiata* but also *P. pinaster* and *P. muricata*, as well as European and Japanese larch and eucalyptus species. The distinctive craters area is well maintained and has a range of thermal vegetation including species listed as rare and endangered. There is a great variety of thermal mosses and lichens, and the area has permanent plots and photo points for continuous monitoring (Given 1989).

Some damage is done by visitors straying from tracks and boardwalks, but in general the vegetation is in good condition. Pine seedlings are regularly removed from the thermal area.

Significance

Rated by Given (1989) as of extreme botanical interest. The thermal mosses *Campylopus holomitrium* and *C. clavatus*, the thermal ferns *Dicranopteris linearis* and *Nephrolepis* sp. 'cf. *cordifolia*', and the clubmoss *Lycopodium cernuum* occur here. Also of interest are the smooth rock fern *Cheilanthes humilis* and the sedge *Fimbristylis squarrosa*, here at its southern limit (reported by P. de Lange). Silver beech (*Nothofagus menziesii*) and *Pittosporum ralphii* recorded here are planted specimens. Karapiti Block is well fenced, and its protection appears secure.

PNA No. 3 MAUNGAKAKARAMEA or RAINBOW MOUNTAIN

Study area No. 18 Area: 100 ha

Authority: Department of Conservation

NZMS 260: U16

Grid Ref.: 064148

Aerial photo: 232371

Physiographic unit: Dacite dome

Bioclimatic zone: Lowland

Altitudinal range: 400-743 m

Ecological pattern

The area is regenerating from predominantly kanuka scrubland, with a mosaic of broadleaved species. Areas of heated soils are dominated by prostrate kanuka, with abundant mosses and terrestrial orchids. Wildling pines occur throughout. Four main vegetation types were noted by Clarkson (1981b) :

- (1.) Kanuka-kamahi mixed broadleaf shrubland and low forest with wildling pines on hillslopes;
- (2.) Heated explosion crater area, with prostrate kanuka on steep faces, and remnant forest with toatoa, rimu, kamahi, etc.;
- (3.) Kanuka-manuka scrub to 3 m high on lower hillslopes;
- (4.) *Baumea rubiginosa* - *Carex virgata* sedgeland on crater floor.

Description

A small dacite dome 25 km south of Rotorua, with geothermal activity in the crater and a steaming lake on the western side. A steep gravel road gives access to the summit, through regenerating shrubland and patches of prostrate kanuka on thermally altered soils. The mountain is intersected by three faults, and steam rising from these faults has reacted with the volcanic rock to produce the multi-coloured faces from which the mountain has received both its Maori and English names (Pearce 1977).

The mountain has been intensively studied, and excellent reports from Cockayne (1929) to the present day describe the process of regeneration that is taking place. The crater forest is of high scientific importance, since it is a remnant of the original vegetation cover destroyed by fire on the exposed slopes. It contains many species not present elsewhere on the mountain, and represents a likely successional end point of the young developing forest of the mountain (B.R. Clarkson 1984).

Wildling pines of several species are increasing, and understorey and ground cover plants are being damaged in some places by wild pigs.

Significance

Has very high botanical and scientific values on account of the geothermal vegetation and the orchid and mistletoe species present, and because it is such an excellent and relatively unmodified example of post-fire regeneration. The easy access and well graded walking tracks, plus the panoramic views from the summit, give the reserve a high recreational value.

PNA No. 4 MATAHANA ECOLOGICAL RESERVE

Study area No. 25	Area: 1725 ha
Authority: Department of Conservation	
NZMS 260: U16 Grid Ref.: 830250	Aerial photo: 232415
Physiographic unit: Rhyolite dome	
Bioclimatic zone: Lowland	Altitudinal range: 450-620 m

Ecological pattern

This remnant of original more common forest types does not fit the description for Atiamuri Ecological District (McEwen 1987) owing to the presence - albeit very local - of hard beech (*Nothofagus truncata*). Nicholls (1978) defined ten vegetation types:

- (1.) rimu/matai-tawa-kamahi forest on the plateau crest;
- (2.) rimu-northern rata/matai-tawa-rewarewa-kamahi forest on hillslopes;
- (3.) rimu-matai/maire-kamahi forest on hillslopes;
- (4.) tawa-kamahi forest on hillslopes;
- (5.) northern rata/tawa-kamahi forest on hillslopes;
- (6.) rimu/tawa-kamahi-hard beech forest on ridges;
- (7.) Hall's totara/kamahi-tawari forest on dome top;
- (8.) rimu/miro-tawa-kamahi tawari forest on steep eastern hillslopes;
- (9.) rewarewa on lower hillslopes;
- (10.) hard beech stands in pockets along the plateau rim.

Description

Cliffs and incised stream valleys on the southern edge of the Mamaku Plateau and wide alluvial wash gullies below. Remnants of the original dense rimu-matai forest that covered the southern quarter of the plateau now surrounded by exotic pine plantations. The reserve shows the transition from lowland podocarp forest with pukatea, mangao, and rewarewa in the lower gullies to Hall's totara and tawari on the

adjacent dome top, with pockets of hard beech along the plateau rim.

Significance

Ranked as of prime scientific value, this extensive reserve contains virgin stands of several of the original forest types of the area, and a wide range of forest species in a single ecological area. *Juncus holoschoenus*, ranked as “insufficiently known” by Cameron *et al.* (1995), was recorded from here in 1967 (NZFRI 6211).

PNA No. 5 UPPER KIRIOHINEKI STREAM

Study area No. 63	Area: approx. 120 ha
Authority: Electricorp	
NZMS 260: U17 Grid Ref.: 766824	Aerial photo: 232193
Physiographic unit: Geothermal	
Bioclimatic zone: Lowland	Altitudinal range: 440-565 m

Ecological pattern

Distinctive geothermal vegetation and mossfields on heated ground. *Pinus radiata* some 35 m high over native shrubland occupies a large portion of the area. Wallace (1990) identified four zones of geothermal vegetation generally related to heat flux, plus the radiata pine forest:

- (1a.) Bare ground, most extensive on Waiora hilltop, but also present throughout the valley;
- (1b.) Thermal mossland, cushions of mosses and liverworts, and scattered lichens, with *Lycopodium cernuum* covering most of the southern face of Waiora hilltop, and present elsewhere;
- (1c.) Prostrate kanuka shrubland and scrub present over much of the northern half of Waiora hill and north and west of the Claret Cup, but also elsewhere in the reserve;
- (1d.) Radiata pine/prostrate kanuka treeland, on the periphery of the thermal areas and on warm ground such as the eastern side of Waiora hill;
- (2.) *Pinus radiata* /broadleaved shrubs and ferns;

Description

The upper catchment of the Kiriohineki Stream consists of a central valley with radiating gullies at the head rising to rolling country in the north, and the steep-sloped Waiora hill to the south. Geothermal activity has enabled a distinctive vegetation and flora to develop here, including a number of nationally important types and species.

The mossland contains the geothermal endemic *Campylopus holomitrium* and liverworts such as *Lepidozia berteriana* and *L. glaucophylla*, as well as lichens of the genera *Usnea*, *Cladia*, and *Cladonia* (Given

1989). The thermal ferns *Christella dentata* 'N.Z', *Nephrolepis* sp. cf. *cordifolia*, and *Dicranopteris linearis* are present.

The extensive geothermal activity is of considerable scientific and visual interest, although the unstable nature of the heated ground limits the tourist potential of the area. Nineteen bird species were recorded during the survey, and the presence of skinks and geckos has been noted by previous authors (Wallace 1990).

Significance

This is a unique scientific area of the highest ranking, classified by Given (1989) as "an area of extreme botanical interest", containing probably the most extensive geothermal moss/lichen fields in New Zealand. Management considerations and recommendations for specific protection of the remaining unmodified areas have been outlined by Given (1989), including suggestions for removal of potentially troublesome weed species.

PNA No. 6 WAIHUNUHUNU STREAM

Study area No. 69	Area: 8 ha
Authority: Department of Conservation stewardship area	
NZMS 260: U17	Grid Ref.: 890280 Aerial photo: 232470
Physiographic unit: Geothermal springs on river bank	
Bioclimatic zone: Lowland	Altitude: 290 m

Ecological pattern

This is one of the richest communities of thermal ferns in the district. Also the inlet contains a rich reedland and other aquatic vegetation.

- (1.) Thermal ferns around geothermal springs on riverbank;
- (2.) Broadleaf shrubland (pines) on river terrace;
- (3.) Reedland/aquatic vegetation.

Description

A large inlet on the north-eastern shore of Lake Ohakuri where Te Kopia Road reaches the lake. Several hot springs, with large outflows of alkaline waters, arise close to the lake edge and support a rich population of the thermal ferns *Cyclosorus interruptus*, *Christella* sp. cf. *dentata*, *Nephrolepis* sp. cf. *cordifolia*, and *Dicranopteris linearis*, all sheltered by the rough pine / broadleaf vegetation behind it. Between road and lake, where the Waihunuhunu Stream enters, is a large area of pines with broadleaved shrub regeneration underneath. In the stream gully are several boiling springs.

On the northern shore of the inlet farmland borders the lake, with extensive raupo reedlands and grey willow/raupo-*Carex secta* reed-sedge-shrubland on swampy ground with patches of blackberry, *Cyperus ustulatus*, *Carex geminata* agg., and *Juncus gregiflorus*. In this area some maimai (hides) have been built by duckshooters.

Within the inlet the lake waters are warmed by the spring flows, consequently producing a rich growth of reeds, sedges, and aquatic plants and providing an important food resource for a wide range of birds. During the survey an Australasian bittern - a threatened species (Bell 1986) - landed in raupo close to the boat. The inlet is a popular boat launching and bathing area for local people, known to them as Paradise Inlet.

Significance

As well as its very high botanical values, the estuary is an important area for wading and aquatic birds. Recreational use and the operations of farming and forestry are the major threats to this area; increased protection through Ecological Reserve status is recommended. It is noted that before the flooding of Lake Ohakuri in 1961 this area was marked on topographical maps (ca 1940) as a Thermal Reserve (Cody 1995). The location is ranked B2 in Cody (1995) by virtue of the significance of the boiling springs.

PNA No. 7 RED HILLS, ORAKEIKORAKO

Study area No. 7	Area: 611 ha
Authority: Department of Conservation stewardship area	
NZMS 260: U17	Grid Ref.: 850980 Aerial photo: 232470
Physiographic unit: Geothermal	
Bioclimatic zone: Lowland	Altitude: 375 m

Ecological pattern

Predominantly prostrate kanuka, with ferns in sheltered gullies and small broadleaf shrubs along the edge of Lake Ohakuri.

- (1.) Thermal vegetation to 1 m tall, comprising prostrate kanuka and mingimingi, with seedling pines on hillslopes;
- (2.) Treeferns and *Coprosma* spp. with ferns and *Carex* spp. in stream gully above boiling pool.

Description

An extensive geothermal field, known locally as Red Hills, contains many steam vents and small boiling pools. Thermally altered soils show patches of bare or moss-covered ground, unstable in some places, amongst an open cover of prostrate kanuka (*Kunzea ericoides* var. *microflora*) with a few stunted

mingimingi (*Leucopogon fasciculatus*) and wildling pine seedlings.

The stream valley has heated water, and supports thermal ferns in the lower reaches. A hot pool feeding the stream near the lake is at 98.5°C and has a pH of 9. Below this the stream drops over a waterfall, where local people have installed pipes to a hot bath. The thermal fern *Christella dentata* ‘N.Z.’ is abundant along the stream edges in the upper valley, and *Cyperus ustulatus*, *Carex secta*, and *Histiopteris incisa* grow under a canopy of kanuka, mingimingi, *Coprosma* spp., and *Dicksonia squarrosa* near the lake.

Significance

The area is in good condition, has considerable scenic value in the skyline vista from the lake, and has some infrequent use of the hot water baths near the lake edge by boat users. The location is classified B3 in Cody (1995), and is considered as a component of the Orakeikorako Geothermal Field.

PNA No. 8 KAPENGA SWAMP LEASE AREA

Study area No. 21	Area: 166 ha
Authority: Department of Conservation lease from Kapenga M Trust	
NZMS 260: U16	Grid Ref.: 930240 Aerial photo: 232671
Physiographic unit: Wetland in lacustrine system	
Bioclimatic zone: Lowland	Altitude: 360 m

Ecological pattern

Predominantly carex sedgeland surrounding pools of open water, with areas of grey willow intrusion. A pumice fan to the north, and areas of herbfield, pasture, gorse, and blackberry, with pine plantations along the western perimeter.

- (1.) Manuka / flax-sedge peatland and carex sedgeland;
- (2.) Willow / carex association, raupo, rush, sedge, and herbfield, and open water;
- (3.) Silt fan, grass, and sedgeland with willow, manuka, and open waterways;
- (4.) Pines, broom, blackberry, gorse, hawthorn, grassland.

Description

This 166 ha wetland was thoroughly studied by Robyn M. Irving (1992). Her report covers fully the flora and vegetation types of the swamp, and makes recommendations on management aspects. A very large range of species are present, among them several that do not appear elsewhere or are uncommon in the district. The rush *Juncus holoschoenus* (listed as “insufficiently known” in Cameron *et al.* 1995) occurs here, and would be worthy of further monitoring. Also here was the ladies’ tresses orchid (*Spiranthes sinensis* ssp. *australis*), not rare but very locally distributed (Beadel *et al.* 1985).

The area is mostly unmodified, despite the fact that grazing has previously occurred, some ponds are used for duck shooting, and a proposal had been made to artificially raise water levels to facilitate further game bird management. Grey willow poses a serious threat to the naturalness of the area, and appears to be spreading. It is understood that control measures are being undertaken by the Department of Conservation to reduce this threat. When the area was visited during the PNA survey the access gates and fences were broken, permitting stock entry.

Significance

Considering that this swamp contains about 16% in area of all wetland remaining in the Atiamuri Ecological District its significance is obvious. Its good condition and the range of species present define it as the largest good wetland left in the district, and as such it has very high conservation values.

PNA No. 9 PAEROA RANGE

Study area No. 24 Area: 2250 ha

Authority: Department of Conservation

NZMS 260: U17 Grid Ref.: 930070 Aerial photo: 232413, 232364, 232432, 232433

Physiographic unit: Tilted ignimbrite block

Bioclimatic zone: Lowland to sub-montane Altitudinal range: 400-975 m

Ecological pattern

Cloud forest occurs along the range top. Tawari is present in one small area. Nicholls (1979) has defined five forest types for the range:

- (1.) Hardwood seral forest - kamahi predominant, with rewarewa, tawa, hinau, maire, and mangeao;
- (2.) Valley floor podocarp-hardwood at 450-600 m - rimu, matai, kahikatea, and occasional totara with maire, mahoe, broadleaf, putaputaweta, and tarata;
- (3.) Lower-altitude podocarp-hardwood forest, up to 600 m - rimu-rata / tawa, with frequent hinau, rewarewa, mangeao, and kamahi, and occasional miro and Hall's totara;
- (4.) Mid-altitude podocarp- hardwood forest at 600-750 m, - kamahi dominant, with broadleaf, tawheowheo, and local toro, also rimu, miro, and Hall's totara common, but no mangeao;
- (5.) High-altitude podocarp-hardwood forest at 750-975 m, - dense low kamahi, broadleaf, and tawheowheo, occasional toatoa with pepperwood shrubs and scattered large Hall's totara and miro.

Description

A 15 km range with a very steep fault scarp on the west flank, forest covered along the crest and much of the back slope, and clearly visible to the west of the Rotorua-Taupo highway from Waiotapu to Reporoa.

Most of the eastern slopes were logged from the 1920s to about 1966, considerably changing the forest structure. Previously Type 3 was the general vegetation of the lower slopes, but is now confined to strongly gullied terrain with steep to very steep slopes. Minor unlogged areas of Type 2 remain near the northern and southern ends of the forest.

Clear felling and pine planting are still taking place outside the reserve, with occasional illegal logging operations inside the reserve. Deer, pigs, and possums are present throughout the forest.

Significance

Easy access and high species diversity make this forest an important conservation area. It contains the southernmost tawari in the district, and is an important buffer for Te Kopia Scenic Reserve. With an area of 2250 ha, it contains about 26% of the total indigenous forest area still existing in the Atiamuri Ecological District.

PNA No. 10 HUKA FALLS - ARATIATIA RAPIDS SCENIC RESERVE

Study area No. 68	Area: 252 ha
Authority: Department of Conservation	
NZMS 260: U18 Grid Ref.: 790790	Aerial photo: 232171
Physiographic unit: Riparian in rhyolite	
Bioclimatic zone: Lowland	Altitudinal range: 340-380 m

Ecological pattern

Severely modified, mostly secondary scrub-shrubland, much of it planted, and large numbers of pines. Cliffs and spray zones contain a great variety of mostly common species. Beverley Clarkson (1989) described four major indigenous vegetation types within this mosaic:

- (1.) Kohuhu-fivefinger-kanuka / bracken scrub and shrubland - mixtures of these species with other broadleaved shrubs, in places up to 8 m high with patchy ground cover of seedlings, *Dianella nigra*, and fern species, in particular kiokio, and in places merging into (2);
- (2.) Cabbage-tree treeland - young trees to 8 m high over a layer of blackberry, flax, bracken and Himalayan honeysuckle;
- (3.) Rock faces and spray-zone vegetation - small shrubs of five finger, pate, karamu, wheki, and kohuhu, with mixed ferns including *Phymatosorus scandens* and the hanging orchid *Earina mucronata*;
- (4.) Turf communities - on parts of the river shore, *Glossostigma elatinoides*, *Myriophyllum propinquum*, *Lilaeopsis* sp., *Isoetes* sp., and *Limosella lineata*.

Description

A 12-km-long strip comprising two scenic reserves and adjacent lands lining both sides of the Waikato River. Major tourist features - the Huka Falls and the Aratiatia Rapids - lie within the area. There are extensive and popular walking tracks, viewing platforms, toilet facilities, and car parking provided. Large areas of the reserve are under mixtures of exotic trees, shrubs, and weeds additional to the vegetation types listed above. There are also areas planted in native species, but unfortunately not always those indigenous to the Taupo district. Small local areas of geothermal activity are present in the reserves, well fenced and generally well managed.

Significance

Botanical values are low. Although no rare thermal ferns occur within the reserve, the fern *Pilularia novae-zelandiae* is present on the river edge just opposite the reserve. The area has very high scenic and recreational values.

PNA No. 11 WAIKITE THERMAL RESERVE

Study area No. 80	Area: 11 ha
Authority: Rotorua District Council	
NZMS 260: U16 Grid Ref.: 988143	Aerial photo: 232651
Physiographic unit: Geothermal	
Bioclimatic zone: Lowland	Altitude: 350 m

Ecological pattern

Ecroyd & Coham (1976) and, more recently, Miller & Ecroyd (1993) have reported in depth on this reserve. They defined two main parts to the natural flora, relating closely to soil temperatures:

- (1.) Tall shrubland and geothermal vegetation of the upper part of the valley, surrounding the springs and extending through the short, steep-sided gorge beside the baths complex;
- (2.) Swamp and stream-side vegetation of the lower, more gently graded part of the reserve, below the baths, coinciding with the organic peaty soils but still warmed by the stream and its contributing seepages.

Description

An 11-hectare reserve bordered by Waikite Valley Road, Corbett Road, and the Otamakokere Stream, containing a swimming pool, tearoom, camping ground, and squash club building. Between the squash club building and Corbett Road much of the reserve is grazed pasture, fenced off from a wide stream boundary and a small woodlot. The remainder of the reserve comprising the stream borders, ungrazed swamp beside the camping ground, and the native vegetation around and upstream of the springs contains the vegetation of botanical interest.

The Waikite Geothermal Field has been extensively studied over many years. Within the reserve the largest spring is Manuroa, which boils continuously, with 20-30 lps outflows and an oscillating boiling head 0.2-1.5 m high (Cody 1995). The total collective discharge within the baths gully is about 80 lps of alkaline water at 80-100°C.

One spring here depositing pure calcite sinter is unique to the entire Central Volcanic Zone. Other springs in the gully also deposit calcite, but admixed with silica. Collectively, this group of calcite-depositing springs is unique in New Zealand. Although surrounded by largely native vegetation the whole area is being rapidly overwhelmed by blackberry. Elsewhere blackberry, pampas, and an introduced sedge, *Cyperus involucratus*, are spreading strongly and there are some problems with dumping of garden rubbish.

Significance

The site is of particular botanical interest, with several rare and local ferns and lycopods, as listed by Cameron *et al.* (1995). The swamp fern *Cyclosorus interruptus* (rare), soft fern *Christella dentata* 'N.Z.', thermal umbrella fern *Dicranopteris linearis* (local), and ladder fern *Nephrolepis* sp. cf. *cordifolia* are all here, as is the thermal clubmoss *Lycopodium cernuum*. Extensive recreational use is made of the baths complex, particularly by the residents of the Waikite Valley, for whom this is an important social venue. The camping ground is used continually over the summer months, predominantly by overseas tourists.

PNA No. 12 IVAN SWAN'S CONSERVATION AREA

Study area No. 53	Area: Not known
Authority: Department of Conservation, Ivan Swan Covenant	
NZMS 260: T17	Grid Ref.: 665837 Aerial photo: 232225
Physiographic unit: Escarpment on ignimbrite sheet	
Bioclimatic zone: Lowland	Altitudinal range: 520-620 m

Note: During mapping and editing of this report it was considered that this study area may actually fall within the Taupo Ecological District. In the interim it was decided to continue to include it here, as it fits well ecologically with PNA 17 and RAPs 32 and 35 nearby.

Ecological pattern

Steep faces burnt about 30 years ago.

- (1.) A mosaic of broadleaf shrubs with strips of mature kamahi-rewarewa on the ridge tops;
- (2.) Mixed broadleaved shrubs with kamahi and rewarewa emerging on the steep southeast-facing hillslopes;
- (3.) Pockets of mature kamahi-matai with young totara emerging on the stream terraces.

Description

A long escarpment runs northeast to southwest with a dry wadi at the base. Regenerating native vegetation covers the slopes and valley floor, and contains some significant groves of young totara, miro, and matai. The face contains huge obsidian deposits which are visible in slip debris along the toe-slopes. The obsidian source was well known to Maori, and is of considerable archaeological interest. The covenant area is well fenced, and opossum control appears to be ongoing, although two groups of goats were observed moving through.

Seven bird species, including kereru, were identified, the general level of activity being notably high.

Significance

The covenant area has high wildlife values, with large numbers of birds present. The obsidian deposits are of considerable archaeological and geological interest, and the native vegetation is providing a good seed resource for future regeneration.

PNA No. 13**MAUNGAONGAONGA SCENIC RESERVE**

Study area No. 19

Area: 191 ha

Authority: Department of Conservation

NZMS 260: U16

Grid Ref.: 027143

Aerial photo: 232372

Physiographic unit: Dacite dome (partly collapsed)

Bioclimatic zone: Lowland

Altitudinal range: 480-825 m

Ecological pattern

Mainly fire-modified podocarp/broadleaf forest, with minor virgin areas. An area of 'thermal vegetation' in the heated thermally altered soils of the lowermost southern slope. Exotic pine plantations on the western flanks. Clarkson (1981a) defined the following vegetation types:

- (1.) Rimu- rewarewa/hinau-mangeao primary forest on hillslopes;
- (2.) (Rimu)-(matai)/tawa-hinau primary forest on hillslopes;
- (3.) Tawa-hinau-rewarewa secondary forest on hillslopes;
- (4.) Rewarewa secondary forest on hillslopes;
- (5.) Douglas fir-larch plantation on lower hillslopes;
- (6.) Bracken and pasture fern-grassland on hillslopes;
- (7.) Prostrate kanuka-monoao shrubland in geothermal area.

Description

A dacite dome with a collapse crater and active steaming vents on the southern slopes, clearly visible to the north of Waikite Valley Road at Waiotapu. The vegetation is a complex mixture of types 1-4 with bordering types 5-7. The thermal vegetation of this reserve is particularly valuable as it is largely unmodified, being untracked and without the marked invasion by adventive conifers that is characteristic of many other geothermal reserves (Clarkson 1981a).

The tropical fern *Dicranopteris linearis*, the arching clubmoss *Lycopodium cernuum*, and the comb fern *Schizaea bifida* are present in the thermal vegetation.

Significance

The unmodified thermal area is still relatively weed free, as it is not visited by humans or animals. One species listed as 'Local' by Cameron *et al.* (1995) is present (*Dicranopteris linearis*).

PNA No. 14 PUAITI SCENIC RESERVE

Study area No. 62	Area: 54 ha
Authority: Department of Conservation	
NZMS 260: U17 Grid Ref.: 870045	Aerial photo: 232431
Physiographic unit: Rhyolite plateau	
Bioclimatic zone: Lowland	Altitudinal range: 500-604 m

Ecological pattern

Predominantly successional forest dominated by rewarewa and kamahi. Some bad areas of kamahi dieback in the northwest corner. The vegetation types were defined by King (1984) as follows:

- (1.) Fernland, mostly bracken with blackberry and *Muehlenbeckia australis* along the margins;
- (2.) Wineberry-fuchsia shrubland on hillslopes;
- (3.) Rewarewa/mahoe-wineberry forest, mainly in the northwestern end of the reserve on hillslopes;
- (4.) Rewarewa/mangeao-mahoe with scattered matai and miro, on hillslopes with northeastern aspect;
- (5.) Rewarewa-pigeonwood forest on hillslopes;
- (6.) Rewarewa-kamahi forest, forming a dense canopy on hillslopes along the southwestern margin;
- (7.) Rewarewa-lemonwood forest on a central ridgetop;
- (8.) Rewarewa-mangeao-hinau forest covering much of the southern and southeastern hillslopes.

Description

A relatively large, logged forest remnant, remote from the road but easily accessible by right-of-way from Puaiti Road. Rolling hillslopes surrounded by pasture, with an exceptionally large grass airstrip on the

eastern side. Mentioned by McCaskill (1979) as having been used by early settlers for a community picnic area (this, however, contradicted by locals).

No rare or endangered species are present; however, the area is a good example of successional forest types, and other than an unusual number of dead rewarewa and kamahi trees the reserve is in good condition, although some fence repairs are needed. The southern corner, probably the old mill site, has a range of unusual exotic weeds: hop (*Humulus lupulus*), kiwifruit (*Actinidia deliciosa*), bamboo (*Bambusa* sp.), and montbretia (*Crocasmia x crocosmiifolia*). There are some wildling pines present.

Significance

A large and representative area of secondary forest succession, typical of the Atiamuri Ecological District. Previously thought to contain the southernmost population of mangeao in the Central North Island; however, other specimens were located during this survey in the Tutukau Block on the south side of the Waikato River. The reserve is also exceptional in that a total of thirty-six fern species were recorded.

PNA No. 15 MALEME ROAD SCENIC RESERVE

Study area No. 16	Area: 18 ha
Authority: Department of Conservation	
NZMS 260: U16 Grid Ref.: 834107	Aerial photo: 232359
Physiographic unit: Rhyolite plateau	
Bioclimatic zone: Lowland	Altitudinal range: 400-500 m

Ecological pattern

A very small remnant of primary forest destroyed by fire in pre-European times, with later regeneration (King 1988). The forest vegetation types are:

- (1.) Rewarewa / kamahi forest varying from low canopy with a fringe of tree fuchsia on the margins to 10-12 m high, with a dense understorey of fuchsia, treeferns, *Coprosma* spp., and hangehange on gentle hillslopes;
- (2.) Mahoe-tree fuchsia-pate forest in eastern gully;
- (3.) Mangeao-tawa with matai and rimu, and understorey of broadleaved shrubs and treeferns on hillslopes.

Description

This reserve is on the eastern side of Maleme Road, and at first sight would appear to be separated from the road by farmland. Although a right of way is apparently present there is no indication of this, and consequently the reserve is almost totally unused by the public.

It is a well preserved example of secondary mangeo-tawa forest, with some remnant matai and rimu, surrounded by farmland, with a small area of open tawa forest and grassland to the east (outside the reserve). The forest types present illustrate the progression of forest regeneration after clearing or fire. The reserve is in excellent condition, although a small amount of deer sign was seen. Fences need some maintenance.

Significance

Along with the Puaiti Scenic Reserve and the Paeroa Range forest, this area contains the southernmost **protected** mangeo in the central North Island.

PNA No. 16

WAIOTAPU SCENIC RESERVE

Study area No. 20

Area: 357 ha

Authority: Department of Conservation

NZMS 260: U16

Grid Ref.: 040105

Aerial photo: 232367

Physiographic unit: Geothermal area

Bioclimatic zone: Lowland

Altitude: 320 m

Ecological pattern

Vegetation cover of the active thermal area is generally prostrate kanuka-mingimingi shrubland, with the surroundings dominated by pines over an understorey of wheki-mahoe-mingimingi. Wetlands to the south contain the rare fern *Cyclosorus interruptus* (Clarkson 1982; Miller & Miller 1983).

The following vegetation types are present:

- (1.) Prostrate kanuka-mingimingi around the tourist area;
- (2.) *Pinus pinaster* forest surrounding the reserve;
- (3.) Manuka shrubland covering much of the western fringe of the reserve;
- (4.) (*P. pinaster*) / manuka / toru shrubland;
- (5.) Kamahi forest in a small pocket at the eastern end of Whangi-o-te-rangi (Echo Lake);
- (6.) Swampland to the south of Lake Ngakoro and outside the reserve boundaries, containing flax-raupo herbfields and *Carex secta* and *Baumea juncea* sedgelands.

Description

An extensive area of eroded pumiceous lakebed terraces, dotted with active collapse and explosion craters, most of which contain hot mud or water. To the south the area drains to a series of lakes and wetlands also containing heated springs.

The vegetation is for the most part substantially modified or dominated by adventive pines.

Near the southern shore of Lake Ngakoro (U17 044098), where hot springs occur, is a substantial population of the thermal fern *Cyclosorus interruptus*, classified as Rare by Cameron *et al.* (1995). Major geothermal features in the reserve are the champagne pool and its several hectares of sinter terraces (the Primrose Terrace). These are unique in New Zealand today for their size and undisturbed state, and are of high international significance (Cody 1995). Similar explosion and collapse craters are present elsewhere only at Rotokawa, Karapiti, and Te Kopia.

Of seven geysers remaining in the Waiotapu field, only five are visible to the public, and one of these, the Lady Knox geyser, is man made. Built in 1906 over a naturally geysering spring, it is now 'soaped' on a daily basis for tourists.

Significance

The reserve has exceptional significance as a tourist operation. High usage of the developed thermal area appears to do little damage; the rare thermal ferns are not accessible to the public and consequently are thriving. Nine geothermal features are noted, and rankings ranging from C3 to as high as A2 have been given (Cody 1995). Removal of pines would in the long term enhance the native vegetation and improve the naturalness of the reserve.

PNA No. 17 WAIPAPA MAORI RESERVE

Study area No. 47	Area: Not known
Authority: Waipapa Trust (Chairman Bob Andrews, Mokai)	
NZMS 260: T17	Grid Ref.: 658878 Aerial photo: 232716
Physiographic unit: Secondary forest on tephra hillslopes	
Bioclimatic zone: Lowland	Altitudinal range: 520-640 m

Ecological pattern

Logged former totara-dominant forest. Now kamahi-dominant with old emergent matai remnants. One small area of totara near the forest edge.

- (1.) Kamahi-tarata-mahoe-fuchsia (matai-rewarewa) in a regenerating mosaic on hillslopes;
- (2.) Kamahi-coprosma (radiata) secondary regeneration on steep lower hillslopes.

Description

A good forest remnant to the south-west of Poihipi Road, adjacent to a small topdressing airstrip. Rolling hillslopes with pumice washes and flats with a generally northeast aspect run from the road to the ridgetop. Old remnant matai are prominent in the canopy, and a small stand of young totara is developing well near the southern boundary. Some deer are present, and intensive possum control is being undertaken by

Environment Waikato.

Significance

High numbers of native birds were seen, including kereru, and the forest contains the endangered wood rose (*Dactylanthus taylorii*). Here is a good example of the regeneration of former totara-dominant forest following logging. The reserve is well fenced and protected by the Waipapa Trust.

PNA No. 18 WAIKITE WILDLIFE MANAGEMENT RESERVE

Study area No. 11 Area: 250 ha

Authority: Department of Conservation (Covenants U16 067, 085, 111, 112)

NZMS 260: U16 Grid Ref.: 103170 Aerial photo: 232651

Physiographic unit: Wetland on tephra

Bioclimatic zone: Lowland Altitude: 450 m

Ecological pattern

Hillslopes previously cleared and now reverting to scrub and kanuka-manuka shrubland, above a slow-flowing stream with patches of open water bordered with raupo, and juncus-carex- baumea rush and sedgeland. Willow and blackberry occur in places. Six major vegetation types are present in a rapidly evolving landscape:

- (1.) Kanuka-manuka (pines) shrub treeland on hillslopes;
- (2.) Manuka-fern-broom shrubland on hillslopes;
- (3.) Five finger regenerating shrubland on hillslopes;
- (4.) Blackberry-broom scrub on valley floor;
- (5.) Grey willow treeland on valley floor;
- (6.) Wetlands.

Description

The reserve comprises the central section of the study area, which follows the southeastern side of Earthquake Flat Road. The stream valley and associated swamps have several thermal springs, and are backed by a scrub-covered ridge. See Irving (1992) for more details. Despite strong management recommendations in Irving's comprehensive report, grazing is doing serious damage to the wetlands as well as promoting the increase of weed species. The rare swamp fern *Thelypteris confluens* recorded by Irving could not be located during the present survey.

Significance

The area contains vulnerable fern species and wetlands now becoming rare in the district. Botanical conservation values are high, and the reserve is an excellent wildlife habitat. The objectives of this reserve cannot be achieved if cattle are to be allowed free access as at present.

PNA No. 19 TIROHANGA SCENIC RESERVE

Study area No. 48	Area: 350 ha
Authority: Department of Conservation	
NZMS 260: T17 Grid Ref.: 603000	Aerial photo: 232774
Physiographic unit: Tephra hillslopes on rhyolite dome	
Bioclimatic zone: Lowland to sub-montane	Altitudinal range: 540-700 m

Ecological pattern

Totally logged out forest. Now kamahi-mahoe forest with very few podocarps, on east-facing hillslopes.

Description

Southeast-facing slopes leading to a high, flat-topped peak. There is a notable absence of ground cover or seedling regeneration in most of the area surveyed. Deer, goats, and possums are present, although control is at present under way. Kereru occur, and also a small colony of some 5-7 sulphur-crested cockatoos. Rosella parrots are also reported from here. Fences are in good condition.

Significance:

Not of great value at present, but has the potential to regenerate if browsing is greatly reduced.

PNA No. 20 WAIKORAPA BUSH

Study area No. 3	Area: 15 ha
Authority: Waikite Farm Block Covenant	
NZMS 260: U16 Grid Ref.: 013181	Aerial photo: 232399
Physiographic unit: Rhyolite dome	
Bioclimatic zone: Lowland	Altitudinal range: 520-690 m

Ecological pattern

Formerly podocarp/tawa forest. Heavy logging has almost eliminated the podocarps; a few small rimu still occur on the western ridges. Three vegetation types are present:

- (1.) Mixed broadleaved species to 15 m high on hillslopes;

- (2.) Rewarewa / kamahi to 20 m high on western hillslopes;
- (3.) Kamahi to 15 m high in an unfenced area of pasture.

Description

A smaller version of Tumunui Bush just to the north. The forest was covenanted and fenced in 1994, but at the time of survey no tree or shrub seedlings or regeneration of ground cover plants was seen. Comparison with the almost identical Tumunui Bush will be valuable when regeneration does proceed.

There was a good range of bird species present, notable being the single kakariki observed. As in Tumunui, possum numbers are high. Some recent deer and pig sign was seen, and eels in a small pond near the hilltop.

Significance

A good range of forest species is present, including podocarps, which are absent from Tumunui Bush. Waikorapa Bush should provide a useful seed source for the area in the future, and forms a wildlife corridor between Tumunui and the Waikite Valley Wildlife Management Reserve.

PNA No. 21

KAAHU SCENIC RESERVE

Study area No. 51

Area: 102 ha

Authority: Department of Conservation

NZMS 260: T17

Grid Ref.: 563030

Aerial photo: 232772

Physiographic unit: Escarpment; part breccia, part rhyolite dome

Bioclimatic zone: Lowland

Altitudinal range: 240-692 m

Ecological pattern

Slowly regenerating fern shrubland, containing many wildling pines on steep hillslopes.

Description

Northeast-facing slopes above the Waikato River, grading from hilltop and cliffs to farmland. Some visually interesting ignimbrite formations near the top. The general impression is of predominant fernland on steeper slopes with shrub regeneration on colluvial toeslopes. Some areas are apparently being grazed. Pines are probably increasing. Fences badly need upgrading.

Significance

Significant landscape values, and erosion protection.

PNA No. 22 TAHUNAATARA STREAM MARGINS

Study area No. 2 Area: Not known
 Authority: Department of Conservation covenant (Manager Bruce Southward)
 NZMS 260: U16 Grid Ref.: 811141 Aerial photo: 232382
 Physiographic unit: Riparian, on lacustrine breccia and siltstone/sandstone
 Bioclimatic zone: Lowland Altitude: 300 m

Ecological pattern

Deeply incised narrow valley, cleared of fern and scrub, but now reverting in places with little defined vegetation pattern. Manuka/kanuka shrubland with broadleaf regeneration on the ridges and treeferns in the gullies. Willows along the stream margins in some places, and many large wildling pines throughout.

Description

Stream valley with areas of steep cliffs, or shrubland and pasture on side-slopes. In the upper reaches the stream drains Laliche's Swamp, which is now almost completely dry. The stream contains the introduced brook char (*Salvelinus fontinalis*), Cran's bully (*Gobiomorphus basalis*), common bully (*Gobiomorphus cotidianus*), and koura (*Paranephrops* spp.); a range of bird species occur nearby. Goats and cattle were seen, and there was plentiful possum sign.

Significance

The valley has considerable recreational value for fishermen, duck shooters, and canoeists. It also provides excellent wildlife habitat. Values would be improved by fencing to keep stock out, particularly on the left bank.

PNA No. 23 NGATAMARIKI SCENIC RESERVE

Study area No. 27 Area: 50 ha
 Authority: Department of Conservation, and Fletcher Challenge Forests
 NZMS 260: U17 Grid Ref.: 866917 Aerial photo: 232487
 Physiographic unit: Geothermal area on pumice alluvium and deep tephra
 Bioclimatic zone: Lowland Altitude: 300 m

Ecological pattern

Before planting of exotic forest, the vegetation is likely to have been monoao-kanuka-bracken shrubland. Pines have been planted, felled, and replanted, in the meantime producing the inevitable crop of weeds. Tasmanian blackwood (*Acacia melanoxylon*) has been planted on the western stream banks. The area

around the springs contains *Cyclosorus interruptus*, *Psilotum nudum*, and *Lycopodium cernuum*.

Description

A wide stream valley incised through alluvial pumice terraces by the Orakonui Stream. Hot springs emanate both in and near the streambed, also above a small sinter terrace on the true right bank. The largest spring forms a pool approximately 50 m in diameter at about 50°C and flowing at 10 lps. The spring producing the sinter is depositing calcite, and is the only one of this type in the Central Volcanic Zone outside of the Waikite Thermal Reserve (Cody 1995). One new boiling spring has formed within the last year.

Pines and Tasmanian blackwood are planted extensively within the reserve, and residues of the original planting and felling operations now litter the ground and fill the pools, as well as allowing the intrusion of rampant blackberry.

Significance

The area is of high scientific value, ranked B2 by Cody (1995), and is constantly monitored by university students. It is currently the subject of an MSc thesis by a student of the Geothermal Institute. The *Cyclosorus interruptus* population appears to be healthy at the moment: some 30-50 plants were seen. The valley holds a wide variety of birds. Reserve status appears to give no protection, as logging operations are still going on. The hot springs should be fenced and closed off from commercial activity as recommended in previous reports (Ecroyd 1979b).

RAP No. 24

PAKURI SCENIC RESERVE

Study area No. 81

Area: 32.9 ha

Authority: Department of Conservation

NZMS 260: U17

Grid Ref.: 792919

Aerial photo: 232230

Physiographic unit: Hillslopes on deep tephra

Bioclimatic zone: Lowland

Altitudinal range: 480-618 m

Ecological pattern

- (1.) Rimu-matai / fivefinger-kohuhu forest on steep east facing hillslopes;
- (2.) Dense rewarewa regeneration on upper slopes.

Description

A small logged forest remnant with generally low canopy, possibly also burnt in the 1946 Taupo fires. Contains a range of common secondary broadleaf species and stands of treeferns in gullies. Kereru and

other more common forest birds are present. Some possum sign and stock intrusion through broken fences. Blackberry and pines intruding in places.

Significance

Fairly low, although there is a possibility that *Dactylanthus taylorii* may be present.

PNA No. 25 MANGATETE STREAM

Study area No. 4 Area: approx. 50 ha
 Authority: Department of Conservation and Environment Waikato (Manager Mr Hawkins, Te Kopia Road)
 NZMS 260: U17 Grid Ref.: 904084 Aerial photo: 232416
 Physiographic unit: Hillslopes on deep tephra
 Bioclimatic zone: Lowland Altitudinal range: 340-400 m

Ecological pattern

Secondary regeneration on hillslopes. Good regeneration under conservation plantings, particularly the poplar.

- (1.) Plantations of poplar and other exotic trees to 15 m, with understorey of native secondary growth, on river terraces;
- (2.) Kanuka/manuka-kohuhu-five finger(pines)(cabbage-tree)/bracken fern shrubland on hillslopes;
- (3.) Mangeao (rewarewa)(pines)/five finger forest on hillslopes;
- (4.) Manuka-*Pomaderris ericifolia*-Spanish heath shrubland on hillslopes.

Description

River valley with flats and most hillslopes in dairy pasture. Conservation plantings along stream bed. A large area of native vegetation on southwest-facing hillslope. Thermal vents in tributary gullies near Te Kopia Road. Blackberry is a threat along streambanks.

Significance

High value as a wildlife corridor and for protection of water quality. Units 2 and 3 well worthy of protective fencing.

PNA No. 26 LAKE NGAHEWA RECREATION RESERVE

Study area No. 17 Area: 40 ha

Authority: Department of Conservation

NZMS 260: U16

Grid Ref.: 052154

Aerial photo: 232371

Physiographic unit: Lacustrine in explosion crater

Bioclimatic zone: Lowland

Altitudinal range: 380-400 m

Ecological pattern

Extensive planting of exotic trees and incursion of blackberry and broom have severely modified the surroundings; however, the wetland vegetation is in good condition and contains a good range of native species. Clarkson (1987) identified thirteen vegetation types, mostly dominated by exotic plantings and adventive species. These are summarised as follows:

- (1.) Exotic species planted on hillslopes with flax-carex shrubland in hollows;
- (2.) Coprosma-flax-*Cortaderia* shrubland;
- (3.) Exotic plantation;
- (4.) Raupo-flax tussock-reedland;
- (5.) Aquatic vegetation, open water.

Description

A cold lake fills a 900 yrs B.P. explosion crater, to the west of SH 5 and Rainbow Mountain. The reserve has a picnic area beside the road, with the hemi-parasitic mistletoe *Ileostylus micranthus*, classed as Local by Cameron *et al.* (1995), clearly visible on nearby trees. To the north of the lake an extensive coprosma-flax shrubland extends parallel to the road, to where the soil is dry enough to support a small poplar plantation. On the west side of the lake the amenity plantings are being overwhelmed by blackberry, broom, and wildling pines. In some areas blackberry is now impenetrable, and it is to be expected that this will become more common. The native buttercup *Ranunculus macropus* occurs in the fertile swamp, which is an example of a wetland type not well represented in the district.

Significance

Of high value as one of few remaining examples of fertile swamp vegetation in the district. Also is a very good aquatic bird habitat. The spread of exotic weeds is a serious problem.

PNA No. 27

LAKE NGAPOURI

Study area No. 5

Area: 25 ha

Authority: -

NZMS 260: U16

Grid Ref.: 016128

Aerial photo: 232366

Physiographic unit: Lacustrine in explosion crater

Bioclimatic zone: Lowland

Altitude: 570 m

Ecological pattern

Heavily modified, mostly kanuka or dense blackberry; mixture of native species, many probably planted. Sedgeland/reedland in places around the shore, particularly the southeast corner adjacent to the outlet.

Description

A water-filled explosion crater (named on map U16 as Lake Opouri) in a level terrace to the south of Maungaongaonga, with road access from the Waikite Valley Road to a launching ramp. A narrow rim of vegetation around the lake edges is fenced off from adjacent farmlands. The lake is apparently used for water skiing by local people, but at other times supports a good population of aquatic birds. Thirteen bird species were seen here, including a spotless crane. Heavy infestations of blackberry are taking over much of the land around the outlet stream and in gullies to the west. On the northern shore a 300 m gap in the fencing gives stock access to the lake. Rubbish is being dumped from farmland at about GR. 014132 in a gully above the lake.

Significance

High usage for water sports and duck shooting. Good bird habitat at other times.

PNA No. 28 WHIRINAKI ARM

Study area No. 6

Area: approx. 650 ha

Authority: Department of Conservation (covenants on riparian strips from Waikite Valley Road to Lake Ohakuri)

NZMS 260: U17

Grid Ref.: 830060

Aerial photo: 232419

Physiographic unit: Riparian

Bioclimatic zone: Lowland

Altitudinal range: 280-340 m

Ecological pattern

Secondary broadleaf vegetation following clearing and burning on the west bank, and natural succession from manuka and fern on the east bank. Treeferns in deep gullies. Wildling pines throughout.

Description

Riparian strip of mostly steep faces dropping to the lake. Some alluvial terraces and reverting farmland along the shore where the arm widens out into the lake. Considerable damage being done to regeneration during removal of pines. Severe ingress of weed species in some parts and increased seedling pines in places.

Significance

Vegetation provides a buffer to the lake edge, wildlife habitat, and seed sources for future regeneration.

PNA No. 29 PAEROA SCARP THERMAL AREA

Study area No. 12	Area: approx. 50 ha
Authority: Department of Conservation stewardship area	
NZMS 260: U16	Grid Ref.: 995140 Aerial photo: 323651
Physiographic unit: Rhyolite escarpment	
Bioclimatic zone: Lowland	Altitudinal range: 400-560 m

Ecological pattern

Fern-shrubland with regenerating five finger, kohuhu, and mahoe on hillslopes.

Description

Steep north-facing slopes with farmland above and below. Thermal hot spots occur along the base of the scarp. The area is geologically an extension of the Waikite Valley geothermal field, and is surrounded by farmland and a golf course. Poor fencing in places allows stock to threaten regeneration.

Significance

Possible value as a bird corridor between Waikite Valley and the Paeroa Range, and as a seed source for continued regeneration.

PNA No. 30 OTAMAKOKORE STREAM

Study area No. 14	Area: Not known
Authority: Department of Conservation stewardship area	
NZMS 260: U16	Grid Ref.: 953154 Aerial photo: 232376
Physiographic unit: Riparian on pumice alluvial terrace	
Bioclimatic zone: Lowland	Altitude: 360 m

Ecological pattern

Much modified wetland; some areas fenced, but others continue to be grazed. Basic vegetation units are:

- (1.) Willow-flax-kiokio swampland;
- (2.) Willow-flax-toetoe-blackberry swampland.

Description

Small swamp with a meandering stream at around 26°C fed from the Waikite Valley Thermal Area; surrounded by farmlands. Willow and blackberry are increasing. Farm tracks cross the middle of a major wetland.

Significance

Very little importance except for some wildlife habitat and preservation of water quality.

PNA No. 31 LAKE OHAKURI RIPARIAN COVENANT

Study area No. 10	Area: Not known
Authority: Department of Conservation riparian covenant	
NZMS 260: U17	Grid Ref.: 840080
Aerial photo: 232470	
Physiographic unit: Riparian	
Bioclimatic zone: Lowland	Altitudinal range: 280-340 m

Ecological pattern

Mostly modified secondary vegetation, with some small pockets of good podocarp regeneration. Tanckaha, uncommon in the district, is starting to appear on small riverside terraces.

Description

A narrow riparian strip with some steep cliffs and small terraces. Much is in pasture, with regeneration and wildling pines scattered throughout.

Significance

Aesthetic values of river edge, and considerable value as seed sources for further downstream regeneration.

PNA No. 32 LONGVIEW RD THERMAL AREA

Study area No. 13	Area: Not known
Authority: Department of Conservation covenant with Peter Molloy	
NZMS 260: U17	Grid Ref.: 037047
Aerial photo: 232437	
Physiographic unit: Geothermal area	

Bioclimatic zone: Lowland

Altitude: 290 m

Ecological pattern

Thermally altered soils of old lake-bed sediments, with typical low fertility and species diversity.

- (1.) Prostrate kanuka-mingimingi shrubland;
- (2.) Small area of heated open water.

Description

A small geothermal field by the intersection of Longview Road and Loop Road. It comprises a small lake of heated groundwater surrounded by old sinter terraces, and patches of bare thermally altered soils. It is much altered by drainage channels, fire, and cattle grazing.

Drainage has lowered the water table and so considerably altered ground temperatures. There is no fencing, but small drains give a little protection; however, cattle still have access. There are no species of any botanical significance.

Significance

Very low, rated C3 by Cody (1995).

PNA No. 33 GOLDEN SPRINGS

Study area No. 76

Area: 0.5 ha

Authority: Rotorua District Council Reserve

NZMS 260: U17 Grid Ref.: 987983

Aerial photo: 232452

Physiographic unit: Geothermal area

Bioclimatic zone: Lowland

Altitude: 290 m

Ecological pattern

Many exotic trees and weeds, and extensive aquatic growths in the main pool. The thermal fern *Christella dentata* 'N.Z.' occurs on steep banks and under blackberry along the stream where stock cannot penetrate.

Description

A small thermal area west of SH 5 a few kilometres north of the Waikato River. Two large warm pools, one used for bathing, supply a stream with a hot spring in its bed. After passing under the main road, the spring waters flow through the grounds of the Golden Springs Motor Camp. The major bathing pool is at the base of a small hillock and backed by exotic trees, and is not at all well maintained. Stock have access to the area, and considerable degradation of the stream vegetation is evident. Rubbish is also noticeable. Small patches of *Christella* are present along the stream on both sides of the road.

Stock grazing and rubbish are the main problems. Although it would be good to see the stock removed, blackberry would probably then take over.

Significance

The continued survival of the thermal fern *Christella* sp. cf. *dentata* is important here. Public use of the hot pools is of some social value. Rated C2 by Cody (1995).

5.2 Recommended Areas For Protection

5.2.1 Ranking

The recommended areas for Protection (RAPs) in the Atiamuri Ecological District are listed in approximate order of importance in Table 2, and their locations are shown on Figure 4. Category 1 comprises the highest-ranked RAPs, which are those with the highest priorities for protection. RAPs in Category 2 are also of high priority, and complement the vegetation types and landforms of Category 1 and the existing Protected Natural Areas. Category 3 comprises RAPs which tend to be of smaller size, in poorer condition, or of a type better represented in other RAPs, but could with simple management such as fencing or revegetation still be valuable in ensuring adequate representation of the ecological diversity of the district.

The selection criteria used for identifying Recommended Areas for Protection in the PNA Programme are: vegetation dynamics; representativeness; natural diversity; pattern; rarity and special features; naturalness; long-term ecological viability; size and shape; buffering; and the value of surrounding landscapes.

Symbols used in the following assessments to describe vegetation dynamics are: P = primary; S = secondary; M = modified. Other criteria are described by H, M, L, or N for high, medium, low, or nil as appropriate.

	RAP No.	Study No.	Site Name
Table 2 Ranking of Recommended Areas for Protection			
Category 1	1	22	Horohoro Bluff
	2	32	Kemp Road Bush
	3	49	Mangakowhiriwhiri Stream
	4	8	Orakeikorako Thermal Area
	5	50	Maraemanuka Stream
	6	1	Tumunui Bush
	7	66	Hardcastle Lagoon
	8	33	Tutukau Bush
	9	72	Tureporepo Bush
	10	28	River Road Lake and Wetland
Category 2	11	42	Hoiho Road Swamp
	12	55	Tereina Road Swamp
	13	58	Forest Road Wetland
	14	31	Hauwai Stream Riparian Strip
	15	40	Oruanui Bush
	16	43	Waipapa Stream Geothermal Area
	17	59	Mill Road Wetland
	18	35	Oruanui Road Swamp
	19	71	Torepatutahi Stream
	20	39	Maroanui Private Reserve
	21	36	Mangamingi Station Bush
	22	56	Tram Road Riparian Strip
	23	61	“Spring Valley“
	24	78	Whangairorohea Hot Pool
	25	9	Sun Club, Orakeikorako
	26	41	Pakuri Block, Kiwitahi Lease
	27	79	Hakereteke Stream Bush
	28	38	Pohaturua
	29	60	Mathews Road Wetland
	30	34	Bracey Road Wetland
	31	57	Hemlock Road Wetland
	32	45	Otanepae Station Bush
	33	67	Rawhiti Lagoon
	34	37	Te Kopia Road Swamp

35 46 Takapau Bush

	RAP No.	Study No.	Site Name

CATEGORY 1

RAP No. 1 HOROHORO BLUFF

Study area No. 22	Area: 1304 ha
Ownership: Part Maori Reserve, part D.O.C., part private land, remainder Carter Holt Harvey Ltd	
NZMS 260: U16	Grid Ref.: 840230 Aerial photo: 232667
Physiographic unit: Rhyolite dome	
Bioclimatic zone: Lowland	Altitudinal range: 440-817 m

Ecological pattern

- (1.) Tawa-tawari forest/ pepperwood-(Hall's totara)(miro) on the upper slopes and summit;
- (2.) Tawa-mahoe-pukatea-(rewarewa)(rimu) forest on the colluvial fan;
- (3.) Rewarewa/kamahi-manuka-monoao regenerating on burnt western faces.

Description

A striking feature of this RAP is a very imposing escarpment with an uppermost line of cliffs, visible to the west of SH 30 about 25 km south of Rotorua. It is the result of extreme down-faulting of the eastern half of the original dome. At its north end the broad remaining summit abuts the southern rim of the Mamaku Plateau. Native forest cover is almost complete, but on the dome has been selectively logged for podocarps. Some large trees, notably Hall's totara, remain. Regeneration is occurring, although somewhat restricted by deer and possum browsing.

Vegetation

The area has exceptionally high species diversity, 192 native species having been identified to date, and more coming to notice at almost every visit (Clarkson, 1986). Several species have their national vegetation limits here, and some do not appear elsewhere in the district. Tawari (*Ixerba brexioides*) is uniquely common here. Also not recorded elsewhere are *Brachyglottis kirkii*, *Epacris alpina*, the perching orchid *Bulbophyllum pygmaeum*, and the small alpine rush *Luzula colensoi*. Many other sub-montane species exist only here and on the crest of the Paeroa Range, the highest summit in the Atiamuri Ecological District (by approx. 150 m). Although the now rare wood rose (*Dactylanthus taylorii*) has not yet been discovered here, the area is a favourable habitat and has appropriate hosts.

As the western slopes adjoining the exotic forest boundary have been cleared and burnt in the past, there is an excellent example of the natural forest regeneration pattern, almost totally free of the usual farm boundary weed infestations. This rewarewa/kamahi association, re-establishing through fire-induced low manuka-monoao scrub, is probably the most intact example of this formerly common sequence still existing in the district.

Fauna

Kokako (an endangered species), kaka, and blue duck (both threatened species), have been recorded here. The adjacent Mamaku Plateau has remnant populations of North Island kiwi, also a threatened species, which may well be present on the Horohoro Dome. A wide range of more common birds are present in the forest and on adjacent farmlands.

Modifiers or threats

Fencing is continuous between the forest-covered escarpment and adjacent farmland on the colluvial toeslope, and no sign of stock browsing was seen. However, deer and possum browsing is reducing the diversity of species regeneration, particularly in the summit forest.

Significance

Local farmers hunt in the area; walking and school groups make limited use of the steep face for outdoor recreation. There is excellent buffering on the western side, particularly in the areas abutting the Matahana Ecological Reserve and the pine forests to the north and south. The size of the area under consideration for protection should ensure its future viability.

As well as its very high value as a functioning and viable ecological unit, the area has high botanical value as the only remaining example of the tawa-tawari forest in the Atiamuri Ecological District. It has considerable aesthetic value as the skyline vista, both from State Highway 30 and as the backdrop to Rotorua City itself, when viewed from the north.

Selection criteria

Vegetation Dynamics	PM	Viability	H
Representativeness	H	Size & Shape	H
Diversity & Pattern	H	Fragility	L
Rarity	M	Buffering	H
Naturalness	H	Other Values	H

RAP No. 2 KEMP ROAD BUSH

Study area No. 32	Area: 79.6 ha
Ownership: Carter Holt Harvey Ltd	
NZMS 260: U17 Grid Ref.: 765000	Aerial photo: 232461
Physiographic unit: Rhyolite dome	
Bioclimatic zone: Lowland to sub-montane	Altitudinal range: 500-730 m

Ecological pattern

- (1.) Rewarewa-kamahi (rimu)(matai) to a height of 30-50 m on hillslopes;
- (2.) Rewarewa-kamahi/mahoe-pate(rimu)(matai) to 15-20 m on hillslopes;
- (3.) Rewarewa-kamahi/podocarps 10-15 m on hillslopes;
- (4.) Pate-*Dicksonia fibrosa-Coprosma* spp. 5-8 m on hillslopes;
- (5.) Lancewood, kohuhu, *Coprosma* spp., etc. 5-10 m, along the bush edge and 'frost flat'.

Description

Closely west of SH 1 and 6 km north of the branch road to Orakeikorako, this forested hillside is the largest and best remnant of the formerly large Maroa Forest. The lower part appears to have been selectively logged, with large cut stumps clearly visible, yet many large matai, rimu, and some totara remain. The upper portion was more heavily logged, and is now mostly secondary vegetation. The marginal alluvial pumice terrace supports a variety of divaricating shrubs, indicating the pre-European vegetation of the cold valley floors in the district.

Vegetation

Matai, rimu, and totara, the major forest trees for which the Maroa Forest was famous, are all well represented, with both adults and seedlings present. Several species indicative of higher altitude are present, namely the mountain cabbage tree, pepperwood, and mountain wineberry. Twenty-four fern species were recorded during the survey.

Fauna

Birds seen were long-tailed cuckoo, tui, whitehead, grey warbler, kereru, tomtit, robin, fantail, bellbird, and silvereye.

Modifiers or threats

Goats have been released from nearby Maori land, but numbers are now low. Moderate possum and pig sign, and deer browsing observed.

Significance

This is considered to be the most natural and representative native forest remnant seen in the district, including the existing Department of Conservation reserves. It is well buffered by surrounding exotic forests and contains a good bird population.

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	H	Fragility	M
Rarity	H	Buffering	H
Naturalness	H	Other values	H

RAP No. 3**MANGAKOWHIRIWHIRI STREAM**

Study area No. 49

Area: 178 ha

Ownership: Private farmland and a 15.58 ha Department of Conservation reserve

NZMS 260: T17

Grid Ref.: 542025

Aerial photo: 232772

Physiographic unit: Tephra over Whakamaru ignimbrite

Bioclimatic zone: Lowland

Altitudinal range: 260-320 m

Ecological pattern

- (1.) Local extensive area of almost pure tanekaha pole stands on sideslopes;
- (2.) Kamahi/mahoe-treeferns with abundant ground ferns in gullies and alongside stream;
- (3.) Rewarewa/kamahi with emergent podocarps on terraces and ridges.

Description

A north-flowing stream with a deeply incised gully in the central section flows from farms and exotic forestry land to Lake Whakamaru. The stream has cut through deep tephra and underlying ignimbrite to give a narrow valley, sloping more gently through the tephra and with steep bluffs through the harder ignimbrite. On both sides farmland or forestry border the native forest, in most places with adequate fencing. The small reserve administered by the Department of Conservation is about halfway along the gorge. Access is difficult, down steep banks; however, this enhances the integrity of this outstanding area.

Vegetation

In the upper catchment a large stand of vigorously regenerating tanekaha covers almost the entire valley. This stand is unique in the Atiamuri Ecological District (although similar areas are quite common in the neighbouring Pureora District). Very little tanekaha is present elsewhere in the district, existing merely as individual young trees along the Waikato River, and occasionally along streams in the exotic forests.

Several very large podocarps - matai, rimu, matai, and kahikatea - are present along the valley shoulders, and seedlings of these species were seen. Some parts of the valley may not have been logged, owing to the difficulty of removing timber up the steep slopes. This area has an extremely wide range of species, as the habitat varies from deep, wet gullies to steep, dry, sunny slopes. The preliminary plant list has 140 indigenous species, with the certainty of more to be located. Regeneration is good, showing the value of goat culling by the Department of Conservation. Some possum control is also being carried out by Environment Waikato staff.

Fauna

The valley supports a wide range of bird species: tui, tomtit, harrier, bellbird, silvereye, and chaffinch were seen during the survey. The stream is ideal for spawning fish.

Modifiers or threats

Blackberry is prevalent along the bush edges, and some weed species were seen within the indigenous forest. Of some concern, but not as yet serious, was the presence of barberry (*Berberis glaucocarpa*) in one small side valley. Possum sign was observed. Farmers mentioned possible presence of goats; however, none were seen. Some areas were not fenced, and in other places repairs were needed. As is common in such places, the local farmers use the forest edge to dispose of rubbish. This could undoubtedly be prevented by consultation and education.

Significance

The valley is excellent wildlife habitat, well protected by its topography, and offers little to attract farm development. Fencing stock out would seem to be in the interests of both landowners and conservation, and once completed would be relatively easy to maintain. The quality of the water appeared to be excellent, and is important to adjacent landowners who pump from the stream.

The very high botanical values have already been commented on, and the uniqueness of the tanekaha stands in the context of the Atiamuri Ecological District must be emphasised. It would be highly desirable to secure protection for the whole valley system because of its exceptional ecological value.

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	H	Fragility	L
Rarity	H	Buffering	M
Naturalness	H	Other values	H

RAP No. 4**ORAKEIKORAKO THERMAL AREA**

Study area No. 8

Area: 19.4 ha

Ownership: Orakeikorako Geyserland Resort Ltd, some Electricorp lease, and Department of Conservation covenant

NZMS 260: U17

Grid Ref.: 847985

Aerial photo: 232470

Physiographic unit: Geothermal area in a lacustrine zone

Bioclimatic zone: Lowland

Altitude: 310 m

Ecological pattern

The margins of the thermal area are predominantly kanuka-mingimingi-kohuhu shrubland with many wildling pines. Most vegetation is fairly young owing to shifting thermal vents and the consequent severe changes in soil conditions. Large areas of sinter and bare thermally altered soils. See Ecroyd (1985).

Description

An active thermal area centred on a small stream valley on the eastern shore of Lake Ohakuri.

Hot pools are also present on the western shore in the vicinity of the tourist facilities and parking area. Many springs of predominantly alkaline water flow, producing large, flat sinter terraces. In some areas acidic water is causing erosion of terraces from below. Soil temperatures under prostrate kanuka at a depth of 20 cm were in the range 46-61°C. At least 13 and at times up to 20 geysers are active in the area, the greatest concentration remaining in New Zealand, although before the filling of the Ohakuri Dam up to 90 were known (Cody 1995). Access to the main geothermal activity is by water only.

Fauna

Catfish up to about 350 mm in length have been seen here in recent months (A.D. Cody, pers. comm.).

Significance

Medium to high usage as a tourist attraction.

Selection criteria

Vegetation dynamics	P	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	M	Buffering	M
Naturalness	H	Other values	H

RAP No. 5 MARAEMANUKA STREAM

Study area No. 50	Area: 35.2 ha
Ownership: Bob & Sandra Brunt	
NZMS 260: T17 Grid Ref.: 577023	Aerial photo: 232772
Physiographic unit: Tephra over Mokai ignimbrite	
Bioclimatic zone: Lowland	Altitudinal range: 300-360 m

Ecological pattern

- (1.) Mosaic of hardwood species with large emergent matai on the gully floor;
- (2.) Totara/ treeferns/ground ferns on steep, shaded sideslopes;
- (3.) Kamahi/kohuhu/mahoe on forest edge along gully sides.

Description

A deep, steep-sided gully cutting through the ignimbrite sheet drains a valley supporting mixed farming and exotic forest. Apparently unmodified on steeper slopes, although possibly logged in accessible parts, the forest is in excellent condition as most is too steep to graze. Contains some fine matai and totara, with plentiful regeneration of a variety of broadleaf species. The gully sides are extremely steep in places, and this, combined with the limited time available, prevented a full investigation. However, it was evident that a wide range of species are present, and there is an unusually good pattern of ground cover on the steep slopes. The valley opens out into farmland and a small wetland as the stream enters Lake Whakamaru.

Fauna

Birds seen were grey warbler, magpie, finches, and fantails. Rainbow trout were seen in the stream from the bridge at the lower end of the forest.

Modifiers or threats

Sheep have access to the forest edges, owing to poor fencing. Emergent wildling pines near the upper margins could easily be removed.

Significance

The valley is excellent bird habitat, and provides a wildlife corridor from the lake edge to the upper valley hillslopes, which are variously covered by exotic plantation and fern and shrubland. There is a wide range of plant species, providing a good mixed seed source not present in the nearby Kaahu Scenic Reserve. Despite draining of farmland the water quality was high, owing probably to extensive catchment plantations further up the valley. The adjacent farm owners, fairly new to the area, were under the impression that the forest was already under DoC control, and would be pleased to see it fenced off because of the risk of stock

losses down the steep bank.

Selection criteria

Vegetation dynamics	SM	Viability	M
Representativeness	H	Size and shape	H
Diversity and pattern	H	Fragility	L
Rarity	H	Buffering	M
Naturalness	M	Other values	H

RAP No. 6 TUMUNUI BUSH

Study area No. 1 Area: 562 ha
 Ownership: Tumunui Trust
 NZMS 260: U16 Grid Ref.: 995195 Aerial photo: 232399
 Physiographic unit: Rhyolite dome
 Bioclimatic zone: Lowland to sub-montane Altitudinal range: 540-761 m

Ecological pattern

Previously podocarp/tawa forest, heavily logged, podocarp regeneration now almost totally absent. Regrowth is now predominantly tawa-rewarewa-mangeao with a diverse range of understorey species. Vegetation on steep cliffs on the north-west side was destroyed by fire long before the logging.

- (1.) Tawa-rewarewa-mangeao, canopy height 15-20 m, over the dome top and hillslopes;
- (2.) Kamahi(rewarewa) to about 10-15 m, over previously burnt areas on hillslopes;
- (3.) Kanuka-five finger-Spanish heath shrubland on steep bluffs to the north-west.

Description

An impressive forest-covered dome surrounded by pasture, and clearly visible on the west side of the Rotorua-Taupo Highway (SH 5) from near the Waimangu Road turnoff. Although heavily logged during the 1950s it has recovered well, and now appears quite natural from a distance, although an area on the southern side, not visible from the road, has been planted in pines. Old logging roads are kept open by the Maori owners, who regularly hunt here, and deer browsing also serves to keep tracks open. There are excellent fences all round, and no sign of cattle damage was seen.

Vegetation

The interior has a very fair species range, somewhat inhibited by the presence of many wild animals. The almost total absence of podocarp regeneration is unusual, although this could be expected to occur with the

natural introduction of seed from the nearby Waikorapa Bush (which has now been fenced). The steep bluffs on the north-west have not been thoroughly investigated; several orchid species are likely to be found in the appropriate season, and other species, beyond the reach of browsing animals.

Fauna

A considerable range of birds were seen: N.Z. falcon, paradise duck, tui, fantail, shining cuckoo, tomtit, whitehead, bellbird, long-tailed cuckoo, kereru, kingfisher, and rifleman.

Modifiers or threats

Pigs, deer, wallabies, and possums were all present in some numbers. Some possum control is being undertaken. The presence of such a large pool of introduced animals considerably threatens the viability of this and neighbouring forests. A large area on the southern slopes has recently been cleared and planted in pines.

Significance

The area is used extensively for hunting by the owners, who are reluctant to allow access to outsiders. Despite this, Tumunui Bush rates highly amongst the recommended areas for protection on account of its significant area, representing a considerable portion of the remaining indigenous vegetation of the Atiamuri Ecological District. It has a reasonable botanical species diversity, which would undoubtedly rapidly increase if adventive animals were reduced. Moreover it has probably the most extensive range of forest bird species encountered during the survey. It is already well fenced, but ongoing legal protection may be desirable.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	M	Buffering	M
Naturalness	M	Other values	H

RAP No. 7 HARDCASTLE LAGOON

Study area No. 66 Area: 57.4 ha

Ownership: Electricorp

NZMS 260: U17 Grid Ref.: 000940

Aerial photo: 232477

Physiographic unit: Riverine/lacustrine system

Bioclimatic zone: Lowland

Altitude: 295 m

Ecological pattern

Large areas of open water with vegetation patches, primarily of *Scirpus lacustris*. Small areas of carex sedgeland and raupo rushland. Levees have a mixed cover of exotic trees and shrubs with introduced weeds and grasses underneath.

- (1.) Aquatic vegetation and open water;
- (2.) Mixed shrubland on levee banks and faces.

Description

An extensive lagoon has been formed by a bypassed horseshoe bend on the eastern bank of the Waikato River opposite the Ohaaki Geothermal Power Station. The lagoon is still open to the river. Consequently flood debris is sometimes deposited in it, and water net (*Hydrodictyon reticulatum*) periodically covers the aquatic vegetation. In addition the water levels fluctuate daily, when Electricorp activate the Aratiatia Rapids. The lagoon is bordered by farmland, behind the levee banks and associated shrublands. Some duck shooting appears to be done, since maimai are visible in places. Large numbers of waterfowl use the lagoon.

Vegetation

During a survey by the Rotorua Botanical Society 35 indigenous and 57 introduced plants were recorded (Howard-Williams 1989). Along the levees a mosaic of willow (*Salix fragilis*) and cotoneaster (*Cotoneaster glaucophyllus*) is interspersed with patches of tall fescue, *Lotus pedunculatus*, and *Leersia oryzoides*. The sedgelands of *Carex sinclairii*, *Carex ovalis*, and other species grade into wetter herbfields of *Ludwigia palustris*, willow-weed, and patches of *Eleocharis acuta*. The channel edges are dominated by *Scirpus lacustris*, with an understorey of herbaceous plants such as *Ludwigia*, *Ranunculus flammula*, and *Callitriche stagnalis*. The adventive species *Lagarosiphon major* dominates the permanent channels, in association with *Ceratophyllum demersum* and *Elodea canadensis*. The most common native species are *Myriophyllum triphyllum* and *M. propinquum*, with *Potamogeton ochreatus*, *P. cheesemanii*, and *Nitella pseudoflabellata*. The conspicuous water lilies *Nymphaea mexicana* and *N. alba* are present also.

Fauna

A large population of water birds uses the area, as well as the common birds of the surrounding farmlands. Brown and rainbow trout, rudd, and koura are present in the river.

Modifiers or threats

The daily fluctuation of water level (approx. 1.2 m), caused by hydro-electric generation control, has a significant effect on the range of species that can survive here. Also, the seasonal flushes of the introduced

water-net have been observed to smother vegetation when water levels fall naturally in summer.

Significance

This lagoon has been rated as a Wetland of National Importance in the WERI Database of the Biological Resources Centre, and is considered an important ecological feature of the Waikato River system. Although no rare or endangered species were found, the area has high botanical value. There is a good range of aquatic vegetation, both native and introduced, and the presence of *Rorippa palustris*, an indigenous yellow marsh cress listed as being of national significance, is noted (Clarkson & Druce 1984).

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	M	Buffering	M
Naturalness	M	Other values	H

RAP No. 8 TUTUKAU BUSH

Study area No. 33

Area: 850 ha

Ownership: Maori land

NZMS 260: U17

Grid Ref.: 820990

Aerial photo: 232820

Physiographic unit: Rhyolite domes

Bioclimatic zone: Lowland-submontane

Altitudinal range: 400-803 m

Ecological pattern

A mosaic of regenerating broadleaf species on hillslopes, with treeferns in the gullies and emergent matai and mangero on the ridges. A tendency to kamahi domination on hillslopes of the higher dome to the north, and tawa on the southern ridges.

Description

A conglomeration of domes on the line of the Paeroa Fault, on the southwestern side of the Waikato River. This forest is a remnant of the Tauroa Tutukau, formerly containing rimu of exceptional height and stand density (see Vucetich & Wells 1978, photos p. 24), all removed in the logging era of the 1950s-60s (Rod Farrow, pers. comm.). The vegetation rises from the Waikato as scrub and fern, then develops into a mosaic of regenerating forest species along the range. The lower central saddle was especially heavily logged, and has a close network of logging tracks. Access is restricted by a sector of the Kinleith Exotic Forest (Carter Holt Harvey Ltd.) on the south and west, and farmlands on the east, off Tutukau and Orakeikorako roads.

Vegetation

To the north the vegetation is generally rewarewa / kamahi, regenerating in fire-induced fern and manuka. A large part of the high ridge about GR 820993, previously an old skid area, is now totally covered in pampas grass (*Cortaderia* spp.). Old logging tracks from here to the site of the old mill are kept open by pigs, and have extensive areas of bush rice grass (*Microlaena avenacea*) and hook grass (*Uncinia* spp.). In this area, and on the ridges to the south, treeferns, (mostly *Dicksonia squarrosa* and *Cyathea medullaris*) fill the gullies, and regenerating tawa and mangeao, with some large matai, cover the ridges.

It is significant that few rimu seedlings were seen, an indication of the almost total removal of all seed trees during logging. Owing to the poor quality of many of the matai, they were left standing and now provide a major seed source for regeneration, and a matai-dominated succession. Regenerating totara, miro, and kahikatea are also present.

In the marginal regenerating forest on the south a large colony of *Dactylanthus taylorii* has been located (C.E. Ecroyd, pers. comm.). There is a considerable area of suitable habitat for this parasitic plant, which is being monitored as part of the ongoing research into the ecology of the species.

A total of 97 species were recorded during the survey, among which a very high number of ferns (34 species) are a feature.

Fauna

Birds were relatively abundant, and it was pleasing to see kereru in some numbers. Also seen during the survey were tui, grey warbler, shining cuckoo, whitehead, bellbird, chaffinch, and tomtit.

Modifiers or threats

Pigs are present in very high numbers, and some deer sign was evident. Heavy possum damage was seen on five finger and kamahi trees.

Significance

This forest contains the most southerly mangeao in the central North Island, and an outstanding colony of *Dactylanthus taylorii*, an endangered species (Cameron *et al.* 1995) which is currently intensively studied. The area is a significant remainder of the previous podocarp-dominated forest of this district, and although severely modified has good potential for regeneration. A long-term covenant or reserve status, and ongoing wild animal control, will be necessary to ensure its viability.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	M	Size and shape	M
Diversity and pattern	M	Fragility	H
Rarity	M	Buffering	M
Naturalness	L	Other Values	H

RAP No. 9 TUREPOREPO BUSH

Study area No. 72

Area: 570 ha

Ownership: Maori Trust

NZMS 260: U16

Grid Ref.: 890280

Aerial photo: 236070

Physiographic unit: Eroded tephra

Bioclimatic zone: Lowland

Altitudinal range: 400-598 m

Ecological pattern

Heavily logged forest, now tawa dominant, listed as P1, M3, and N7 on NZFS Forest Type Map N76. The western end appears to have been burnt. Vegetation types present are:

- (1.) Rewarewa-kamahi forest;
- (2.) Rimu-rata/matai-tawa-kamahi forest;
- (3.) Manuka-broadleaved shrubland;
- (4.) Tree-fernland.

Description

Low, forest-covered hills to the north of SH 30 and west of the Horohoro Dome. Although logged and still dissected by logging tracks, they present a pleasant aspect as a backdrop to the surrounding farmland.

Vegetation

A wide range of common forest and shrubland species is present. The forest types here show the full range of regeneration patterns that would probably have existed in pre-European times.

Fauna

A range of common forest birds is present.

Modifiers or threats

Grazing by farm animals is a constant danger; however, pressure to clearfell and plant in pines is the

greatest long-term threat.

Significance

This remnant is one of the most easily accessible bush areas of the Atiamuri Ecological District, and is within a short distance of Rotorua city. Although recently logged there is good regeneration, and in time this would become a valuable example (although somewhat modified) of the forest types previously common in the district. The substantial area provides a good habitat for a range of birds, and is within flight range of the Horohoro Bluff for most species.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	M	Size and shape	H
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	L	Other values	M

RAP No. 10 RIVER ROAD LAKE AND WETLAND

Study area No. 28	Area: 4.6 ha
Ownership: Fletcher Challenge Forests	
NZMS 260: U17 Grid Ref.: 941941	Aerial photo: 232253
Physiographic unit: Lacustrine system	
Bioclimatic zone: Lowland	Altitude: 310 m

Ecological pattern

- (1.) Aquatic, with open water in a small central zone of approx. 250 m²;
- (2.) Raupo reedland bordering open water;
- (3.) Carex sedgeland, a small area on western shore;
- (4.) Coprosma-flax shrubland with carex-rush understorey.

Description

A wetland of 2-3 hectares with a small central lake, possibly spring-fed, occupies a natural depression between River Road and the Waikato River. The surrounding pines have been recently felled, with commendably little damage.

Vegetation

The swamp is an almost perfect example of unmodified natural vegetation so commonplace in earlier times.

The progression from clear water (no introduced lakeweeds) through raupo (*Typha orientalis*) and carex sedgeland (*Carex geminata*, *C. virgata*, *C. secta*) into rushes (*Juncus articulatus*, *J. effusus*) and mixed coprosma-flax shrubland is clearly defined, and is buffered by surrounding grassland.

The species range is typical, though small and without rare or endangered species.

Fauna

Many birds were present. The limitations on access provide protection for shy species such as fernbirds, which were seen in good numbers. Other birds seen were black shag, grey duck, silvereye, kingfisher, thrush, shining cuckoo, tui, bellbird, and grey warbler.

Modifiers or threats

There is an ever-present risk of damage from careless use of logging machinery. It is likely that the lakelet may be used as a water source for fire control.

Significance

Although small, this wetland has very high naturalness. Its location within an exotic forest minimises the risk of draining. If an agreement for protection could be reached, provision of a maintained buffer zone would ensure its survival.

Selection criteria

Vegetation dynamics	P	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	H	Fragility	M
Rarity	L	Buffering	M
Naturalness	H	Other values	H

CATEGORY 2

RAP No. 11 HOIHO ROAD SWAMP

Study area No. 42 Area: 7 ha
 Ownership: Carter Holt Harvey Ltd
 NZMS 260: T16 Grid Ref.: 655125 Aerial photo: 232833
 Physiographic unit: Riverine/lacustrine system
 Bioclimatic zone: Lowland Altitude: 380 m

Ecological pattern

- (1.) Open water, about 50 m by 20 m;
- (2.) Raupo reedland, along downstream margin;
- (3.) Baumea, flax, manuka, willow margins adjacent to pine plantations.

Description

A long, narrow strip of wetland with a small area of clear water. A culvert under the road serves as a small dam and controls the water level. Duck-shooting maimai near the road are the only intrusion on the wetland area.

Vegetation

A wide range of common wetland vegetation is present, unfortunately including many adventives. Owing to the closely surrounding pines several species not typical of wetland, such as *Pomaderris ericifolia*, *Gaultheria antipoda*, and *Aristotelia serrata*, are present. The endemic buttercup *Ranunculus macropus* was found here, but no rare or endangered species were noted.

Fauna

Birds observed were bellbird, tui, and grey duck. Australian golden bell frogs (*Litoria aurea*) were present in large numbers.

Modifiers or threats

The presence of large mature pines at the wetland margins has caused some problems, as dead trees lie across the swamp in many places. Grey willow (*Salix cinerea*) is intruding into much of the coprosma-flax shrubland, as is blackberry along the road and pine margins. Eventually logging of the pines will damage the margins, as has occurred further down the valley.

Significance

This wetland provides good bird habitat, and the riparian vegetation is in good condition. It is worth protecting with a small buffer strip.

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	L	Buffering	M
Naturalness	H	Other values	H

RAP No. 12 TEREINA ROAD SWAMP

Study area No. 55 Area: 15.1 ha
Ownership: Carter Holt Harvey Ltd
NZMS 260: T17 Grid Ref.: 667947 Aerial photo: 232742
Physiographic unit: Riverine wetland
Bioclimatic zone: Lowland Altitude: 415 m

Ecological pattern

- (1.) Flax-kohuhu shrubland with regenerating podocarps;
- (2.) Flax-toetoe shrubland with broadleaf regeneration;
- (3.) Blackberry-willow-poplar shrubland.

Description

Wetland and shrubland bordering an upper reach of Makauteure Stream, in pine forest. On the topographical map (NZMS 260, T17), the stream is shown on the wrong side of Tereina Road.

Vegetation

The vegetation shows the pattern of regeneration from open swampland, through broadleaved shrubland, and on to podocarp forest with young rimu, totara, and matai all emerging. The species list shows a good mix of native vegetation, and some exotic weeds mostly in the exotic shrubland.

Fauna

Fernbirds are common, and tui and bellbirds were also seen.

Modifiers or threats

There are many deer tracks, and wildling pines are a threat throughout. Exotic weeds are prevalent in the willow-poplar unit.

Significance

Units 1 and 2 have high value as a good example of regeneration sequence. Unit 3 is very weedy, but continues the wildlife corridor. The whole area is excellent fernbird habitat. A buffer zone between the wetland and exotic forest is desirable.

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	L	Buffering	M
Naturalness	H	Other values	H

RAP No. 13 FOREST ROAD WETLAND

Study area No. 58	Area: 49.1 ha
Ownership: Carter Holt Harvey Ltd	
NZMS 260: U17 Grid Ref.: 705910	Aerial photo: 232742
Physiographic unit: Riverine wetland	
Bioclimatic zone: Lowland	Altitude: 420 m

Ecological pattern

- (1.) Flax-toetoe-baumea swampland;
- (2.) Flax-coprosma shrubland.

Descriptions

Very extensive high-fertility wetland with unthrifty sown pines in the drier areas and surrounded by pine plantations. Access is readily available from Mokai-Oruanui Road, where the outlet stream flows through a culvert.

Vegetation

This large swamp has a wide range of species with 29 indigenous and 11 introduced plants, and although some weeds are present the overall appearance is very good. A native broom (*Carmichaelia* sp.) occurs here, along with the indigenous buttercup *Ranunculus macropus*. Also present are the native grasses *Hierochloe redolans* and *Rytidosperma gracile*.

Fauna

Several fernbirds were seen, along with tui, bellbirds, and whiteheads.

Modifiers or threats

Logging damage is possible, as pines are planted to the swamp edge. A 50 m buffer zone is desirable, as the coprosma-pittosporum shrubland is regenerating well. The pines growing within the wetland should be poisoned or ringbarked. Some deer and possum sign was seen.

Significance

This wetland contains extensive flaxland and sedgeland areas and provides good bird habitat. Access is good, as the adjacent forest road is open to the public.

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	L	Fragility	L
Rarity	L	Buffering	H
Naturalness	H	Other values	H

RAP No. 14

HAUWAI STREAM RIPARIAN STRIP

Study area No. 31

Area: 72.7 ha

Ownership: Carter Holt Harvey Ltd

NZMS 260: U17

Grid Ref.: 784015

Aerial photo: 232461

Physiographic unit: Riverine on pumice alluvium

Bioclimatic zone: Lowland

Altitudinal range: 400-500 m

Ecological pattern

A good selection of podocarp saplings and seedlings indicative of former forest type.

- (1.) Pate-fuchsia-putaputaweta-mahoe to 5-8 m over ferns in a narrow strip along stream-side;
- (2.) Kamahi-rewarewa, with scattered podocarps to 8-10 m on sideslopes throughout;
- (3.) Tanekaha, other podocarps, and divaricating shrubs on a small 'frost flat' upstream of Wilson Rd.

Description

Olive Road gives access to the Hauwai Stream, which is close to the pylon corridor. The stream runs through a deep gully with a riparian flat, in some places parallel to the road for a distance. In the upper catchment, where it crosses Wilson Road, the stream bed is open and wide, and is shaded by mature pine forest. Here is one of the few sites of tanekaha regeneration in the Atiamuri Ecological District

Vegetation

Within the stream catchment are six podocarp species: kahikatea, rimu, tanekaha, totara, miro, and matai. Ferns are also strongly represented, with 15 species seen during the survey, and the spider orchid (*Corybas trilobus*) also.

There is very strong, healthy regeneration, especially alongside the stream within the deep gorge. Notable are the 'frost flat' divaricates such as rohutu, pokaka, and *Melicope simplex*.

Fauna

Birds seen were tui, whitehead, tomtit, fantail, kereru, silvereye, robin, and bellbird.

Modifiers or threats

Pampas, a common weed species in exotic forests, was present in one area. There is some erosion risk in the deeply incised stream system, although the vegetation cover is the best possible protection, and a recurring risk of logging damage.

Significance

The valley contains a unique seed source, readily distributed by the wide range of bird species present, and is part of a wildlife corridor extending from Lake Atiamuri to the extensive Tutukau Bush (RAP No. 8). There are low weed numbers, a high number of native seedlings and saplings, and little browsing.

Selection criteria

Vegetation dynamics	S	Viability	H
Representativeness	II	Size and shape	M
Diversity and pattern	M	Fragility	M
Rarity	M	Buffering	M
Naturalness	H	Other values	H

RAP No. 15

ORUANUI BUSH

Study area No. 40

Area: 76.9 ha

Ownership: Andrew Brown, E.R. Hall, and Maori land

NZMS 260: U17

Grid Ref.: 720885

Aerial photo: 232227

Physiographic unit: Rhyolite dome

Bioclimatic zone: Lowland

Altitudinal range: 600-700 m

Ecological pattern

Previously logged and partially burnt. Now a mosaic of rewarewa, kamahi, and mahoe, with some podocarps on ridges, and fuchsia and mahoe on the flats and in valleys.

- (1.) Kamahi-mahoe to 8-10 m high, with emergent rewarewa and podocarps to 10-15 m on hillslopes;
- (2.) Fuchsia-mahoe-wineberry to 8-10 m on hillslopes.

Description

This is the most worthwhile remnant of the former Oruanui Forest, frequently mentioned by early European travellers. All the formerly abundant podocarps were felled before World War II. The site is characterised by gentle hillslopes and open valleys, partially fenced but grazed in places. Surrounding it are 'lifestyle blocks' and some Maori land.

Vegetation

The forest contains a characteristic mosaic of broadleaved species, with ferns where stock cannot enter. There are some regenerating podocarps: young rimu, totara, miro, and matai were seen. Overall the condition of the forest appears to be improving.

Fauna

Bellbird, fantail, grey warbler, chaffinch, and tomtit were seen during a brief visit.

Modifiers or threats

Stock damage is currently the greatest problem. Some sections are well fenced, and the increase in understorey plants there is very obvious. Damage by possums appears to be relatively slight.

Significance

The forest is well worth protecting; it is very significant as a wildlife refuge. There are high aesthetic

values for residents of adjacent blocks, access is easy, and if the area were reserved there are excellent picnic spots.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	M	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	L	Buffering	M
Naturalness	M	Other values	H

RAP No. 16 WAIPAPA STREAM GEOTHERMAL AREA

Study area No. 43

Area: 2.8 ha

Ownership: Carter Holt Harvey Ltd

NZMS 260: T17

Grid Ref.: 677008

Aerial photo: 232777

Physiographic unit: Geothermal feature in ignimbrite sheet

Bioclimatic zone: Lowland

Altitude: 280 m

Ecological pattern

A series of hot springs discharging clear, neutral water at approx. 65-70°C, with very little sinter deposit (Cody 1995). Thermal vegetation is dense around the outflows, and algae are present in the spring waters.

Description

Access to the springs is via an old bulldozed track about 600 m south of the junction of Mulberry Road with Laurel Road. A small series of hot springs in the valley floor flow into the Waipapa Stream in an area of intensive *Pinus radiata* forestry.

Vegetation

Christella dentata 'N.Z.' is profuse in the vicinity of the larger springs in association with *Gleichenia dicarpa*, kiokio (*Blechnum* 'blackspot'), and the thermal clubmoss *Lycopodium cernuum*. Also recorded previously (Beadel & Clarkson 1986), but not found during either of our two visits, was the fern ally *Psilotum nudum*.

A range of typical second-growth species (karamu, kanuka, tutu, mingimingi, koromiko, etc.) surrounds the springs. The cyclical activity of planting and logging the exotic plantation obviously influences the character of this vegetation. Despite this the flora seems to be remarkably stable, and shows close agreement with the list of Ecroyd (1979c).

Modifiers or threats

The surroundings of the springs were bulldozed during the last logging sequence to give access to forestry workers. Evidence was seen that one spring is frequently used for scalding pigs.

Significance

This is an isolated area containing the third-best population of *Christella dentata* 'N.Z.' in New Zealand (Beadel & Clarkson 1986). Every report sighted since about 1979 has recommended some form of protection for this area. The springs themselves are rated as regionally significant, C2 classification, in Cody (1995).

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	M	Size and shape	M
Diversity and pattern	L	Fragility	L
Rarity	M	Buffering	H
Naturalness	M	Other values	H

RAP No. 17

MILL ROAD WETLAND

Study area No. 59

Area: 17.9 ha

Ownership: Carter Holt Harvey Ltd

NZMS 260: T17

Grid Ref.: 688940

Aerial photo: 232742

Physiographic unit: Wetland on a tephra deposit

Bioclimatic zone: Lowland

Altitude: 460 m

Ecological pattern

- (1.) Manuka-flax-coprosma shrubland/*Baumea* and *Gleichenia dicarpa*;
- (2.) *Baumea* and *Blechnum* sedge-fermland;
- (3.) Flax-manuka-coprosma shrubland.

Description

A fairly extensive modified wetland area with regeneration, to the north of Mill Road. From appearances it has possibly been burnt over.

Vegetation

The usual range of swamp *Coprosma* spp. and kohuhu, with monoao and introduced weeds such as Spanish heath, Himalayan honeysuckle, broom, and pines. The endemic buttercup *Ranunculus macropus* is present.

Fauna

There is a large population of fernbirds, and tui, bellbird, whitehead, tomtit, grey warbler, yellowhammer, and harrier were also seen.

Modifiers or threats

Deer and possums are present. As usual, the threat from logging is very high.

Significance

The large fernbird population and the variety of other birds is a feature.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	L	Fragility	M

Rarity	L	Buffering	M
Naturalness	H	Other values	H

Diversity and pattern	L	Fragility	M
Rarity	L	Buffering	L
Naturalness	H	Other values	H

RAP No. 19 TOREPATUTAHİ STREAM

Study area No. 71 Area: 85 ha
 Ownership: Various
 NZMS 260: U17 Grid Ref.: 009956 Aerial photo: 232477
 Physiographic unit: Riverine system
 Bioclimatic zone: Lowland Altitude: 300 m

Ecological pattern

Raupo reedlands along river side, with cabbage trees and occasional coprosma on stream banks. Mostly heavily infested with blackberry and willows.

Description

Extensive riparian swamplands along the stream. Much modified by farming practices - in some places clearing and cultivation are evident right to the very bank of the stream.

Fauna

Many water birds use the area; species seen were pukeko, ducks, and harriers.

Modifiers or threats

Cultivation and other soil disturbance is the major concern, with persistent stock damage through unrestricted grazing.

Significance

Shallow riparian swamps and reedlands are now rare in the district. This is the most extensive area of the type remaining.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	H	Size and shape	H
Diversity and pattern	M	Fragility	M

Rarity	L	Buffering	L
Naturalness	M	Other values	H

RAP No. 20

MAROANUI HILL

Study area No. 39

Area: 313 ha

Ownership: McGloughlin Family Trust, Carter Holt Harvey Ltd, and Maori land

NZMS 260: U17

Grid Ref.: 735938

Aerial photo: 2324829

Physiographic unit: Rhyolite dome

Bioclimatic zone: Lowland to sub-montane

Altitudinal range: 500-897 m

Ecological pattern

Heavily logged podocarp forest on lower slopes now mainly a kamahi-mahoe-broadleaved association. Above about 750 m a transition to horopito-kamahi occurs. All in indifferent condition, owing to heavy grazing on lower slopes and kamahi dieback on upper slopes.

Description

A forest-covered dome to the west of SH 1 near the turnoff to Orakeikorako. Pasture surrounds the forest except along the long northwestern boundary, where it abuts the exotic plantations of Carter Holt Harvey Ltd. Access is across farmland, using an old logging track that services the multiple repeater installations on the dometop. The private reserve area is reasonably well fenced, although both fences and gates need some maintenance.

Vegetation

The upper slopes are high enough for occurrence of sub-montane species such as Hall's totara and horopito. Although no unusual species were noted there is a good range of regeneration occurring within the fenced area. Three podocarps - rimu, miro, and matai - were present, as well as black maire, haumakaroa, and kaikomako, all amongst a mosaic of kamahi and mahoe.

Fauna

Birds recorded were grey warbler, harrier, and shining cuckoo.

Modifiers or threats

The lower slopes are regarded as a grazing area by the owner, who is outspoken in his intention to continue "doing his own thing", and some illegal logging takes place as well. Comments were made that the administration of the private Reserve is fairly casual.

Significance

The Reserve area is already fenced, although repairs are needed, and the road gives good access to uncommon sub-montane vegetation. On the basis of size alone this hill forest is very significant, but only if

further heavy stock damage can be prevented.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	L	Size and shape	H
Diversity and pattern	M	Fragility	M
Rarity	M	Buffering	M
Naturalness	M	Other values	M

RAP No. 21

MANGAMINGI STATION BUSH

Study area No. 36

Area: 78 ha

Ownership: Landcorp, Mangamingi Station (Manager Mike O'Driscoll)

NZMS 260: U17

Grid Ref.: 845015

Aerial photo: 232456

Physiographic unit: Rhyolite dome

Bioclimatic zone: Lowland

Altitudinal range: 560-640 m

Ecological pattern

A heavily logged outlier of the Paeroa Range forest showing regeneration of podocarps-rewarewa-mangeo-kamahi.

Description

Patches of remnant podocarp-tawa forest with old logging tracks and skid sites. To be clear-felled, except within existing fenced area.

Fauna

Harrier, tui, turkey, magpie, kingfisher, tomtit, fantail, blackbird, whitehead, redpoll, yellowhammer, bellbird, shining cuckoo, silvereve, and grey warbler were seen.

Modifiers or threats

Some radiata pine along edges; moderate possum numbers.

Significance

Excellent podocarp regeneration and little browsing sign. Some fence repairs needed (possibly now covenanted).

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	M	Size and shape	H
Diversity and pattern	M	Fragility	L
Rarity	L	Buffering	L
Naturalness	M	Other values	M

RAP No. 22 TRAM ROAD RIPARIAN STRIP

Study area No. 56 Area: 26.7 ha
 Ownership: Carter Holt Harvey Ltd
 NZMS 260: T17 Grid Ref.: 698951 Aerial photo: 232742
 Physiographic unit: Riparian on pumice alluvium
 Bioclimatic zone: Lowland Altitude: 420 m

Ecological pattern

Flax-carex sedgeland with broadleaved regeneration on valley floor.

Description

A shallow stream and associated small floodplain within exotic forest.

Vegetation

The normal range of swamp species for this district is present. However, a few less common species - mountain wineberry, narrow-leaved mahoe, and the crepe fern *Leptopteris hymenophylloides* - indicate either higher rainfall or lower temperatures than usual.

Fauna

Many fernbird and tui were seen, as well as whitehead, tomtit, blackbird, robin, kingfisher, and fantail.

Modifiers or threats

Possum and pig sign were seen.

Significance

Good bird habitat - lots of tui and fernbird. A buffer zone to the exotic plantation is desirable.

Selection criteria

Vegetation dynamics	PM	Viability	H
Representativeness	M	Size and shape	M
Diversity and pattern	L	Fragility	M
Rarity	L	Buffering	M
Naturalness	H	Other values	H

RAP No. 23 "SPRING VALLEY"

Study area No. 61 Area: 2 ha
Ownership: Spring Valley Station
NZMS 260: U17 Grid Ref.: 717910 Aerial photo: 232228
Physiographic unit: ‘Frost flat’ on pumice alluvium
Bioclimatic zone: Lowland Altitude: 460 m

Ecological pattern

A remnant of 'frost flat'-type shrubland along the edge of cultivated terraces.

Description

A small remnant of streamside shrubland, visible on the north side of Mokai-Oruanui Road across the Ongarahu Stream.

Vegetation

A unique remnant containing *Olearia virgata* (one plant), a species previously common but now to be found only as a few scattered plants within the Atiamuri Ecological District. *Coprosma acerosa* var. 'brunnea', *Stackhousia minima*, and *Celmisia gracilentia*, common at the turn of the century but now seldom seen in the district, are also present. Other plants characteristic of colder zones are *Arisotelia fruticosa*, *Leucopogon fraseri*, and *Podocarpus hallii*. For such a small area a list of 15 fern species is also significant.

Modifiers or threats

The area is totally unprotected from stock grazing, and is on the edge of a winter fodder paddock. Erosion of the stream terraces due to grazing could also be a problem.

Significance

Owing to its unique vegetation, this small area is highly important. It needs to be fenced off to ensure any protection. The topography lends itself to this, and would not involve any large area of good grazing land.

Selection criteria

Vegetation dynamics	PM	Viability	L
Representativeness	H	Size and shape	M
Diversity and pattern	H	Fragility	H

Rarity	H	Buffering	L
Naturalness	L	Other values	H

RAP No. 24 WHANGAIROROHEA HOT POOL

Study area No. 78 Area: 1 ha
 Ownership: Paeroa South Block, Maori Land Trust (Chairman Mr Kusabs, Rotorua)
 NZMS 260: U17 Grid Ref.: 931947 Aerial photo: -
 Physiographic unit: Geothermal feature in tephra terrace
 Bioclimatic zone: Lowland Altitude: 300 m

Ecological pattern

Totally surrounded by pines due for milling about 2003. Some blackberry, but mostly clean pasture.

Description

A hot pool 35 m in diameter with no outflow on a pumice terrace about 5 m above a stream bed. The spring water has a pH of 7.0 at 40°C and produces no sinter deposits. This spring has never been studied, and is a unique feature of high scientific interest owing to both its location and structure (Cody 1995). It is not associated with any known geothermal or geophysical anomaly.

Vegetation

Pinus radiata plantation.

Modifiers or threats

Logging or damage by stock or vandalism are the greatest threats.

Significance

Geologically this a unique feature, of very high scientific value, and classified B2 by Cody (1995). Ideally it needs a ring fence at a radius of about 100 m, and control of the encroaching blackberry within that area.

Selection criteria

Vegetation dynamics	M	Viability	M
Representativeness	H	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	H	Buffering	L
Naturalness	H	Other values	H

RAP No. 25

SUN CLUB, ORAKEIKORAKO

Study area No. 9

Area: 10 ha

Ownership: Rotorua Sun Club (caretaker normally on site)

NZMS 260: U17

Grid Ref.: 848992

Aerial photo: 232470

Physiographic unit: Geothermal feature in tephra

Bioclimatic zone: Lowland

Altitude: 330 m

Ecological pattern

Thermally altered and heated soils, with consequent low species diversity. Prostrate kanuka-*Dicranopteris linearis*-*Gleichenia dicarpa*.

Description

An active thermal area with little free water. Mostly small steam vents from badly decomposed soils under prostrate kanuka. The surrounding vegetation is second growth on formerly burnt hillslopes.

Vegetation

Mostly prostrate kanuka, with tangle fern and *Dicranopteris linearis* round the edges. The thermal clubmoss *Lycopodium cernuum* is also present.

Fauna

There are unconfirmed reports of kiwi in the area since logging of the adjacent exotic forest commenced (V. Froude, pers. comm.)

Modifiers or threats

Some concerns are held over the introduction of many exotic species in forest-edge plantings around camping areas. Wildling pines are present throughout.

Significance

Recreational use is made of the area by club members, but the thermal area is visited only occasionally. For purposes of PNA recommendation it should perhaps be considered jointly with the Orakeikorako Thermal Area, to which it geologically belongs.

Selection criteria

Vegetation dynamics	P	Viability	M
Representativeness	M	Size and shape	M

Diversity and pattern	L	Fragility	L
Rarity	L	Buffering	M
Naturalness	M	Other values	M

RAP No. 26**PAKURI BLOCK, KIWITAHİ LEASE**

Study area No. 41

Area: 45.7 ha

Ownership: Maori land, Pakuri Block (Manager Mike Proser, Kiwitahi Station)

NZMS 260: U17

Grid Ref.: 718883

Aerial photo: 232227

Physiographic unit: Tephra hillslopes over ignimbrite

Bioclimatic zone: Lowland

Altitudinal range: 640-717 m

Ecological pattern

Previously logged and partially burnt. Now a mosaic of rewarewa, kamahi, mahoe, and tarata to 10-12 m, with some podocarps emerging, on hillslopes.

Description

This is another small remnant of the Oruanui forest. There are gentle hillslopes and open valleys, only partially fenced and grazed in places. Some 'lifestyle blocks' and some Maori Land adjoin.

Vegetation

A mosaic of regeneration; where there is no grazing pressure a wide range of ferns are evident. Totara, miro, and matai are present, and some wildling pines throughout.

Fauna

Grey warbler, tomtit, fantail, and bellbird were seen.

Modifiers or threats

Very high possum numbers. Neighbours sometimes open gates and allow cattle in.

Significance

Wildlife and aesthetic values for surrounding 'lifestyle blocks'. Very good but incomplete fencing.

Selection criteria

Vegetation dynamics

SM

Viability

H

Representativeness	L	Size and shape	H
Diversity and pattern	L	Fragility	L
Rarity	L	Buffering	M
Naturalness	M	Other values	M

RAP No. 27 HAKERETEKE STREAM BUSH

Study area No. 79

Area: 44 ha

Ownership: Forestry company (ex Wedd property); managed by Asset Forestry Ltd, Whakatane

NZMS 260: U16 Grid Ref.: 033163

Aerial photo: 232372

Physiographic unit: Deep tephra deposits

Bioclimatic zone: Lowland

Altitudinal range: 440-520 m

Ecological pattern

A relatively young stand of rewarewa/kamahi with abundant heavily browsed tree ferns beneath.

- (1.) Rewarewa/kamahi/wheke forest on hillslopes;
- (2.) Rewarewa treeland on hillslopes;
- (3.) Pasture grass/carex and shrubland in valley floor.

Description

The headwaters of the Hakereteke Stream, 3 km northwest of Rainbow Mountain, containing two small remnants of regenerating bush plus one area on which all kamahi has been felled. See photo frontispiece in Vucetich & Wells (1978).

Vegetation

A restricted range of species typical of regenerating kamahi-rewarewa forest; no palatable species, owing to years of grazing.

Fauna

Chaffinch, blackbird, tui, spur-winged plover, harrier, and fantail were seen.

Modifiers or threats

An Asset Forestry Ltd application to clearfell made to the Rotorua District Council was granted on 10 November 1995 .

Significance

The area of remnant is about 12 ha, but if both patches were included with the valley floor it would become a significant wildlife corridor bridging the Waikite Wildlife Management Reserve to Lake Ngahewa and Rainbow Mountain. The area is almost completely fenced.

Selection criteria

Vegetation dynamics	SM	Viability	M
Representativeness	H	Size and shape	M
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	H
Naturalness	M	Other values	M

RAP No. 28 POHATUROA

Study area No. 38	Area: 26.5 ha
Ownership: Carter Holt Harvey Ltd	
NZMS 260: U17 Grid Ref.: 729069	Aerial photo: 232648
Physiographic unit: Rhyolite dome	
Bioclimatic zone: Lowland	Altitudinal range: 300-520 m

Ecological pattern

Planted in pines in 1927, before which it was sparsely covered in monoao, manuka, and flax (see Duncan, 1918, photo p. 36). The trees are now up to about 60 m high. Beneath is a subcanopy of shrubs and ferns with sparse ground cover except on steep cliff faces, where xerophytic species abound.

Description

An isolated rhyolite dome surrounded by a river terrace, and clearly visible downstream of the Atiamuri bridge on SH 1. Public access is via a good track and steps up the steep southern side. The Ngati Kahupungapunga tribe had a pa on the summit in pre-European times. Some pits are still evident, and there are records of old shelter caves in the vicinity (N.Z. Archaeological Association, site records U17/1, /2, /3, /4).

Vegetation

A good range of secondary shrubs, including *Dracophyllum strictum*; and 14 fern species are present.

Fauna

Whitehead, tomtit, and bellbird were seen.

Modifiers or threats

Other than the possible damage from logging, there are few foreseeable problems here.

Significance

A well known pa site, with cultural and archaeological values, and an interesting climb for visitors. Tracks and carparks managed as a recreational facility by Carter Holt Harvey Ltd.

Selection criteria

Vegetation dynamics	SM	Viability	H
Representativeness	L	Size and shape	H
Diversity and pattern	M	Fragility	M
Rarity	L	Buffering	L
Naturalness	L	Other values	M

Ecological pattern

Description

Vegetation

Fauna

Modifiers or threats

Significance

Selection criteria

Vegetation dynamics	M	Viability	M
Representativeness	M	Size and shape	M
Diversity and pattern	L	Fragility	M
Rarity	L	Buffering	M
Naturalness	M	Other values	M

RAP No. 30 BRACEY ROAD WETLAND

Study area No. 34 Area: 3.6 ha
 Ownership: Carter Holt Harvey Ltd
 NZMS 260: U17 Grid Ref.: 715932 Aerial photo: 232829
 Physiographic unit: Riverine system on pumice alluvium
 Bioclimatic zone: Lowland Altitude: 470 m

Ecological pattern

Grading from flax-toetoe at the drier eastern end to flax-toetoe-*Coprosma propinqua*, which is the dominant vegetation type. Below the dam, *Juncus*/marsh bedstraw is predominant.

Description

A long and narrow wetland approx. 600 m x 60 m, crossed by Bracy Rd at its lower end. A logging dam divides it near the centre.

Vegetation

The native fireweed (*Senecio minimus*) occurs here, and mountain wineberry, in association with the common shrubs. In the deeper water of the dam is the endemic buttercup *Ranunculus macropus*.

Fauna

Tui, bellbird, robin, harrier, whitehead, grey warbler, and tomtit were seen.

Modifiers or threats

Pig numbers are very high, with abundant wallows in the *Juncus articulatus* rushlands. Evidence of frequent bulldozing and regular logging indicate the desirability of a buffer to the plantation forestry operations.

Significance

Wildlife habitat values.

Selection criteria

Vegetation dynamics	PM	Viability	M
Representativeness	M	Size and shape	M
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	M

Naturalness	M	Other values	M
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Vegetation dynamics	SM	Viability	M
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Representativeness	L	Size and shape	H
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	M
Naturalness	L	Other values	L

RAP No. 33**RAWHITI LAGOON**

Study area No. 67

Area: 31 ha

Ownership: Electricorp

NZMS 260: U17 Grid Ref.: 980908

Aerial photo: 232237

Physiographic unit: Riverine/lacustrine

Bioclimatic zone: Lowland

Altitude: 295 m

Ecological pattern

Minor swampland communities occur throughout the area, with many exotic weed species prevalent. Raupo occurs along the lagoon margins, and both meadow and sedgeland species are present. In deep-water areas, beds of *Myriophyllum* and hornwort occur, with scattered *Potamogeton* and starwort.

Description

This lagoon is formed within the arms of a small horseshoe bend, on the eastern bank of the Waikato River just upstream of the Ohaaki Bridge. The lagoon is almost completely surrounded by a willow-covered levee, has less open water than Hardcastle Lagoon, and water flow from the river is more restricted.

Vegetation

Twenty-eight indigenous taxa and 37 adventive taxa (fewer than at Hardcastle Lagoon) have been recorded (Howard-Williams 1989).

Fauna

No records are available.

Modifiers or threats

Introduced weeds and stock damage appear to be the major threats.

Significance

Although no rare or endangered species were found, the area is of some botanical value. The presence of *Rorippa palustris* has been noted (Clarkson & Druce 1984).

surface.

Significance

Fernbirds are common - good habitat for these and nectar feeders. Fencing is not required, but a buffer zone and weed control would help.

Selection criteria

Vegetation dynamics	PM	Viability	L
Representativeness	M	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	M	Buffering	L
Naturalness	M	Other values	M

RAP No. 35 TAKAPAU BUSH

Study area No. 46 Area: 291 ha
 Ownership: Waipapa Trust (Manager Denis Gaten, Otanepae Station)
 NZMS 260: T17 Grid Ref.: 615890 Aerial photo: 232717
 Physiographic unit: Deep tephra on ignimbrite sheet
 Bioclimatic zone: Lowland to sub-montane Altitudinal range: 580-699 m

Ecological pattern

Previously a podocarp forest, heavily logged, burnt, and grazed. Now a mosaic of broadleaved shrubs and trees with old remnant matai. One large patch of regenerating matai-totara.

- (1.) Kamahi-fuchsia-mahoe-wineberry (matai) tree shrubland, to 8-15 m, on hillslopes;
- (2.) Matai-totara/kamahi-pittosporum-mahoe broadleaved forest, on hillslopes.

Description

Rolling hill country to the east of Wereta Road, with forest remnants fenced into blocks, mostly grazed.

Vegetation

Similar to RAP 32, which it adjoins. Also contains lowland ribbonwood, hinau, and pokaka, and has one area of excellent pole totara, which the owners intend to fence (but possibly for future cultural use?).

Fauna

N.Z. falcón, tui, quail, magpie, finches, pheasant, fantail, grey warbler, and bellbird were seen.

Modifiers or threats

One block to be fenced and removed from grazing, but always subject to changes in Trust management.

Significance

Good bird habitat, and has values as tribal land. Could be of conservation value because of its size, but would require fencing and covenant.

Selection criteria

Vegetation dynamics	SM	Viability	M
Representativeness	L	Size and shape	H
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	L	Other values	L

CATEGORY THREE

RAP No. 36

WHAKAMARU GEOTHERMAL AREA

Study area No. 77

Area: 1.4 ha

Ownership: Bob & Sandra Blunt

NZMS 260: T17

Grid Ref.: 615045

Aerial photo: 232782

Physiographic unit: Geothermal spring in lacustrine/riparian zone

Bioclimatic zone: Lowland

Altitude: 230 m

Ecological pattern

Reverting from pasture to manuka scrub and weeds.

Description

Two small pools excavated in the river bank; heated ground occurs for about 70 m along the shoreline. Water flow is perhaps several litres per second, at a temperature of about 75°C.

Vegetation

Manuka scrub.

Fauna

Ducks and shags were seen.

Modifiers or threats

Stock have free access.

Significance

Not of any great significance. Rated C2 in Cody (1995).

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	L	Size and shape	L
Diversity and pattern	L	Fragility	L
Rarity	L	Buffering	M
Naturalness	L	Other values	L

RAP No. 37

TIROHANGA ROAD GEOTHERMAL AREA

Study area No. 74

Area: 16 ha

Ownership: Tuaropaki Trust (Manager Rusty Morris)

NZMS 260: T17

Grid Ref.: 634958

Aerial photo: 232746

Physiographic unit: Geothermal springs on pumice alluvium

Bioclimatic zone: Lowland

Altitude: 500 m

Ecological pattern

Dominated by exotic pasture, with a mixture of mingimingi, manuka, bracken, blackberry, water fern, ring fern, *Hypolepis ambigua*, turutu, and kanuka, with scattered kamahi (Beadel & Clarkson 1986).

Description

Contains one clear acid bath spring (Ohineariki) and two large boiling mudpools.

Vegetation

See above.

Fauna

None.

Modifiers or threats

Radiata pine log lying across one mud pool; another pool has been used as a rubbish dump.

Significance

The mudpools are unique regionally and nationally on account of their large size. The bath and some small fumaroles are used by local Maori for bathing and cooking. Rated B3 by Cody (1995).

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	M	Size and shape	M
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	L	Other values	H

RAP No. 38

SPENCER ROAD BUSH

Study area No. 54

Area: 78.5 ha

Ownership: B.G. Bull

NZMS 260: T17

Grid Ref.: 595980

Aerial photo: 232747

Physiographic unit: Tephra on ignimbrite and part rhyolite dome

Bioclimatic zone: Lowland

Altitudinal range: 500-660 m

Ecological pattern

Formerly totara-dominant forest, heavily logged. Now predominantly mahoe-fuchsia-treeferns to 6-8 m with patches of young totara and rewarewa to 15-20 m emerging.

Description

Predominantly northeast-facing hillside, undulating and rising to a high ridge.

Vegetation

A mosaic of unpalatable regeneration species, but also contains many young podocarps (rimu, totara, and matai), which are missing from the adjacent Tirohanga Scenic Reserve.

Fauna

Tui, bellbird, kereru, fantail, and kingfisher were seen.

Modifiers or threats

Heavy grazing is preventing the regeneration of any except unpalatable species. Understorey very eaten out.

Significance

Contains a lot of young podocarps, which could provide the seed source to help regeneration in the district. Only a small amount of new work would complete a ring fence; however, it is doubtful whether the owner would forego this amount of grazing.

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	L	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	M	Buffering	L
Naturalness	M	Other values	M

RAP No. 39

PAERATA ROAD GEOTHERMAL AREA

Study area No. 75 Area: 16 ha
 Ownership: Tuaropaki Trust (Manager Rusty Morris)
 NZMS 260: T17 Grid Ref.: 634958 Aerial photo: 232746
 Physiographic unit: Geothermal springs in pumice alluvium
 Bioclimatic zone: Lowland Altitude: 500 m

Ecological pattern

Juncus effusus rushland, *Carex virgata* sedgeland, blackberry-bracken-lupin-fern-shrubland. Prostrate kanuka and mingimingi scrub (Beadel & Clarkson 1986).

Description

Contains an extensive area of acid thermal activity, mud cones, pools, and lakelets. The strongly boiling mud pool appears to have recently erupted, as fresh muddy ejecta lies over the surrounding ground and scrub (Cody 1995).

Vegetation

Gleichenia microphylla, *Lycopodium cernuum*, *Psilotum nudum*, *Doodia media* subsp. *australis*, and prostrate kanuka are the plants of interest here.

Fauna

None seen.

Modifiers or threats

Stock have access and are damaging all features.

Significance

The boiling mud pools are classified B3, and the Ohineariki bath pool B2 by Cody (1995). The springs have strong cultural significance to the owners.

Selection criteria

Vegetation dynamics	M	Viability	L
Representativeness	M	Size and shape	M
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	L	Other values	M

RAP No. 40 RIVER ROAD WETLAND

Study area No. 29	Area: 10.8 ha
Ownership: Fletcher Challenge Forests	
NZMS 260: U17 Grid Ref.: 930926	Aerial photo: 232484
Physiographic unit: Wetland on pumice alluvium	
Bioclimatic zone: Lowland	Altitude: 350 m

Ecological pattern

A small juncus-ranunculus wetland being rapidly encroached on by grey willow. Small remnants of manuka, *Coprosma* spp., flax, and *Carex* spp.

Description

A small swamp now surrounded by drained pasture. Spring fed, with an apparent raised peat dome in the centre. Cut drains around the perimeter reduce stock entry to some extent.

Vegetation

The normal range of swamp species; the only unusual specimen was *Amelanchier lamarckii*, a rare adventive not previously recorded in the district (Webb *et al.* 1988).

Fauna

Chaffinch, yellowhead, pukeko, blackbird, thrush, and sparrow were seen.

Modifiers or threats

Greatly threatened by both grazing and drainage.

Significance

If shown to be a true peat dome, may be the only one left in the district. If it is to be protected it will need control of both willow and blackberry.

Selection criteria

Vegetation dynamics	PM	Viability	L
Representativeness	L	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	M	Other values	M

RAP No. 42 MAROTIRI ROAD BUSH

Study area No. 44	Area: 94.8 ha
Ownership: Waipapa Trust	
NZMS 260: T17 Grid Ref.: 600950	Aerial photo: 232739
Physiographic unit: Tephra on rhyolite dome	
Bioclimatic zone: Lowland to sub-montane	Altitudinal range: 540-690 m

Ecological pattern

Logged and burnt forest, previously grazed. Now in reverting kamahi-mahoe forest

with podocarp seedlings emerging.

- (1.) Kamahi-rangiora-wineberry with emerging rewarewa on hillslopes;
- (2.) Treefern-broadleaved shrubland with emerging rewarewa and podocarps on hillslopes;
- (3.) Bracken-broadleaved shrubland on hillslopes;
- (4.) Kamahi-mahoe-fuchsia with emerging rewarewa on hillslopes.

Description

A narrow crescent of remnant forest covering the tableland and a small escarpment of a small rhyolite dome.

Vegetation

The podocarps Hall's totara, rimu, and matai are present, and hinau occurs also. A surprise here is the total of 21 fern species recorded, especially since the forest is used as a deer paddock.

Fauna

New Zealand falcon, sulphur-crested cockatoo, grey warbler, tomtit, magpie, fantail, kereru, tui, and bellbird were recorded.

Modifiers or threats

Used as a deer paddock. Possums are being controlled to low numbers.

Significance

The area has potential for good regeneration, and has increasing kereru numbers (Bob Andrews, pers. comm.), but its use as a deer enclosure threatens long-term viability.

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	L	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	M
Naturalness	L	Other values	L

Study area No. 65	Area: 87 ha
Ownership: Department of Conservation, and sulphur extraction company	
NZMS 260: U17	Grid Ref.: 876815
Aerial photo: 232197	
Physiographic unit: Geothermal area	
Bioclimatic zone: Lowland	
Altitude: 360 m	

Ecological pattern

An area of approximately 36 ha would have originally been covered with manuka-mingimingi scrub. Most has been devastated by mining activities. The Department of Conservation allocation contains a sparse thermal vegetation with few species of botanical significance.

Description

To the west of the Broadlands road, about 12 km from Taupo, an acidic shallow lake occupying a hydrothermal explosion crater. Drained by the Parariki Stream, and has a small active geothermal field on the northern side. The surrounding land is flat to undulating, with some pine plantations but mostly pasture. Commercial sulphur extraction has severely altered the thermal area and vegetation.

Vegetation

Kanuka, manuka, and mingimingi, with wildling pines. Limited areas of thermal vegetation.

Fauna

Although only fantails were recorded, the area is used as a breeding site by black-billed gulls (J. Innes, pers. comm.)

Modifiers or threats

A geothermal power station is planned for the site.

Significance

Judged by both Given and the Clarksons as of low botanical significance (Clarkson *et al.* 1989).
Rated C1 by Cody (1995).

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	L	Size and shape	M
Diversity and pattern	L	Fragility	H

Rarity	L	Buffering	L
Naturalness	L	Other values	L

RAP No. 44**KIWITAHİ BACK BUSH**

Study area No. 52 Area: 65 ha

Ownership: Ivan Swan

NZMS 260: T17

Grid Ref.: 686883

Aerial photo: 232225

Physiographic unit: Tephra on small rhyolite dome

Bioclimatic zone: Lowland

Altitudinal range: 600-740 m

Ecological pattern

Heavily logged by the Taupo Totara Timber Co. A much dissected grassed treeland with a low canopy of kamahi-tarata-mahoe and tree fuchsia on hillslopes.

Description

Generally south-facing slopes, with farm roads and tracks.

Vegetation

A mosaic of secondary vegetation.

Fauna

Bellbird, tui, kereru, magpie, and fantail were seen.

Modifiers or threats

Contains a few pigs. Unlikely to be cleared as it is considered to be ideal stock shelter.

Significance

If fenced and protected would recover to a more viable and representative forest area.

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	L	Size and shape	M
Diversity and pattern	L	Fragility	H

Rarity	L	Buffering	L
Naturalness	L	Other valuesN	

RAP No. 45

UPPER ATIAMURI THERMAL AREA

Study area No. 70 Area: 2.7 ha

Ownership: Carter Holt Harvey Ltd

NZMS 260: U16

Grid Ref.: 766112

Aerial photo: 232356

Physiographic unit: Geothermal springs on pumice alluvium

Bioclimatic zone: Lowland

Altitude: 280 m

Ecological pattern

Ecroyd (1979a) recorded the presence of *Nephrolepis* sp. cf. *cordifolia* when the pools were in more pristine condition, and doubted its viability. The present author, however, found that it is now in strong and luxuriant growth despite the damage done by forestry activities.

Description

Three hot flowing neutral springs in an area of recently clear-felled pine. A concrete bath-house previously here was bulldozed by the contractors after much vandalism. One pool has been partially drained with a digger, exposing the area to the risk of hydrothermal eruption. (A.D. Cody, pers. comm.)

Vegetation

Nephrolepis sp. aff. *cordifolia* is abundant on the active spring walls with, above this, bracken fern, manuka, Spanish heath, and occasional kiokio.

Fauna

None recorded.

Significance

Has high scientific value; rated C2 by Cody (1995). Total prevention of vehicle access is highly desirable.

Selection criteria

Vegetation dynamics	SM	Viability	L
Representativeness	L	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	L	Other values	H

RAP No. 46

HOROHORO GEOTHERMAL AREA

Study area No. 73

Area: 1.5 ha

Ownership: Maori Trust

NZMS 260: U16

Grid Ref.: 885224

Aerial photo: 232669

Physiographic unit: Geothermal springs in tephra

Bioclimatic zone: Lowland

Altitude: 320 m

Ecological pattern

All surrounding indigenous vegetation has been destroyed by grazing.

Description

Three warm springs in the valley floor. The largest remaining feature is a hot spring of approx. 12 m diameter, temperature 60°C, and flow rate about 1 lps (Cody 1995). This spring, named Waipupumahana, has pre-European legends and history associated with it. A log lying in the pool is held to be a taniwha, created long ago following some nefarious deeds (Maxwell 1990).

Vegetation

Stock-trampled rushes and sedges.

Fauna

Pukeko were seen.

Modifiers or threats

Stock have access to the springs and foul the waters.

Significance

Apart from its high scientific value the main spring, Waipupumahana, has great significance to Maori. Fencing and replanting with appropriate native species would be desirable.

Selection criteria

Vegetation dynamics	M	Viability	L
Representativeness	L	Size and shape	L
Diversity and pattern	L	Fragility	H
Rarity	L	Buffering	L
Naturalness	L	Other values	M

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Appendix 1 - Endangered, threatened, vulnerable and local species in Atiamuri Ecological District

Plants

Scientific name	Common name	Category (Cameron <i>et al.</i> 1995)
<i>Caladenia</i> aff. <i>iridescens</i>		local
<i>Calochilus paludosus</i>	beard orchid	rare
<i>Calochilus robertsonii</i>	beard orchid	local
<i>Cyclosorus interruptus</i>		rare
<i>Dactylanthus taylorii</i>	wood rose	vulnerable
<i>Dicanopteris linearis</i>		local
<i>Drymoanthus flavus</i>	'spotted leaf'	local
<i>Ileostylus micranthus</i>	mistletoe	local
<i>Juncus holoschoenus</i>		insufficiently known
<i>Korthalsella salicornioides</i>	mistletoe	insufficiently known
<i>Ophioglossum petiolatum</i>	stalked adder's tongue	vulnerable
<i>Prasophyllum</i> 'aff. <i>patens</i>	broadleaved leek orchid	vulnerable
<i>Pterostylis micromega</i>		endangered
<i>Thelypteris confluens</i>	swamp fern	rare
<i>Urtica linearifolia</i>		local

Wildlife

Scientific name	Common name	Category (Bell 1986)
<i>Chalinolobus tuberculatus</i>	long-tailed bat	threatened
<i>Botaurus stellaris poiciloptilis</i>	Australasian bittern	threatened
<i>Bowdleria punctata vealeae</i>	North Island fernbird	threatened
<i>Cacatua galerita</i> *	White cockatoo	rare
<i>Eudynamys taitensis</i>	long-tailed cuckoo	rare
<i>Falco novaeseelandiae</i>	New Zealand falcon	threatened
<i>Hymenolaimus malacorhynchos</i>	blue duck	threatened
<i>Petroica australis longipes</i>	North Island robin	threatened
<i>Podiceps rufopectus</i>	New Zealand dabchick	threatened

* Introduced species

Appendix 2 - Checklist of the native vascular flora of the Atiamuri Ecological District

This checklist is compiled from the results of this PNA survey, previous survey reports, and herbarium databases of the Forest Research Institute, Rotorua (NZFRI), Auckland Institute & Museum (AK), University of Waikato (WAIK), and Landcare Research, (CHR).

Nomenclature follows Allan (1961), Moore & Edgar (1976), Healy & Edgar (1980), Webb *et al.* (1988), Brownsey & Smith-Dodsworth (1989), and Wilson & Galloway (1993).

Abbreviations used:

aff.	:	affinities with
agg.	:	aggregate, comprising more than one species
cf.	:	compare with
s.l.	:	sensu lato, in the broad sense
sp.	:	species (singular)
spp.	:	species (plural)
ssp.	:	subspecies
s.s.	:	sensu stricto, in the narrow sense
x	:	hybrid
var.	:	variety

Scientific name	Common name	Remarks
<i>Acaena anserinifolia</i>	bidibidi	
<i>Acaena microphylla</i>	red mountain bidibidi	
<i>Adiantum cunninghamii</i>	maiden hair fern	
<i>Adiantum fulvum</i>	maiden hair fern	
<i>Alseuosmia macrophylla</i>	toropapa	
<i>Anarthropteris lanceolata</i>	lance fern	
<i>Aporostylis bifolia</i>	odd-leaved orchid	
<i>Aristotelia fruticosa</i>	mountain wineberry	
<i>Aristotelia serrata</i>	wineberry, makomako	
<i>Arthropodium candidum</i>	star lily, repehinapapa	
<i>Arthropteris tenella</i>	jointed fern	
<i>Asplenium bulbiferum</i>	hen and chickens fern	
<i>Asplenium bulbiferum</i> ssp. <i>gracillimum</i>		
<i>Asplenium flabellifolium</i>	butterfly fern, walking fern	
<i>Asplenium flaccidum</i>	hanging spleenwort	
<i>Asplenium hookerianum</i>	Hooker's spleenwort	
<i>Asplenium lamprophyllum</i>		CHR290567
<i>Asplenium oblongifolium</i>	shining spleenwort	
<i>Asplenium polyodon</i>	sickle spleenwort	
<i>Asplenium terrestre</i>		
<i>Astelia banksii</i>	wharawhara, shore astelia	
<i>Astelia fragrans</i>	bushflax, kakaha	
<i>Astelia</i> aff. <i>nervosa</i>	kahakaha	
<i>Astelia solandri</i>	kowharawhara	
<i>Astelia trinervia</i>	kauri grass	

<i>Australina pusilla</i>		
<i>Azolla filiculoides</i>	Pacific azolla, retoreto	
<i>Baumea huttonii</i>		
<i>Baumea juncea</i>		
<i>Baumea rubiginosa</i>		
<i>Baumea tenax</i>		
<i>Baumea teretifolia</i>	pakihi rush	
<i>Beilschmiedia tawa</i>	tawa	
<i>Blechnum</i> 'black spot'	kiokio	
<i>Blechnum chambersii</i>	nini	
<i>Blechnum colensoi</i>		
<i>Blechnum discolor</i>	crown fern, piuiu	
<i>Blechnum filiforme</i>	thread fern	
<i>Blechnum fluviatile</i>	kiwakiwa	
<i>Blechnum membranaceum</i>		
<i>Blechnum minus</i>	swamp fern, kiokio	
<i>Blechnum nigrum</i>		
<i>Blechnum penna-marina</i>		
<i>Blechnum procerum</i>	mountain kiokio	
<i>Blechnum procerum</i> x 'black spot' hybrid		
<i>Blechnum vulcanicum</i>		
<i>Bolboschoenus fluviatilis</i>	marsh clubrush, kukuraho	
<i>Botrychium australe</i>	parsley fern	
<i>Brachyglottis kirkii</i>		
<i>Brachyglottis repanda</i>	rangiora	
<i>Bulbophyllum pygmaeum</i>	bulb-leaf orchid	
<i>Caladenia</i> aff. <i>iridescens</i>		(local)
<i>Caladenia carnea</i>		
<i>Caladenia catenata</i>		
<i>Callitriche petriei</i>		
<i>Calochilus paludosus</i>	beard orchid	(rare)
<i>Calochilus robertsonii</i>	beard orchid	(local)
<i>Calystegia sepium</i>	pohue, pink bindweed	
<i>Cardamine</i> 'debilis' agg.	native bittercress	
<i>Carex breviculmis</i>		
<i>Carex comans</i>		
<i>Carex coriacea</i>	cutty grass, toetoe, rautahi	
<i>Carex dissita</i>		
<i>Carex fascicularis</i>		
<i>Carex flagellifera</i>		
<i>Carex forsteri</i>		
<i>Carex geminata</i>		
<i>Carex inversa</i>		
<i>Carex lessoniana</i>		
<i>Carex maorica</i>		
<i>Carex secta</i>	niggerhead, pukio	
<i>Carex sinclairii</i>		
<i>Carex solandri</i>		
<i>Carex subdola</i>		
<i>Carex virgata</i>		
<i>Carmichaelia</i> 'common'	common native broom	
<i>Carpodetus serratus</i>	putaputaweta, marble leaf	
<i>Celmisia gracilentia</i>	dainty daisy	

<i>Centella uniflora</i>	
<i>Cheilanthes humilis</i>	smooth rock fern
<i>Chiloglottis cornuta</i>	green bird orchid
<i>Christella</i> sp. cf. <i>dentata</i>	
<i>Clematis forsteri</i>	pataua, green clematis
<i>Clematis paniculata</i>	clematis, puawhananga
<i>Clematis quadribacteolata</i>	clematis
<i>Collospermum hastatum</i>	kahakaha
<i>Collospermum microspERMum</i>	kokaha
<i>Coprosma</i> 'taylorae'	(species 't' of Eagle 1982)
<i>Coprosma acerosa</i> var. "brunnea"	
<i>Coprosma colensoi</i>	springy coprosma
<i>Coprosma foetidissima</i>	stinkwood
<i>Coprosma grandifolia</i>	raurekau
<i>Coprosma lucida</i>	karamu
<i>Coprosma propinqua</i>	mingimingi
<i>Coprosma propinqua</i> x <i>robusta</i>	coprosma cunninghamii
<i>Coprosma rhamnoides</i>	thorn-like coprosma
<i>Coprosma rigida</i>	rigid coprosma
<i>Coprosma robusta</i>	karamu
<i>Coprosma tenuicaulis</i>	wavy-leaved coprosma
<i>Cordyline australis</i>	cabbage tree, ti
<i>Cordyline banksii</i>	ti ngahere
<i>Cordyline indivisa</i>	toi, broad-leaved cabbage tree
<i>Coriaria arborea</i>	tutu
<i>Corokia buddleioides</i>	korokio-taranga
<i>Corokia cotoneaster</i>	yellow buttons
<i>Cortaderia fulvida</i>	kakaho, toetoe
<i>Cortaderia toetoe</i>	toetoe
<i>Corybas</i> aff. <i>rivularis</i>	dancing spider orchid
<i>Corybas cheesemanii</i>	
<i>Corybas macranthus</i>	spider orchid
<i>Corybas trilobus</i>	spider orchid
<i>Craspedia minor</i>	
<i>Ctenopteris heterophylla</i>	
<i>Cyathea cunninghamii</i>	slender tree fern, gully tree fern
<i>Cyathea dealbata</i>	ponga, silver fern
<i>Cyathea medullaris</i>	mamaku, black tree fern
<i>Cyathea smithii</i>	soft tree fern
<i>Cyathodes empetrifolia</i>	mountain mikimiki
<i>Cyathodes juniperina</i>	mingimingi
<i>Cyclosorus interruptus</i>	(rare)
<i>Cyperus ustulatus</i>	cutty grass
<i>Dacrycarpus dacrydioides</i>	kahikatea
<i>Dacrydium cupressinum</i>	rimu
<i>Dactylanthus taylorii</i>	wood rose, pua reinga (endangered)
<i>Dendrobium cunninghamii</i>	bamboo orchid
<i>Deparia petersenii</i>	
<i>Deyeuxia</i> 'quadriseta'	
<i>Deyeuxia avenoides</i>	mountain oatgrass
<i>Dianella nigra</i>	blueberry, turutu
<i>Dichelachne crinita</i>	long-hair plume grass
<i>Dichondra</i> sp.	Mercury Bay weed

<i>Dicksonia fibrosa</i>	wheki-ponga	
<i>Dicksonia lanata</i>	tuokura	
<i>Dicksonia squarrosa</i>	wheki, rough tree fern	
<i>Dicranopteris linearis</i>		(local)
<i>Diplazium australe</i>		
<i>Dodonaea viscosa</i>	akeake	
<i>Doodia media</i>	rasp fern, pukupuku	
<i>Doodia mollis</i>	mokimoki	AK136199
<i>Doodia squarrosa</i>		
<i>Dracophyllum strictum</i>	totorowhiti, grass tree	
<i>Dracophyllum subulatum</i>	monoao	
<i>Dracophyllum subulatum</i> x <i>strictum</i>		
<i>Drosera auriculata</i>		
<i>Drosera binata</i>	scented sundew	
<i>Drosera peltata</i>	spoon-leaved sundew	
<i>Drosera spathulata</i>	sundew	
<i>Drymoanthus adversus</i>	perching orchid	
<i>Drymoanthus flavus</i>	'spotted leaf'	
<i>Earina autumnalis</i>	Easter orchid, raupeka	
<i>Earina mucronata</i>	spring orchid, peka-a-waka	
<i>Elaeocarpus dentatus</i>	hinau	
<i>Elaeocarpus hookerianus</i>	pokaka	
<i>Elatine gratioloides</i>	waterwort	
<i>Eleocharis acuta</i>	spike rush	
<i>Eleocharis gracilis</i>		
<i>Eleocharis pusilla</i>		
<i>Eleocharis sphacelata</i>		
<i>Epacris alpina</i>		
<i>Epilobium alsinoides</i>		
<i>Epilobium chionanthum</i>		
<i>Epilobium cinereum</i>		
<i>Epilobium linnaeoides</i>		
<i>Epilobium nummulariifolium</i>	creeping willow-herb	
<i>Epilobium pallidiflorum</i>		
<i>Epilobium pedunculare</i>	creeping willow-herb	
<i>Epilobium pubens</i>		
<i>Epilobium rotundifolium</i>	round-leaved willowherb	
<i>Fimbristylis squarrosa</i>		(local)
<i>Festuca novae-zelandiae</i>	hard tussock	
<i>Fuchsia excorticata</i>	tree fuchsia, kotukutuku	
<i>Gahnia pauciflora</i>		
<i>Gahnia setifolia</i>		
<i>Galium propinquum</i>		
<i>Gastrodia cunninghamii</i>	black orchid, huperei	
<i>Gaultheria antipoda</i>	snowberry, tawiniwini	
<i>Gaultheria oppositifolia</i>		
<i>Gaultheria paniculata</i>		
<i>Geniostoma rupestre</i>	hangehange	
<i>Geranium microphyllum</i>	small-leaved crane's bill	
<i>Geranium potentilloides</i>		
<i>Gleichenia dicarpa</i>	tangle fern, waewaekaka	
<i>Gleichenia microphylla</i>	carrier tangle, waewaekaka	
<i>Glossostigma elatinoides</i>		

<i>Gnaphalium audax</i>	
<i>Gnaphalium delicatum</i>	creeping cudweed
<i>Gnaphalium gymnocephalum</i>	creeping cudweed
<i>Gnaphalium involucratum</i>	creeping cudweed
<i>Gnaphalium limosum</i>	creeping cudweed
<i>Gonocarpus aggregatus</i>	
<i>Gonocarpus incanus</i>	
<i>Gonocarpus micranthus</i>	
<i>Grammitis billardierei</i>	strap fern
<i>Grammitis ciliata</i>	
<i>Grammitis magellanica</i>	
<i>Grammitis pseudociliata</i>	
<i>Gratiola sexdentata</i>	
<i>Griselinia littoralis</i>	broadleaf, kapuka
<i>Griselinia lucida</i>	puka
<i>Gunnera prorepens</i>	creeping gunnera
<i>Haloragis erecta</i>	toatoa
<i>Hebe stricta</i>	koromiko
<i>Hedycarya arborea</i>	pigeonwood, porokaiwhiri
<i>Helichrysum filicaule</i>	slender everlasting
<i>Hierochloa redolens</i>	sweet-scented grass, kuretu
<i>Histiopteris incisa</i>	water fern
<i>Hoheria populnea</i>	houhere, lacebark
<i>Hydrocotyle dissecta</i>	
<i>Hydrocotyle elongata</i>	
<i>Hydrocotyle heteromeria</i>	waxweed
<i>Hydrocotyle microphylla</i>	hydrocotyle
<i>Hydrocotyle moschata</i>	
<i>Hydrocotyle novae-zeelandiae</i>	common pennywort
<i>Hydrocotyle pterocarpa</i>	
<i>Hydrocotyle</i> spp.	
<i>Hymenophyllum bivalve</i>	
<i>Hymenophyllum cupressiforme</i>	
<i>Hymenophyllum demissum</i>	irirangi
<i>Hymenophyllum dilatatum</i>	
<i>Hymenophyllum ferrugineum</i>	
<i>Hymenophyllum flabellatum</i>	
<i>Hymenophyllum flexuosum</i>	
<i>Hymenophyllum lyallii</i>	
<i>Hymenophyllum minimum</i>	(Dobbie 1951)
<i>Hymenophyllum multifidum</i>	
<i>Hymenophyllum pulcherrimum</i>	
<i>Hymenophyllum rarum</i>	
<i>Hymenophyllum revolutum</i>	
<i>Hymenophyllum sanguinolentum</i>	
<i>Hymenophyllum scabrum</i>	
<i>Hypericum japonicum</i>	matted St John's wort
<i>Hypolepis ambigua</i>	
<i>Hypolepis dicksonioides</i>	giant hypolepis
<i>Hypolepis distans</i>	
<i>Hypolepis lactea</i>	
<i>Hypolepis rufobarbata</i>	
<i>Ileostylus micranthus</i>	mistletoe (local)

<i>Isachne globosa</i>	swamp millet	
<i>Isolepis aucklandica</i>		(Kirk 1872)
<i>Isolepis distigmatica</i>		
<i>Isolepis habra</i>		
<i>Isolepis inundata</i>		
<i>Isolepis nodosa</i>	wiwi, leafless sedge	
<i>Isolepis pottsii</i>		
<i>Isolepis prolifer</i>		
<i>Ixerba brexioides</i>	tawari	
<i>Juncus australis</i>		
<i>Juncus distegus</i>		
<i>Juncus gregiflorus</i>	wiwi	
<i>Juncus holoschoenus</i>		
<i>Juncus maritimus</i>	sea rush	
<i>Juncus pallidus</i>	wi	
<i>Juncus planifolius</i>		
<i>Juncus prismatocarpus</i>		
<i>Juncus sarophorus</i>		
<i>Knightia excelsa</i>	rewarewa	
<i>Korthalsella salicornioides</i>	mistletoe	(indeterminate)
<i>Kunzea ericoides</i> var. <i>microflora</i>	prostrate kanuka, 'thermal'	
<i>Kunzea ericoides</i> var. <i>ericoides</i>	kanuka, white teatree	
<i>Lachnagrostis filiformis</i>	tumble grass	
<i>Lagenifera pumila</i>	taniwhaniwha	
<i>Lastreopsis glabella</i>		
<i>Lastreopsis hispida</i>	hairy fern	
<i>Lastreopsis microsora</i>		
<i>Lastreopsis velutina</i>	velvet fern	
<i>Laurelia novae-zelandiae</i>	pukatea	
<i>Lemna</i> 'minor N.Z.'	duckweed	
<i>Lepidosperma australe</i>	four square sedge	
<i>Leptocarpus similis</i>	jointed wire rush, oioi	
<i>Leptolepia novae-zelandiae</i>		
<i>Leptopteris hymenophylloides</i>	single crepe fern, heruheru	
<i>Leptopteris superba</i>	Prince of Wales feather	
<i>Leptospermum scoparium</i>	manuka, teatree	
<i>Leucopogon fasciculatus</i>	mingimingi	
<i>Leucopogon fraseri</i>	patotara	
<i>Libertia ixioides</i>	mikoikoi, native iris	
<i>Limosella lineataris</i>	mudwort	
<i>Lindsaea trichomanoides</i>		
<i>Litsea calicaris</i>	mangeao	
<i>Luzula decipiens</i>		
<i>Luzula picta</i>		
<i>Lycopodium cernuum</i>	thermal clubmoss	
<i>Lycopodium deuterodensum</i>	puakarimu	
<i>Lycopodium fastigiatum</i>	mountain clubmoss	
<i>Lycopodium scariosum</i>	creeping clubmoss	
<i>Lycopodium varium</i>	hanging clubmoss	
<i>Lycopodium volubile</i>	waewae-koukou	
<i>Lygodium articulatum</i>	mangemange	
<i>Machaerina sinclairii</i>	broad-leaved sedge	
<i>Macropiper excelsum</i>	kawakawa	

<i>Mazus radicans</i>	swamp musk	(Allan 1961)
<i>Melicope simplex</i>		
<i>Melicytus lanceolatus</i>	narrow-leaved mahoe, mahoe-wao	
<i>Melicytus ramiflorus</i>	mahoe, hinahina	
<i>Metrosideros colensoi</i>	climbing rata, akatea	
<i>Metrosideros diffusa</i>	white climbing rata	
<i>Metrosideros excelsa</i>	pohutukawa	
<i>Metrosideros perforata</i>	small-leaved white rata	
<i>Metrosideros robusta</i>	northern rata	
<i>Microlaena avenacea</i>	bush rice grass	
<i>Microlaena stipoides</i>	meadow rice grass	
<i>Microseris scapigera</i>		
<i>Microtis parviflora</i>	slender onion orchid	
<i>Microtis unifolia</i>	onion orchid	
<i>Mida salicifolia</i>	willow-leaved maire	
<i>Morelotia affinis</i>		
<i>Muehlenbeckia australis</i>	pohuehue	
<i>Muehlenbeckia axillaris</i>	creeping pohuehue	(Kirk 1872)
<i>Muehlenbeckia complexa</i>	pohuehue	
<i>Myosotis forsteri</i>		
<i>Myriophyllum propinquum</i>	water milfoil	
<i>Myriophyllum triphyllum</i>	water milfoil	
<i>Myrsine australis</i>	red matipo, mapou	
<i>Myrsine salicina</i>	toro	
<i>Neomyrtus pedunculata</i>	rohutu	
<i>Nephrolepis</i> sp. 'cf. <i>cordifolia</i> '	thermal sword fern	
<i>Nertera depressa</i>	common nertera	
<i>Nertera dichondrifolia</i>	hairy nertera	
<i>Nertera scapanioides</i>		
<i>Nestegis cunninghamii</i>	black maire	
<i>Nestegis lanceolata</i>	white maire	
<i>Nestegis montana</i>	orooro	
<i>Nothofagus menziesii</i>	silver beech	
<i>Nothofagus truncata</i>	hard beech	
<i>Olearia arborescens</i>	tree daisy	
<i>Olearia furfuracea</i>	akepiro	
<i>Olearia rani</i>	heketara	
<i>Olearia virgata</i>		
<i>Ophioglossum coriaceum</i>	adder's tongue	
<i>Ophioglossum petiolatum</i>	stalked adder's tongue	CHR569 (vulnerable)
<i>Orthoceras novae-zeelandiae</i>	horned orchid	
<i>Paesia scaberula</i>	scented fern, hard fern	
<i>Parsonsia capsularis</i>	native jasmine, aka kiore	
<i>Parsonsia heterophylla</i>	native jasmine, kaiku, kaiwhiria	
<i>Passiflora tetrandra</i>	passionfruit, kohia	
<i>Pellaea rotundifolia</i>	tarawera	
<i>Pennantia corymbosa</i>	kaikomako	
<i>Phormium cookianum</i>	mountain flax, wharariki	
<i>Phormium tenax</i>	flax, harakeke	
<i>Phyllocladus glaucus</i>	toatoa	
<i>Phyllocladus trichomanoides</i>	tanekaha	
<i>Phymatosorus diversifolius</i>	hound's tongue fern	
<i>Phymatosorus novae-zelandiae</i>	fragrant fern	

<i>Phymatosorus scandens</i>	fragrant fern, mokimoki
<i>Pilularia novae-zelandiae</i>	pillwort
<i>Pimelea prostrata</i>	Strathmore weed
<i>Pittosporum eugenioides</i>	lemonwood, tarata
<i>Pittosporum ralphii</i>	
<i>Pittosporum tenuifolium</i> subsp. <i>colensoi</i>	
<i>Pittosporum tenuifolium</i> subsp. <i>tenuifolium</i>	black matipo, kohuhu
<i>Plagianthus regius</i>	lowland ribbonwood, manatu
<i>Pneumatopteris pennigera</i>	gully fern
<i>Poa anceps</i>	coastal poa
<i>Poa cita</i>	silver tussock
<i>Poa imbecilla</i>	weak poa
<i>Podocarpus hallii</i>	Hall's totara, thin-barked totara
<i>Podocarpus totara</i>	totara
<i>Polygonum salicifolium</i>	swamp willow weed
<i>Polystichum richardii</i>	common shield fern
<i>Polystichum silvaticum</i>	
<i>Polystichum vestitum</i>	prickly shield fern
<i>Pomaderris ericifolia</i>	tauhinu
<i>Potamogeton cheesemanii</i>	red pondweed
<i>Potentilla anserinoides</i>	silverweed
<i>Prasophyllum</i> aff. <i>patens</i>	leek orchid (Cheeseman 1925) (vulnerable)
<i>Prasophyllum colensoi</i>	onion-leaved orchid
<i>Prasophyllum nudum</i>	leek orchid
<i>Pratia angulata</i>	panakenake
<i>Pratia perpusilla</i>	white root
<i>Prumnopitys ferruginea</i>	miro
<i>Prumnopitys taxifolia</i>	matai
<i>Pseudognaphalium luteoalbum</i>	Jersey cudweed
<i>Pseudopanax anomalus</i>	
<i>Pseudopanax arboreus</i>	five finger, whauwhaupaku
<i>Pseudopanax crassifolius</i>	lancewood, horoeaka
<i>Pseudopanax edgerleyi</i>	raukawa
<i>Pseudopanax simplex</i>	haumakoroa
<i>Pseudowintera axillaris</i>	horopito
<i>Pseudowintera colorata</i>	pepperwood
<i>Psilotum nudum</i>	
<i>Pteridium esculentum</i>	bracken, rauaruhe
<i>Pteris macilenta</i>	sweet fern
<i>Pteris tremula</i>	turawera
<i>Pterostylis australis</i>	greenhood orchid
<i>Pterostylis banksii</i>	tutukiwi
<i>Pterostylis foliata</i>	
<i>Pterostylis micromega</i>	greenhood orchid (endangered) (Cheeseman 1925)
<i>Pterostylis trullifolia</i>	trowel-leaved orchid
<i>Pyrrosia eleagnifolia</i>	leather-leaf fern
<i>Quintinia serrata</i>	tawheowheo
<i>Ranunculus glabrifolius</i>	
<i>Ranunculus macropus</i>	swamp buttercup
<i>Ranunculus reflexus</i>	maruru, hairy buttercup
<i>Raoulia glabra</i>	
<i>Raoulia hectorii</i>	(Kirk 1872)

<i>Ripogonum scandens</i>	supplejack, kareao	
<i>Rorippa palustris</i>	yellow cress	
<i>Rubus cissoides</i>	bush lawyer	
<i>Rubus schmidelioides</i>	bush lawyer	
<i>Rubus squarrosus</i>	leafless lawyer	
<i>Rumohra adiantiformis</i>		
<i>Rytidosperma clavatum</i>		
<i>Rytidosperma gracile</i>	forest fairy grass	
<i>Rytidosperma unarede</i>	cliff fairy grass	
<i>Rytidosperma viride</i>		
<i>Schefflera digitata</i>	pate	
<i>Schizaea bifida</i>	forked comb fern	
<i>Schizaea dichotoma</i>	fan fern	
<i>Schizaea fistulosa</i>	southern comb fern	
<i>Schoenoplectus validus</i>	kuwawa	
<i>Schoenus maschalinus</i>		
<i>Schoenus tendo</i>		
<i>Senecio hispidulus</i>	fireweed	
<i>Senecio lautus</i>	shore groundsel	(Kirk 1872)
<i>Senecio glomeratus</i>		
<i>Senecio minimus</i>	fireweed	
<i>Solanum americanum</i>	small-flowered nightshade	
<i>Solanum aviculare</i>	poroporo	
<i>Solanum laciniatum</i>	poroporo	
<i>Sophora tetraptera</i>	kowhai	
<i>Spiranthes novae-zelandiae</i>	ladies' tresses	
<i>Stackhousia minima</i>		
<i>Stellaria parviflora</i>	native chickweed	
<i>Sticherus cunninghamii</i>	umbrella fern, waekura	
<i>Streblus heterophyllus</i>	turepo, milk tree	
<i>Thelymitra</i> 'aff. <i>ixioides</i> '	dotted sun orchid	
<i>Thelymitra carnea</i>		
<i>Thelymitra decora</i>	broad-leaved sun orchid	
<i>Thelymitra longifolia</i>	white sun orchid	
<i>Thelymitra pauciflora</i>	slender sun orchid	
<i>Thelypteris confluens</i>	swamp fern	(rare)
<i>Tmesipteris elongata</i>		
<i>Tmesipteris tannensis</i>		
<i>Toronia toru</i>	toru	
<i>Trichomanes elongatum</i>	bristle fern	
<i>Trichomanes endlicherianum</i>		
<i>Trichomanes reniforme</i>	kidney fern	
<i>Trichomanes strictum</i>		
<i>Trichomanes venosum</i>		
<i>Typha orientalis</i>	raupo	
<i>Uncinia banksii</i>		
<i>Uncinia clavata</i>	fish-hooks	
<i>Uncinia gracilentia</i>		
<i>Uncinia scabra</i>		
<i>Uncinia uncinata</i>	watu, hook grass	
<i>Uncinia zotovii</i>		
<i>Urtica ferox</i>	tree nettle, ongaonga	
<i>Urtica incisa</i>	stinging nettle	

<i>Urtica linearifolia</i>	(local)
<i>Viola cunninghamii</i>	white violet, haka
<i>Wahlenbergia gracilis</i>	blue harebell, rimu-roa
<i>Wahlenbergia marginata</i>	harebell
<i>Weinmannia racemosa</i>	kamahi, tawhero

Appendix 3 - Checklist of adventive naturalised vascular plants of the Atiamuri Ecological District

This list is compiled from the results of this PNA survey, previous survey reports, and herbarium databases of the Forest Research Institute, Rotorua (NZFRI), Auckland Institute & Museum (AK), University of Waikato (WAIK), and Landcare Research, Lincoln (CHR).

Nomenclature follows Allan (1961), Moore & Edgar (1976), Healy & Edgar (1980), Webb *et al.* (1988), and Brownsey & Smith-Dodsworth (1989).

Scientific name	Common name	Remarks
<i>Acacia melanoxylon</i>	Tasmanian blackwood	
<i>Acacia</i> spp.	wattle	
<i>Acaena agnipila</i>		
<i>Acaena novae-zelandiae</i>	red bidibid, piripiri	
<i>Acer</i> spp.	maple	
<i>Achillea millefolium</i>	yarrow	
<i>Actinidia deliciosa</i>	kiwifruit, Chinese gooseberry	
<i>Agrostis capillaris</i>	browntop	
<i>Agrostis stolonifera</i>	creeping bent	
<i>Aira caryophyllea</i>	silvery hairgrass	
<i>Aira praecox</i>	early hairgrass	
<i>Alisma plantago-aquatica</i>	water plantain	
<i>Alnus glutinosa</i>	alder	
<i>Amelanchier lamarckii</i>	amelanchier	(rare adventive)
<i>Anagallis arvensis</i>	scarlet pimpernel	
<i>Anthemis cotula</i>	stinking mayweed	
<i>Anthoxanthum odoratum</i>	sweet vernal	
<i>Anthriscus sylvestris</i>		(rare adventive)
<i>Aphanes inexpectata</i>	parsley piert	
<i>Apium nodiflorum</i>	water celery	
<i>Arctium minus</i>	burdock	
<i>Aster subulatus</i>	sea aster	
<i>Azolla pinnata</i>	ferny azolla	
<i>Barbarea vulgaris</i>	winter cress	
<i>Bellis perennis</i>	lawn daisy	
<i>Berberis darwinii</i>	Darwin's barberry	
<i>Berberis glaucocarpa</i>	barberry	
<i>Betula pendula</i>	silver birch	
<i>Bidens frondosa</i>	beggar's ticks	
<i>Briza minor</i>	shivery grass	
<i>Bromus diandrus</i>	ripgut brome	
<i>Bromus hordeaceus</i>	soft brome	
<i>Bromus willdenowii</i>	prairie grass	
<i>Buddleja davidii</i>	summer lilac, buddleia	
<i>Callitriche stagnalis</i>	starwort	
<i>Calluna vulgaris</i>	heather, ling	

<i>Cannabis sativa</i>	hemp, bhang, pot	
<i>Cardamine pratensis</i>	cuckoo cress	
<i>Carduus nutans</i>	nodding thistle	
<i>Carduus tenuiflorus</i>	winged thistle	
<i>Carex demissa</i>		
<i>Carex hirta</i>		
<i>Carex ovalis</i>	oval sedge	
<i>Carex scoparia</i>		
<i>Centaureum erythraea</i>	centaury	
<i>Cerastium fontanum</i>	mouse-eared chickweed	
<i>Ceratophyllum demersum</i>	hornwort	
<i>Chamaecyparis lawsoniana</i>	Lawson's cypress	
<i>Chamaecytisus palmensis</i>	tree lucerne	
<i>Cirsium arvense</i>	Californian thistle	
<i>Cirsium vulgare</i>	Scotch thistle	
<i>Conyza albida</i>	broad-leaved fleabane	
<i>Conyza bonariensis</i>	wavy-leaved fleabane	
<i>Coronopus didymus</i>	twin cress	
<i>Cortaderia jubata</i>	pampas	
<i>Cortaderia selloana</i>	pampas	
<i>Cotoneaster glaucophyllus</i>		
<i>Cotoneaster lacteus</i>		
<i>Crataegus monogyna</i>	hawthorn	
<i>Crepis capillaris</i>	hawksbeard	
<i>Crocasmia x crocosmiiflora</i>	montbretia	
<i>Cupressus macrocarpa</i>	macrocarpa	
<i>Cynodon dactylon</i>	Indian doab	
<i>Cyperus congestus</i>	purple umbrella sedge	
<i>Cyperus involucratus</i>		(rare adventive)
<i>Cyperus rotundus</i>	nut grass	
<i>Cytisus scoparius</i>	broom	
<i>Dactylis glomerata</i>	cocksfoot	
<i>Dianthus armeria</i>	Deptford pink	
<i>Digitalis purpurea</i>	foxglove	
<i>Digitaria sanguinalis</i>	hairy finger grass	
<i>Duchesnea indica</i>	Indian strawberry	
<i>Eleusine indica</i>	crowfoot grass	
<i>Elodea canadensis</i>	Canadian pond weed	
<i>Elymus aff. retisetus</i>	blue wheatgrass, patiti taranui	
<i>Epilobium ciliatum</i>	tall willow-herb	
<i>Eragrostis brownii</i>	bay grass	
<i>Eragrostis curvula</i>	African love grass	
<i>Erica lusitanica</i>	Spanish heath	
<i>Eucalyptus delegatensis</i>	mountain ash, stringy bark	
<i>Eucalyptus obliqua</i>	messmate, stringy bark	
<i>Eucalyptus spp.</i>	eucalypts	
<i>Euonymus japonicus</i>	Japanese spindle tree	
<i>Euphorbia lathyris</i>	caper spurge	
<i>Euphorbia peplus</i>	milkweed	
<i>Festuca arundinacea</i>	tall fescue	
<i>Festuca rubra</i>	Chewings fescue	
<i>Fragaria x annanassa</i>	strawberry	
<i>Fragaria vesca</i>	mountain strawberry	

<i>Galium aparine</i>	cleavers
<i>Galium palustre</i>	marsh bedstraw
<i>Gastridium ventricosum</i>	nit grass
<i>Geranium molle</i>	dove's foot crane's bill
<i>Geranium robertianum</i>	herb Robert
<i>Glyceria declinata</i>	glaucous sweet grass
<i>Glyceria fluitans</i>	floating sweet grass
<i>Glyceria maxima</i>	reed sweet grass
<i>Gnaphalium coarctatum</i>	purple cudweed
<i>Gnaphalium sphaericum</i>	Japanese cudweed
<i>Gnaphalium subfalcatum</i>	
<i>Grevillea robusta</i>	silky oak
<i>Hedera helix</i>	ivy
<i>Holcus lanatus</i>	Yorkshire fog
<i>Hordeum murinum</i>	wall barley grass
<i>Humulus lupulus</i>	hop
<i>Hypericum perforatum</i>	St John's wort
<i>Hypochoeris radicata</i>	catsear
<i>Juncus acutus</i>	sharp rush
<i>Juncus articulatus</i>	jointed rush
<i>Juncus bufonius</i>	toad rush
<i>Juncus bulbosus</i>	bulbous rush
<i>Juncus effusus</i>	soft rush
<i>Juncus microcephalus</i>	
<i>Juncus tenuis</i>	
<i>Lactuca serriola</i>	prickly lettuce
<i>Lactuca virosa</i>	acrid lettuce
<i>Lagarosiphon major</i>	South African oxygen weed
<i>Lapsana communis</i>	nipplewort
<i>Larix decidua</i>	larch
<i>Larix kaempferi</i>	Japanese larch
<i>Leersia oryzoides</i>	cutty grass
<i>Leontodon taraxacoides</i>	hawkbit
<i>Leucanthemum vulgare</i>	oxeye daisy
<i>Leycesteria formosa</i>	Himalayan honeysuckle
<i>Ligustrum sinense</i>	Chinese privet
<i>Linum bienne</i>	pale flax
<i>Lolium multiflorum</i>	Italian ryegrass
<i>Lolium perenne</i>	perennial ryegrass
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Lotus angustissimus</i>	slender birdsfoot-trefoil
<i>Lotus pedunculatus</i>	lotus major
<i>Lotus suaveolens</i>	hairy birdsfoot-trefoil
<i>Ludwigia palustris</i>	water purslane
<i>Ludwigia peploides</i>	primrose willow
<i>Lupinus arboreus</i>	tree lupin
<i>Lythrum hyssopifolia</i>	hyssop loosestrife
<i>Malus domestica</i>	apple
<i>Mentha x citrata</i>	bergamot mint
<i>Mentha x piperita</i>	peppermint, bergamot mint
<i>Mentha pulegium</i>	pennyroyal
<i>Mimulus guttatus</i>	monkey flower
<i>Mimulus moschatus</i>	musk

<i>Mycelis muralis</i>	wall lettuce
<i>Myosotis discolor</i>	grassland forget-me-not
<i>Myosotis laxa</i> ssp. <i>caespitosa</i>	water forget-me-not
<i>Myosotis sylvatica</i>	garden forget-me-not
<i>Nephrolepis cordifolia</i>	tuber sword-fern
<i>Nymphaea alba</i>	water lily
<i>Nymphaea mexicana</i>	water lily (rare adventive)
<i>Oenothera stricta</i>	sand primrose
<i>Ornithopus perpusillus</i>	wild serradella
<i>Orobanche minor</i>	broomrape
<i>Osmunda regalis</i>	royal fern
<i>Parentucellia viscosa</i>	tarweed
<i>Paspalum dilatatum</i>	paspalum
<i>Pelargonium inodorum</i>	
<i>Phleum pratense</i>	timothy
<i>Phytolacca octandra</i>	inkweed
<i>Pinus contorta</i>	lodgepole pine, contorta pine
<i>Pinus muricata</i>	bishop pine
<i>Pinus nigra</i>	Austrian pine
<i>Pinus pinaster</i>	maritime pine
<i>Pinus ponderosa</i>	Ponderosa pine, western yellow pine
<i>Pinus radiata</i>	radiata, Monterey pine
<i>Pinus strobus</i>	Weymouth pine, strobus
<i>Plantago australis</i>	swamp plantain
<i>Plantago lanceolata</i>	ribwort, narrow-leaved plantain
<i>Plantago major</i>	broad-leaved plantain
<i>Poa annua</i>	annual poa
<i>Poa pratensis</i>	Kentucky blue grass
<i>Polygonum capitatum</i>	
<i>Polygonum hydropiper</i>	water pepper
<i>Polygonum persicaria</i>	willow weed
<i>Polygonum punctatum</i>	
<i>Populus alba</i>	silver poplar
<i>Populus x canescens</i>	grey poplar
<i>Populus x euramericana</i>	hybrid black poplar
<i>Populus nigra</i>	Lombardy poplar
<i>Portulaca oleracea</i>	purslane
<i>Prunella vulgaris</i>	selfheal
<i>Prunus domestica</i>	plum
<i>Prunus persica</i> var. <i>nectarina</i>	nectarine
<i>Pseudotsuga menziesii</i>	Douglas fir
<i>Pyracantha angustifolia</i>	firethorn
<i>Ranunculus acris</i>	giant buttercup
<i>Ranunculus flammula</i>	spearwort
<i>Ranunculus glabrifolius</i>	
<i>Ranunculus repens</i>	creeping buttercup
<i>Ranunculus sardous</i>	hairy buttercup
<i>Raphanus raphanistrum</i> ssp. <i>maritimus</i>	sea radish
<i>Reseda lutea</i>	cut-leaved mignonette
<i>Rhododendron ponticum</i>	rhododendron
<i>Robinia pseudacacia</i>	false acacia
<i>Rorippa nasturtium-aquaticum</i>	watercress
<i>Rosa rubiginosa</i>	sweet briar

<i>Rubus fruticosus</i> agg.	blackberry	
<i>Rubus phoenicolasius</i>	Japanese wineberry	
<i>Rumex acetosella</i>	sheep's sorrel	
<i>Rumex conglomeratus</i>	clustered dock	
<i>Rumex obtusifolius</i>	broad-leaved dock	
<i>Sagina procumbens</i>	procumbent pearlwort	
<i>Salix babylonica</i>	weeping willow	
<i>Salix cinerea</i>	grey willow	
<i>Salix fragilis</i>	crack willow	
<i>Salix matsudana</i>	tortured willow	
<i>Salix x reichardtii</i>	pussy willow	
<i>Sambucus nigra</i>	elder	
<i>Senecio bipinnatisectus</i>	Australian fireweed	
<i>Senecio glomeratus</i>	fireweed	
<i>Senecio jacobaea</i>	ragwort	
<i>Senecio sylvaticus</i>	wood groundsel	
<i>Sequoia sempervirens</i>	redwood	
<i>Sherardia arvensis</i>	field madder	
<i>Silene gallica</i>	catchfly	
<i>Sisymbrium officinale</i>	hedge mustard	
<i>Solanum dulcamara</i>	bittersweet	
<i>Solanum nigrum</i>	black nightshade	
<i>Solanum tuberosum</i>	potato	
<i>Sonchus asper</i>	prickly sow thistle, puha	
<i>Sonchus oleraceus</i>	sow thistle, puha, puka	
<i>Sorbus aucuparia</i>	rowan	
<i>Spirodela punctata</i>	purple-backed duckweed	
<i>Sporobolus africanus</i>	needle grass, rat's tail grass	
<i>Stellaria alsine</i>	bog stichwort	
<i>Stellaria media</i>	chickweed	
<i>Stenotaphrum secundatum</i>	buffalo grass	
<i>Taraxacum officinale</i>	dandelion	
<i>Teline monspessulana</i>	Montpellier broom	
<i>Trifolium arvense</i>	haresfoot trefoil	
<i>Trifolium dubium</i>	suckling clover	
<i>Trifolium pratense</i>	red clover	
<i>Trifolium repens</i>	white clover	
<i>Tropaeolum majus</i>	garden nasturtium	
<i>Tropaeolum pentaphyllum</i>	ladies' legs	(rare adventive)
<i>Ulex europaeus</i>	gorse	
<i>Verbascum thapsus</i>	woolly mullein	
<i>Verbena bonariensis</i>	purple-top	
<i>Verbena littoralis</i>	purple vervain	
<i>Veronica anagallis-aquatica</i>	water speedwell	
<i>Veronica officinalis</i>	vervain	
<i>Vicia sativa</i>	vetch	
<i>Viola x wittrockiana</i>	pansy	
<i>Vitis vinifera</i>	grape	
<i>Vulpia bromoides</i>	squirrel-tail fescue	

Appendix 4 - Checklist of vertebrates other than birds in Atiamuri Ecological District

Freshwater fishes

<i>Anguilla dieffenbachii</i>	long-finned eel
<i>Carassius auratus</i>	goldfish
<i>Galaxias brevipinnis</i>	koaro
<i>Gobiomorphus basalis</i>	Cran's bully
<i>Gobiomorphus cotidianus</i>	common bully
<i>Ictalurus nebulosus</i>	catfish
<i>Onchorhynchus mykiss</i>	rainbow trout
<i>Poecilia reticulata</i>	guppy
<i>Retropinna retropinna</i>	common smelt
<i>Salmo trutta</i>	brown trout
<i>Salvelinus fontinalis</i>	brook char
<i>Scardinius erythrophthalmus</i>	rudd

Mammals and marsupials

<i>Capra hircus</i>	goat
<i>Cervus elaphus</i>	red deer
<i>Chalinolobus tuberculatus</i>	long-tailed bat
<i>Erinaceus europaeus</i>	hedgehog
<i>Felis catus</i>	cat
<i>Lepus capensis</i>	hare
<i>Macropus eugenii</i>	Dama wallaby
<i>Mus musculus</i>	mouse
<i>Mustela erminea</i>	stoat
<i>Mustela furo</i>	ferret
<i>Mustela nivalis</i>	weasel
<i>Oryctolagus cuniculus</i>	rabbit
<i>Ovis aries</i>	sheep
<i>Rattus norvegicus</i>	brown rat, Norway rat
<i>Rattus rattus rattus</i>	black rat, ship rat
<i>Sus scrofa</i>	pig
<i>Trichosurus vulpecula</i>	brush-tailed possum

Reptiles and amphibians

Based on Pickard & Towns (1988), Robb (1986), and Dept. of Conservation SSWI database.

<i>Leiopisma infrapunctatum</i>	spotted skink
<i>Litorea aurea</i>	golden bell frog
<i>Litorea raniformis</i>	green tree frog
<i>Naultinus elegans elegans</i>	green gecko

Appendix 5 - Birds of the Atiamuri Ecological District

The following bird species, listed in checklist order (Ornithological Society of New Zealand 1990), have been recorded as currently occurring in the study area.

weweia (N.Z. dabchick)	<i>Poliocephalus rufopectus</i>
kawau (black shag)	<i>Phalacrocorax carbo novaehollandiae</i>
little black shag	<i>Phalacrocorax sulcirostris</i>
little shag	<i>Phalacrocorax melanoleucos</i>
white-faced heron (matuku moana)	<i>Ardea n. novaehollandiae</i>
matuku (Australasian bittern)	<i>Botaurus poiciloptilus</i>
black swan*	<i>Cygnus atratus</i>
putangitangi (paradise shelduck)	<i>Tadorna variegata</i>
mallard*	<i>Anas p. platyrhynchos</i>
parera (grey duck)	<i>Anas s. superciliosa</i>
tete (grey teal)	<i>Anas gracilis</i>
kuruwhegi (N.Z. shoveller)	<i>Anas rhynchotis variegata</i>
papango (N.Z. scaup)	<i>Aythya novaeseelandiae</i>
Australian harrier (kahu)	<i>Circus approximans</i>
karearea (N.Z. falcon)	<i>Falco novaeseelandiae</i>
California quail*	<i>Callipepla californica</i>
brown quail	<i>Synoicus ypsilophorus</i>
ring-necked pheasant*	<i>Phasianus colchicus</i>
wild turkey*	<i>Meleagris gallopavo</i>
puweto (spotless crake)	<i>Porzana tabuensis plumbea</i>
koitareke (marsh crake)	<i>Porzana pusilla affinis</i>
pukcko (swamp hen)	<i>Porphyrio p. melanotus</i>
Australian coot	<i>Fulica atra australis</i>
Australian pied stilt	<i>Himantopus h. leucocephalus</i>
tuturiwhatu (banded dotterel)	<i>Charadrius b. bicinctus</i>
spur-winged plover	<i>Vanellus miles novaehollandiae</i>
Caspian tern	<i>Sterna caspia</i>
karoro (black-backed gull)	<i>Larus dominicanus</i>
kereru (N.Z. wood pigeon)	<i>Hemiphaga novaeseelandiae</i>
sulphur-crested cockatoo*	<i>Cyanorhamphus a. auriceps</i>
pipiwharau (shining cuckoo)	<i>Chrysococcyx l. lucidus</i>
koekoea (longtailed cuckoo)	<i>Eudynamis taitensis</i>
ruru (morepork)	<i>Ninox novaeseelandiae</i>
kotare (N.Z. kingfisher)	<i>Halcyon sancta</i>
titipounamu (N.I. rifleman)	<i>Acanthisitta chloris</i>
skylark*	<i>Alauda arvensis</i>
welcome swallow*	<i>Hirundo tahitica neoxena</i>
N.Z. pipit (pihoihoi)	<i>Anthus n. novaeseelandiae</i>
hedge sparrow*	<i>Prunella modularis</i>
blackbird*	<i>Turdus merula</i>
song thrush*	<i>Turdus philomelos</i>
matata (N.I. fernbird)	<i>Bowdleria punctata vealeae</i>
popokatea (whitehead)	<i>Mohoua albicilla</i>

* Introduced species

riroriro (grey warbler)
 piwakawaka (N.I. fantail)
 miromiro (N.I. tomtit)
 toutouwai (N.I. robin)
 tauhou (silveryeye)
 korimako (bellbird)
 tui
 yellowhammer*
 chaffinch*
 greenfinch*
 goldfinch*
 redpoll*
 house sparrow*
 starling*
 common myna*
 Australian magpie*
 Eastern Rosella parrot

Gerygone igata
Rhipidura fuliginosa
Petroica macrocephala
Petroica australis longipes
Zosterops lateralis
Anthornis melanura
Prothemadera n. novaeseelandiae
Emberiza citrinella
Fringilla coelebs
Carduelis chloris
Carduelis carduelis
Carduelis flammea
Passer domesticus
Sturnus vulgaris
Acridotheres tristis
Gymnorhina tibicen
Platycercus eximius

* Introduced species

Appendix 6 - Landsnails of the Atiamuri Ecological District

(Contributed by Pauline M. Mayhill)

Allodiscus dimorphus (Pfeiffer)
Allodiscus granum (Pfeiffer)
Allodiscus miranda (Hutton)
Allodiscus planulatus (Hutton)
Allodiscus tessellatus (Powell)
Athoracophorus bitentaculatus (Quoy & Gaimard)
Basimocella sp. cf. *manawatawhia*
Cavellia anguicula (Reeve)
Cavellia buccinella (Reeve)
Cavellia irregularis (Suter)
Cavellia reefstonensis (Suter)
Cavellia serpentinula (Suter)
Charopa coma (Gray)
Cytora cytora (Gray)
Cytora torquilla (Suter)
Delos jeffreysiana (Pfeiffer)
Fectola infecta (Reeve)
Fectola mira (Webster)
Flammocharopa costulata (Hutton)
Flammoconcha feredayi (Suter)
Flamulina chiron (Gray)
Flamulina crebiflammis (Pfeiffer)
Flamulina perdita (Hutton)
Flamulina zebra (Le Guillou)
Geminoropa sp. cf. *cookiana*
Geminoropa huttonii (Suter)
Geminoropa subantialba (Suter)
Huonodon hectori (Suter)
Huonodon pseudoleiodon (Suter)
Hydrocena purchasi (Iredale)
Laoma ariel (Hutton)
Laoma poecilosticta (Pfeiffer)
Laoma regularis (Pfeiffer)
Laoma serratocostata (Webster)
Mocella accelerata (Climo)
Mocella eta (Pfeiffer)
Nephenacohelix giveni (Cumber)
Obanella rimutaka (Dell)
Obanella spectabilis (Powell)
Paracharopa bianca (Hutton)
Paralaoma lateumbilicata (Suter)
Paralaoma sericata (Suter)

Pasmaditta jungermanniae (Pettard)
Phenacharopa pseudanguicula (Iredale)
Phenacohelix perplexa (Murdoch)
Phenacohelix rusticus (Suter)
Phrixgnathus brunneum (Goulstone)
Potamopyrgus antipodarum (Grey)
Pseudaneita papillatus (Hutton)
Pseudegestula montivaga (Suter)
Ptychodon wairarapa (Suter)
Punctum 'arboreus'
Punctum 'arewa'
Punctum 'globosa'
Punctum 'gracilis'
Punctum 'microbrunneus'
Punctum microreticulata (Suter)
Punctum 'minuta'
Punctum 'miserabilis'
Punctum 'ordinarium'
Schizoglossa novoseelandica (Pfeiffer)
Sinploya sp. cf. *pilsbryi*
Sinploya pilsbryi (Suter)
Suteria ide (Grey)
Therasia traversi (E.A. Smith)
Therasiella celinde (Grey)
Therasiella cf. *neozelanica*
Therasiella neozelanica (Cumber)
Therasiella serrata (Cumber)
Tubuaia novoseelandica (Pfeiffer)

Appendix 7 - Table of Ecological Units and PNAs or RAPs containing them

GEOHERMAL ECOLOGICAL UNITS	PNA No (P-) or RAP No. (R-).
Bare, thermally altered soils and sinter with temperatures up to 9°C	P2, P5, R4
<i>Baumea rubiginosa</i> - <i>Carex virgata</i> sedgeland on crater floor	P3
Blackberry-bracken-lupin-fern-shrubland in reverting pasture	R39
Bracken-baumea fern-reedland in old explosion crater	P1
Cabbage-tree treeland on river terraces	P10
<i>Carex virgata</i> sedgeland on valley floor	R39
Geothermal vegetation, ferns/moss & lichen field on soils at 55-70°C	P2, P5
<i>Juncus effusus</i> rushland on valley floor	R39
Kanuka, manuka, and mingimingi, with wildling pines adjacent to lake shore	R43
Kanuka-kamahi mixed broadleaved shrubland and low forest with wildling pines on hillslopes	P3
Kanuka-manuka scrub to 3 m on lower hillslopes	P3
Kanuka-mingimingi-kohuhu shrubland with many wildling pines in stream valley	R4
Kohuhu-five finger-kanuka/bracken, scrub and shrubland species on river terraces	P10
Manuka-kamahi/ <i>Cyathodes juniperina</i> scrub on slightly warm soils of colluvial toe slopes	P1
Manuka-makomako/ <i>Hypolepis ambigua</i> fernland on warm soils of alluvial fan	P1
Mingimingi, manuka, kanuka, turutu, bracken, blackberry, ferns, and kamahi in reverting pasture	R37
Pine/mingimingi-manuka scrub, on hillslopes	P1
<i>Pinus radiata</i> forest/broadleaved shrubs and ferns	P2, P5, P6
<i>Pinus radiata</i> forest; some blackberry, with pasture grasses on valley floor	R24
Prostrate kanuka and mingimingi with seedling pines on hillslopes	P5, P7
Prostrate kanuka-mingimingi shrubland and scrub on flats and hillslopes	P1, P2, P5, P16, P32, R39
Prostrate kanuka/ <i>Campylopus</i> moss shrubland on heated soils	P1
Prostrate kanuka on steep faces, and toatoa, rimu, and kamahi in heated crater area	P3
Prostrate kanuka- <i>Dicranopteris linearis</i> - <i>Gleichenia dicarpa</i> on hillslopes	R25
Prostrate kanuka-monoao shrubland in geothermal area on hillslopes	P13
Recently felled plantation areas with prolific introduced weeds on pumice terraces	P2
Reverting pasture with manuka scrub and weeds on lakeshore	R36

Thermal ferns adjacent to geothermal springs	P6, P11, P23, R16, R45
Treeferns and <i>Coprosma</i> spp. with ferns and carex in stream gully on hillslope	P7

WETLAND ECOLOGICAL UNITS

Aquatic vegetation and open water	P6, P26, R7, R10, R11, R33
Baumea, flax, manuka, with willow margins adjacent to pine plantations	R11, R17
<i>Carex secta</i> and <i>Baumea juncea</i> sedgeland in valley	P16
Carex sedgeland in valley	P8, R10
Coprosma-flax shrubland with carex-rush understorey adjacent to lake edge	R10
Coprosma-flax- <i>Cortaderia</i> shrubland on valley floor.	P26
Flax- <i>Carex secta</i> sedgeland in infilled valley.	R18
Flax-Carex sedgeland with broadleaved regeneration on valley floor.	R22
Flax-Carex- <i>Juncus</i> sedgeland with scattered manuka and <i>Coprosma</i> spp. on old lakebed	R41
Flax-coprosma shrubland on valley floor	R13, R31
Flax-coprosma swampland with pines and willows on valley floor	R29
Flax-kohuhu shrubland with regenerating podocarps on valley floor	R12
Flax-raupo herbfields in lake-edge swamp	P16
Flax-toetoe shrubland with broadleaved regeneration on valley floor	R12
Flax-toetoe swampland, with willows encroaching in stream valley	R30, R34
Flax-toetoe- <i>Baumea</i> swampland in stream valley	R13
Flax-toetoe- <i>Coprosma propinqua</i> on valley floor	R30
Grey willow treeland on valley floor	P18
<i>Juncus</i> /marsh bedstraw herbfield	R30
<i>Juncus-ranunculus</i> wetland with grey willow in hollow in tephra	R40
Kohuhu-five finger-cabbage tree shrubland in stream valley	R34
Manuka/flax-sedge peatland in infilled valley	P8
Mixed exotic shrubland on levee banks and cliff faces surrounding oxbow lagoon	R7
Pines, broom, blackberry, gorse, hawthorn, grassland surrounding swamp	P8
Raupo reedlands, with cabbage trees and <i>Coprosma</i> spp. on stream banks	R19
Raupo reedland bordering open water	R10, R11, R33
Raupo-flax tussock-reedland surrounding lake	P26, P27
Spray-zone vegetation, five finger, pate, karamu, wheki, and kohuhu along riverbank	P10
Turf communities, <i>Glossostigma elatinoides</i> , <i>Myriophyllum propinquum</i> , <i>Lilaeopsis</i> sp., <i>Isoetes</i> sp. on riverbank	P10
Willow-flax-kiokio swampland on valley floor	P30
Willow-flax-toetoe-blackberry swampland on valley floor	P30

Willow/Carex association; raupo, rush, sedge and herbfield; open water
in stream valley

P8, P18

FOREST AND SHRUBLAND ECOLOGICAL UNITS

A mosaic of hardwood species with large emergent matai in stream bed	R5
Blackberry-broom scrub on valley floor	P18
Blackberry-willow-poplar shrubland on valley floor	R12
Bracken and pasture fern-grassland on hillslopes	P13
Bracken-broadleaved shrubland on hillslopes	R42
Broadleaved secondary vegetation on hillslopes	P18, P20, P28, R8
Broadleaved shrubs with emergent matai and mangeao on ridges	R8
Broadleaved shrubs with kamahi-rewarewa emerging on hillslopes	P12
Exotic plantations (other than pines) on hillslopes or in valleys	P13, P25, P26
Exotic planted hillslopes with flax-carex shrubland in hollows	P26
Fern shrubland, containing many wildling pines on steep hillslopes	P21
Fern-shrubland with regenerating five finger, kohuhu, and mahoe on hillslopes	P29
Fernland, mostly bracken with blackberry and <i>Muehlenbeckia australis</i> on hillslopes	P14
Flax-manuka-coprosma shrubland on valley floor	R17
Frost-flat type shrubland along the edge of cultivated tephra terraces	R23
Fuchsia-mahoe-wineberry on hillslopes	R15
Grassed treeland with a low canopy of kamahi-tarata-mahoe and fuchsia on hillslopes	R44
Grassland/carex and shrubland in valley floor	R27
Hall's totara/kamahi-tawari forest on high rangetops	P4
Hard beech in pockets along plateau rim	P4
Horopito-kamahi forest on dometop	R20
Kamahi-rewarewa, tawa, hinau, maire and mangeao on hillslopes	P9
Kamahi-rewarewa, with random podocarps on hillslopes	P1, P16, P20, R6, R8, R14
Kamahi with broadleaf, tawheowheo, toro, rimu, miro, and Hall's totara on hillslopes to 600 m	P9
Kamahi-broadleaf- tawheowheo, (toatoa) (horopito) (Hall's totara) (miro) on hillslopes to 975 m	P9
Kamahi-coprosma (pine) secondary regeneration on steep lower hillslopes	P17
Kamahi-fuchsia-mahoe-wineberry (matai) tree shrubland on hillslopes	R20, R32, R35
Kamahi-mahoe broadleaved forest on hillslopes	P19, R20
Kamahi-mahoe-fuchsia with emerging rewarewa on hillslopes	R42
Kamahi-mahoe-with emergent rewarewa and podocarps on hillslopes	R15
Kamahi-matai with young totara emerging on stream terraces	P12
Kamahi-rangiora-wineberry with emerging rewarewa on hillslopes	R42

Kamahi-tarata-mahoe-fuchsia (matai-rewarewa) in a regenerating mosaic on hillslopes	P17
Kamahi/kohuhu/mahoe on bush edge along gully shoulders	R5
Kamahi/mahoe-treeferns with abundant ground ferns in gullies	R3
Kanuka-five finger-Spanish heath shrubland on steep bluffs	R6
Kanuka-manuka (pines) shrub treeland on hillslopes	P18
Kanuka/ manuka-kohuhu-five finger (pines)(cabbage-tree)/bracken fern shrubland on hillslopes	P25
Lancewood, kohuhu, <i>Coprosma</i> spp., along bush edge and 'frost flat'	R2
Mahoe-tree fuchsia-pate forest in gully	P15
Mahoe-fuchsia-treeferns, totara and rewarewa emerging on hillslopes	R38
Mangeao (rewarewa) (pines)/five finger forest on hillslopes	P25
Mangeao-tawa with matai and rimu, and broadleaved shrubs and treeferns on hillslopes	P15
Manuka/kanuka shrubland with broadleaved regeneration on ridges and treeferns in gullies	P22
Manuka shrubland on eroded pumice terraces	P16
Manuka-broadleaved shrubland on hillslopes	R9
Manuka-fern-broom shrubland on hillslopes	P18
Manuka-flax-coprosma shrubland, over <i>Baumea</i> and <i>Gleichenia dicarpa</i> in valley wetland	R17
Manuka- <i>Pomaderris ericifolia</i> -Spanish heath shrubland on hillslopes	P25
Matai-totara/kamahi-pittosporum-mahoe broadleaved forest on hillslopes	R35
Pate- <i>Dicksonia fibrosa</i> / <i>Coprosma</i> spp. on hillslopes	R2
Pate-fuchsia-putaputaweta-mahoe over ferns along streamside	R14
Pine forest on hillslopes of rhyolite dome	R28
<i>Pinus pinaster</i> /manuka/toru shrubland on eroded pumice terraces	P16
<i>Pinus pinaster</i> forest on pumice terrace	P16
Rata/tawa-kamahi forest on hillslopes	P4
Rewarewa/clearfell treeland on hillslopes	R27
Rewarewa/kamahi/dicksonia forest on hillslopes	R27
Rewarewa/kamahi forest on hillslopes	P14, P15, R9
Rewarewa/kamahi to 20 m high on western hillslopes	P20
Rewarewa forest on hillslopes	P4, P13, P24
Rewarewa, kamahi, mahoe and tarata, with podocarps emerging, on hillslopes	R26
Rewarewa-kamahi (rimu)(matai) on hillslopes	R2
Rewarewa-kamahi/podocarp seedlings on hillslopes	R2
Rewarewa-kamahi /mahoe-pate(rimu)(matai) on hillslopes	R2
Rewarewa-mangeao-hinau forest on hillslopes	P14
Rewarewa-mangeao-kamahi (podocarps) on hillslopes	R21
Rewarewa-pigeonwood forest on hillslopes	P14
Rewarewa-tarata forest on ridgetop	P14

Rewarewa/kamahi with emergent podocarps on terraces and ridges	R3
Rewarewa/kamahi-manuka-monoao regenerating on burnt western faces	R1
Rewarewa/mahoe-wineberry forest, on hillslopes	P14
Rewarewa/mangeao-mahoe with scattered matai and miro, on hillslopes	P14
Rimu-matai/five finger-kohuhu forest on steep east-facing hillslopes	P24
Rimu, matai, kahikatea, (totara)(maire) mahoe, broadleaf, putaputaweta, and tarata on valley floor	P9
Rimu-matai/maire-kamahi forest on hillslopes	P4
Rimu-matai/tawa-hinau primary forest on hillslopes	P13
Rimu-northern rata/matai-tawa-rewarewa-kamahi forest on hillslopes	P4, R9
Rimu-rata/tawa, hinau, rewarewa, mangeao, kamahi, miro, and Hall's totara, hillslopes to 600 m	P9
Rimu-rewarewa/hinau-mangeao primary forest on hillslopes	P13
Rimu/matai-tawa-kamahi forest on plateau crest	P4
Rimu/miro-tawa-kamahi-tawari forest on hillslopes	P4
Rimu/tawa-kamahi-hard beech forest on ridges	P4
Tanekaha pole stands on headwater sideslopes	R3
Tanekaha, other podocarps, and divaricates on small 'frost flat'	R14
Tanekaha, regenerating on small riverside terraces	P31
Tasmanian blackwood (<i>Acacia melanoxylon</i>) planted on stream banks	P23
Tawa-hinau-rewarewa secondary forest on hillslopes	P13
Tawa-kamahi forest on hillslopes	P4
Tawa-mahoe-pukatea-(rewarewa)(rimu) forest on colluvial fan	R1
Tawa-rewarewa-mangeao, on dometop and hillslopes	R6
Tawa-tawari forest/pepperwood-(totara) (miro) on upper hillslopes	R1
Totara/treeferns/ground ferns on steep, shaded hillslopes	R5
Tree-fermland on hillslopes	R9
Treefern-broadleaved shrubland with emerging rewarewa and podocarps on hillslopes	R42
Treeferns in deep gullies	P28, R8
Wineberry-fuchsia shrubland on hillslopes	P14

Appendix 8 - 1840's vegetation pattern (after Leathwick *et al.* 1995)

Forests

Forest cover as at 1840 was mapped using the forest classes of Nicholls (1976). In some areas reconstruction down to a type level was not possible from surviving remnants, and mixtures of units have been mapped instead (see Map 1).

Lowland steepland and montane conifer/broadleaved forest (G)

This class occurred mostly above the altitudinal limits of rimu where beeches are absent, but also on harsh sites at low altitudes where many of the broadleaved species usually dominant at lower altitudes were largely absent. Rimu, miro, Hall's totara, and tanekaha were the most widespread conifers at lower altitudes, and occurred as scattered emergents over a canopy of tawa and kamahi; tawari was also present on the Mamaku Plateau. Prominent species on the highest parts of Horohoro Dome and the Paeroa Range are Hall's totara, kamahi, quintinia, toro and broadleaf, plus tawari on the dome only.

Rimu-tawa-beech forest (H)

This class occurred very locally in the northwest of the district, and consisted of rimu-rata/tawa forest (D) with irregular mixtures or frequent pockets of hard beech. Dominant species were rimu, miro, tanekaha, northern rata, tawa, hinau, rewarewa, pukatea, kamahi, quintinia, and hard beech.

Beech forest (K)

This class occurs in a small area on the rim of the Mamaku Plateau.

Conifer forest (L)

Often referred to as dense podocarp forest, this class was most extensive on deep, well drained volcanic soils in southern parts of the district. Matai and totara generally predominated, with more occasional rimu, miro, kahikatea, and very local tanekaha, but extremely dense rimu forest (120 stems per hectare) occurred in the Maroa area.

Rimu-matai-broadleaved forest (M)

This class occurred the most widely. It consisted of forest in which conifers were less abundant than in conifer forest, and occurred with a range of broadleaved species. Rimu, miro, matai, totara, and kahikatea were all occasional to locally frequent, emergent over an understorey of hinau, rewarewa, maire, kamahi, pokaka and/or broadleaf. Rata and tawa were generally present north of the Waikato River, but absent to the south.

Secondary vegetation

Secondary vegetation has been split by region and landform, as follows.

Rhyolite plateaus (rh-p)

Subject to persistent burning by Maori inhabitants, according to the accounts of early European travellers, this unit was largely devoid of woody vegetation over large areas. Dominant species would have been largely scattered silver tussock interspersed with creeping shrubs such as *Coprosma acerosa* and *Leucopogon fraseri*, with both native and adventive grasses and herbs, and manuka and/or monoao invading where sufficient time elapsed between fires. Local areas of steeper topography would have supported similar vegetation to that found in the Taupo rhyolite domes unit (rh-d).

Rhyolite domes (rh-d)

Less prone to fire than the surrounding lower country, and experiencing much less intense frosts, this unit would have supported a wider diversity of species and generally faster recovery of vegetation following fire. Early stages of succession would have probably been dominated by bracken, with subsequent invasion by large-seeded species such as five finger, tutu, tarata, broadleaf, lancewood, and kohuhu, or perhaps by epicormic resprouting of kamahi. Rewarewa would have dominated in the later stages of succession.

Primary scrub

As for wetlands, the distribution of primary scrub and tussock-shrublands would have probably differed little from the present. However, given that the composition of the latter has almost certainly been modified through the combined effects of fire and browsing, some differences in composition are likely, with a greater abundance of both shrubs and of total vegetation cover likely in historic times.

Appendix 9 - Current vegetation pattern (after Leathwick *et al.* 1995)

Current vegetation is mapped (see Map 2) using the following units, based largely on the forest classes of Nicholls (1976) as described both here and previously, extended at a similar level of detail to cover non-forest vegetation.

Primary forest

- Lowland steep-land conifer/broadleaved forest (G1 - 469 ha) (as described in Appendix 8.)
- Montane conifer/broadleaved forest (Gm - 541 ha)
- Rimu-tawa-beech forest (H - 16 ha.)
- Rimu-broadleaved-beech forest (I - 155 ha)
- Conifer forest (L - 6 ha.)
- Rimu-matai forest (M - 886 ha)
- Beech forest (K - 16 ha).

Secondary forest**Secondary broadleaved forest (BL - 1783 ha)**

Has arisen from secondary successions following fire or clearance for agriculture (cf. the modified broadleaved forest remaining after logging of conifer and rimu-matai forest, i.e., Nicholls types L and M respectively), and occurs throughout the district. Rewarewa, five finger, and kamahi are the most widespread species; others of more local occurrence include heketara, quintinia, kohuhu, lancewood, and broadleaf.

Secondary small-leaved forest (SL - 55 ha)

Similar to the previous unit, but dominated by manuka and/or kanuka, the former generally predominant on sites which are colder, wetter, and less fertile and the latter on sites with lower rainfall and/or more fertile soils. Both species are capable of regenerating on land grazed by domestic stock, and so this unit tends to be more widespread than secondary broadleaved forest in agricultural landscapes.

Secondary broadleaved/small-leaved forest (BS - 416 ha)

Occurs throughout the district, consisting of various mixtures of manuka, kanuka, and broadleaved species such as kamahi, rewarewa, and fivefinger.

Secondary conifer forest (CO - 212 ha)

Of limited extent on sites at intermediate altitudes on the ignimbrite plateau in the extreme west, where dense canopies of young podocarps have overtopped former canopies of early-successional broadleaved or

small-leaved species.

Secondary conifer/broadleaved forest (CB - 28 ha)

Of similar structure to secondary conifer/small-leaved forest, with pole and sapling conifers - mainly rimu and tanekaha - emerging through a canopy dominated by broadleaved species such as kamahi, five finger, and lancewood.

Logged forest

Tawa forest (N - 1516 ha)

Consists of the residue left after selective removal of conifers, i.e., logging of rimu-tawa forest (D), and some rimu-matai-broadleaved forest types (M1-M2-M3). Tawa is generally dominant, with lesser amounts of kamahi, hinau, rewarewa, and maire interspersed with dense regrowth of shrubs such as *Pseudopanax* spp., putaputaweta, wineberry, etc. on old skid sites and logging tracks.

Broadleaved forest (logged) (P - 2478 ha) (cf. secondary broadleaved forest)

Has arisen after logging of forest in which tawa was largely absent, i.e., conifer forest (L) and some rimu-matai-broadleaved forest (M1-M2-M3). It consists of variable mixtures of broadleaved trees and shrubs such as kamahi, quintinia, maire, narrow-leaved mahoe, hinau, and broadleaf interspersed with dense regrowth of shrubby species on more disturbed areas, as in tawa forest (N).

Scrub and shrubland

Induced scrub and shrubland with a canopy less than 6 m in height has been divided into eight units on a similar basis to secondary forests, i.e., using the physiognomy of the dominant species.

Broadleaved scrub (bl - 762 ha)

Of similar origin to secondary broadleaved forest, but differing somewhat in composition, with widespread species including five finger, rangiora, mahoe, kohuhu, lancewood, *Gaultheria* spp., broadleaf, *Hebe* spp., and *Coprosma* spp. The mix of species at any one site varies widely according to climate and site history.

Small-leaved scrub (sl - 530 ha)

Much simpler floristically than broadleaved scrub, with only manuka and kanuka widespread. Other species included in this unit, mainly at higher altitudes, are the small-leaved, divaricate *Coprosma* spp.

Broadleaved/small-leaved scrub (bs - 203 ha)

Consists of mixtures of manuka and/or kanuka with broadleaved species as listed for broadleaved scrub.

Treefern 'scrub' (tf - 13 ha)

Although not strictly fitting the physiognomic definition, has been included with these units because of its similar origins and co-dominance of shrubby species. Has generally arisen after partial clearing of forest for agriculture. Consists of scattered treeferns emergent over a layer of shrubby species such as rangiora, mahoe, manuka, and five finger, with varying proportions of pasture species.

Exotic

Exotic forest (EX - 88 924 ha)

No attempt has been made to distinguish radiata pine, by far the predominant species, from those of more limited extent such as Douglas fir and eucalypts.

Exotic scrub (ex - 78 ha)

Of limited extent, occurring mostly around the margins of more extensive blocks of indigenous vegetation. Composition varies from site to site, with gorse, broom, and blackberry the most widespread species.

(Exotic pines)/scrub (sx - 2500 ha)

Occurs throughout the district, mostly adjacent to exotic plantations, and consists of scattered exotic pines, mostly *Pinus radiata*, emergent through manuka, kanuka, or broadleaved scrub.

Fernland

Bracken fernland (br - 515 ha)

Occurs scattered throughout the district, where it has arisen after disturbance, usually by fire, and generally in the absence of domestic stock. Consists of a dense cover of bracken, although in time broadleaved species such as kohuhu and five finger generally begin to invade.

Wetlands

Raupo-flaxland (fl - 87 ha)

Consists of various mixtures or sometimes complex mosaics of raupo and/or *Phormium tenax*, occasionally with abundant *Cortaderia toetoe* and a range of other shrub, sedge, and rush species.

Sedgeland (sg - 122 ha)

Generally occupying sites with less water movement than raupo-flaxland, these occur throughout the district. A wide range of sedge and rush species may be present, in the genera *Carex*, *Juncus*, *Scirpus*, *Elaeocharis*, *Baumea*, *Schoenus*, and *Lepidosperma*. Ferns such as *Blechnum* and *Gleichenia* spp. may also be common, as may a range of herbaceous species.

Shrub/sedgeland (sh - 524 ha)

Similar in distribution to sedgeland, these contain many of the same species but in addition have a shrub tier, generally of manuka. Other species sometimes also present, particularly at higher altitudes, include karamu, *Epacris pauciflora*, *Hebe stricta*, and broadleaf.

Willow wetlands (wl - 346 ha)

A result of general invasion by grey and/or crack willow of any of the freshwater wetland units. The composition is variable, depending on the composition of the original wetland, but with time is drastically altered as a dense, even canopy of willow develops. Crack willow usually dominates alongside river channels where there is more water movement and higher nutrient status; grey willow is more common where fertility is lower, e.g., in backwaters and on areas of peat accumulation.

Geothermal vegetation

Geothermal shrubland (gs - 478 ha)

Occurs around the margins of geothermally active areas on sites with elevated soil temperatures. A prostrate form of kanuka is generally dominant on sites with high soil temperatures (>30°C), but as temperatures decline other species such as mingimingi, manuka, and prickly mingimingi become dominant.

Geothermal wetlands (gw - 15 ha)

Dominated by *Hypolepis ambigua* and *Histiopteris incisa*, with *Baumea* spp. on wetter, cooler sites. *Cyclosorus interruptus* is restricted to this unit, occurring at Waiotapu, Waihunuhunu, and Wairakei.

Appendix 10 - Classification of geothermal fields and individual geothermal features

The only systematic New Zealand-wide attempt to classify geothermal fields (GFs) and individual geothermal features (IGFs) for their significance, uniqueness, and vulnerability is that of the Geological Society of New Zealand (GSNZ) inventory (Houghton *et al.* 1989).

Historically, IGFs have been studied primarily for clues to their deep chemistry and magmatic environments hence usually only hot flowing springs have been studied. Cooler and acid groundwater IGFs have been either not recorded, or noted but not studied. Published knowledge is therefore strongly skewed towards consideration and study of the flowing alkaline hot springs, often to the exclusion of most other types. The GSNZ inventory is therefore as yet quite incomplete, even though some acid features (e.g., mud cones) are very rare in New Zealand.

The present survey has confirmed the incompleteness of the existing GSNZ GF and IGF inventory, with the discovery of several IGFs never previously recorded or described. Within the Atiamuri Ecological District two separate sites of calcite-depositing springs have been discovered, and two large hot springs have been found which have never previously been studied. Other IGFs are similarly undescribed in any previous works.

GSNZ classification of geothermal fields and features

Ranking and classifying criteria used by GSNZ (Houghton *et al.* 1989) may be too restrictive in scope to allow thorough objective scoring to be achieved. A work programme using a series of objective observations and records would allow scores and rankings to be obtained on a more rigorous basis, although such a task would require more work to develop and establish. For this report the existing GSNZ ranking and classification system has been used as a basis for comparative evaluations of GFs and IGFs; their criteria (pp. 9-10 in Houghton *et al.* 1989) are reproduced below.

Both field and feature entries are classified in two ways - by importance and by vulnerability. These classifications match those for other parts of the Geopreservation Inventory (e.g., Hayward & Ward 1987; Stirling 1988).

Assessment of importance

Each field or feature has been assigned an A, B, or C classification, where:

A = of international significance;

B = of national scientific, scenic, or educational importance;

C = of regional scientific, scenic, or educational value.

Assessment of vulnerability

There are four categories of vulnerability within the series of geoscience inventories. All geothermal features are very vulnerable on an absolute scale because water and other fluids are highly subject to modifying influences. The classification used here is:

- (1.) a feature or field currently at risk from exploitation of the geothermal resource or natural influences such as ongoing volcanism;
- (2.) a feature or field discharging geothermal fluid and hence highly vulnerable to disturbance, but not currently under any known threat;
- (3.) a feature or field not discharging fluid and hence less susceptible to disturbance; and
- (4.) a feature that may be enhanced by human activity.

Collectively these scores for importance and vulnerability are given as, e.g., A1, B2, etc. for each GF and IGF.

Classifications in this PNAP survey

Classifications for GFs and IGFs are given in Table 10. These are consistent with the criteria defined by the GSNZ (Houghton *et al.* 1989), but are more comprehensive because fieldwork has provided additional fields, features, and sites to be included. Orakeikorako is recommended for a change from B2 to A4, as explained in sections 8.7.2 and 11.0 (Cody 1995).

Appendix 11 - Rankings of geothermal areas

A summary of rank scores, based on the GSNZ classification, in which the GSNZ rank is set alongside that suggested by A.D. Cody (1995). For background information, see Appendix 10.

Field or feature	GSNZ rank	ADC rank	Comments
Atiamuri	C2	C2	Extinct vent and 3 hot flowing springs
Horohoro	C2	C2	Three flowing springs
Mokai	C2	B2	
Tirohanga Rd mud pools	---	B3	Two large boiling mud pools
Paerata Rd mud pool	---	B3	Powerfully boiling large pool
Ohineariki Bath spring	---	B2	Flowing clear acid spring; rare for type
Waipapa Rd springs	C2	C2	
Ngatamariki	C2	B2	Undisturbed thermal features
crater formed ca.1950; calcite sinter spring; new boiling spring formed ca. 1993.			Explosion
Ohaaki	C1	C4	All flowing springs now gone
Ohaaki pool	C1	C1	Destroyed by power scheme
Orakeikorako	B2	A2	Largest grouping of active geysers remaining in N.Z.
Artist's Palette	B2	A2	Large boiling spring
Cascade geyser	---	A2	
Diamond geyser	B2	A2	
Sapphire geyser	---	A2	
Golden Fleece Terrace	B2	A2	Large silica sinter terraces; now rare in N.Z.
Rainbow Terrace	B2	A2	Large silica terraces
Ruatapu Cave	B3	A3	Large fumarole crater; rare in N.Z..
Umukuri Sinter	B3	A3	
Red Hills area	---	B3	Large extent of natural hot ground
Waihunuhunu springs	---	B2	Boiling flowing springs; public bathing
Reporoa	C2	C1	Surface features of Reporoa Basin
Golden Springs	C2	C1	Three large, warm flowing springs
Opaheke	---	C1	
Longview Road sinters	---	C3	Rare example of algal sinter deposits.
Rotokawa	C2	C1	Sulphur mining; planned power station

Te Kopia	B2	B2	
Te Kopia fumarole	---	B3	Very rare feature type in N.Z. today
Mud geyser	---	B3	Active since 1859; unique in CVZ*
Waikite Valley	B2	A2	Calcite sinters in Baths Gully; unique in CVZ*
Manuroa	---	A2	Large boiling alkaline spring
Puakohurea	B2	B2	Modified by land drainage
Waiotapu	A2	A1	Undisturbed flowing springs
Primrose Terrace	A2	A1	Largest remaining silica terraces in N.Z.
Champagne Pool	A2	A4	Large spring in explosion crater
Devil's Inkpot	C2	C4	
Echo (Whangioterangi) Lake	C2	C2	
Lady Knox geyser	B2	A1	Man-made geyser; now rare in N.Z.
Lake Ngakoro	C2	C2	
Loop Rd mud volcanoes	B2	C3	No volcanoes remaining
Rainbow Crater mud pools	B2	B3	No flowing springs present
Waiotapu collapse craters	C3	B3	Uncommon in N.Z.
Wairakei	C1	C1	No alkaline springs or geysers remain
Whakamaru (Ongaroto)	C2	C2	Springs along shore; earlier springs flooded by man-made lake
Whangaioroheia	C2	B2	Unique for location and structure

* Central Volcanic Zone

Appendix 12 - Schematic diagrams of geothermal features and landform types

Appendix 13 - Common names of plants referred to in the text and their scientific equivalent

Common name	Scientific name	
black maire	<i>Nestegis cunninghamii</i>	
black matipo	<i>Pittosporum tenuifolium</i>	
broadleaf	<i>Griselinia littoralis</i>	
Douglas fir	<i>Pseudotsuga menziesii</i>	
five finger	<i>Pseudopanax arboreus</i>	
flax	<i>Phormium tenax</i>	
Hall's totara	<i>Podocarpus hallii</i>	
hard beech	<i>Nothofagus truncata</i>	
haumakoroa	<i>Pseudopanax simplex</i>	
heketara	<i>Olearia rani</i>	
hinau	<i>Elaeocarpus dentatus</i>	
horoeaka	<i>Pseudopanax crassifolius</i>	
kahikatea	<i>Dacrycarpus dacrydioides</i>	
kamahi	<i>Weinmannia racemosa</i>	
kanuka	<i>Kunzea ericoides</i> var. <i>ericoides</i>	
kapuka	<i>Griselinia littoralis</i>	
karamu	<i>Coprosma robusta</i>	
kohuhu	<i>Pittosporum tenuifolium</i>	
lancewood	<i>Pseudopanax crassifolius</i>	
lemonwood	<i>Pittosporum eugenioides</i>	
mahoe	<i>Melicytus ramiflorus</i>	
makomako	<i>Aristotelia serrata</i>	
mamaku	<i>Cyathea medullaris</i>	
mangeao	<i>Litsea calicaris</i>	
manuka	<i>Leptospermum scoparium</i>	
matai	<i>Prumnopitys taxifolia</i>	
mingimingi	<i>Cyathodes juniperina</i>	or
<i>Leucopogon fasciculatus</i>		
miro	<i>Prumnopitys ferruginea</i>	
monoao	<i>Dracophyllum subulatum</i>	
mountain wineberry	<i>Aristotelia fruticosa</i>	
narrow-leaved mahoe	<i>Melicytus lanceolatus</i>	
pokaka	<i>Elaeocarpus hookerianus</i>	
prostrate kanuka	<i>Kunzea ericoides</i> var. <i>microflora</i>	
pukatea	<i>Laurelia novae-zelandiae</i>	
puriri	<i>Vitex lucens</i>	
putaputaweta	<i>Carpodetus serratus</i>	
rangiora	<i>Brachyglottis repanda</i>	
raupo	<i>Typha orientalis</i>	
red beech	<i>Nothofagus fusca</i>	
rewarewa	<i>Knightia excelsa</i>	
rimu	<i>Dacrydium cupressinum</i>	
silver beech	<i>Nothofagus menziesii</i>	

swamp buttercup
 tanekaha
 tarata
 tauhinu
 tawa
 tawari
 tawheowheo
 teatree
 thermal clubmoss
 ti ngahere
 totara
 towai
 wheki
 wineberry
 wood rose

Ranunculus macropus
Phyllocladus trichomanoides
Pittosporum eugenoides
Cassinia leptophylla
Beilschmiedia tawa
Ixerba brexioides
Quintinia serrata
Leptospermum scoparium
Lycopodium cernuum
Cordyline banksii
Podocarpus totara
Weinmannia sylvicola
Dicksonia squarrosa
Aristotelia serrata
Dactylanthus taylorii

Appendix 14 - Glossary of scientific terms (Source reference: Myers *et al.* 1987)

ADVENTIVE Self introduced, or spreading naturally from cultivation.

BIOCLIMATIC ZONE One of the categories used in classifying natural ecosystems in the PNA Programme. It refers to the broad distribution of vegetational zones along altitudinal gradients where a particular climatic regime dictates the character of the natural ecosystem. There are eight classes of bioclimatic zone (coastal, semi-coastal, lowland, montane, subalpine, lower alpine, upper alpine, nival). For example, the upper limit of rimu may denote the upper limit of the lowland bioclimatic zone.

CANOPY The layer or layers formed by the uppermost crown or their parts. The concept is applicable to any kind of vegetation. In forests it includes lianes and epiphytes.

COMMUNITY A collection of populations of the animals and plants that occur naturally together in a common environment of any size.

ECOLOGICAL CHARACTER The distinguishing features of a particular place, definable in terms of biotic composition, climatic, edaphic, and topographical information.

ECOLOGICAL DISTRICT A local part of New Zealand in which geological, topographical, climatic, and biological features and processes, including the broad cultural pattern, interrelate to produce a characteristic landscape and range of biological communities. New Zealand has been subdivided into 268 such districts. It represents the level for assessing the representativeness of major ecosystem types in the national network of Protected Natural Areas.

ECOLOGICAL REGION A group of adjacent ecological districts with very closely related ecological characteristics or, in some cases, a single very distinctive ecological district. New Zealand has been divided into 85 such regions.

ECOLOGICAL UNIT Any combination of vegetation types (or suite of interrelated types), plus the landform it occurs on e.g., kahikatea forest on alluvial river terraces, narrow-leaved snow tussock-hard tussock tussockland on alluvial terraces. Other important attributes of the unit such as the bioclimatic zone (e.g., montane, coastal) may be added to the name. The concept of ecological units has been designed to give specific meaning to the Reserves Act 1977 phrase "all classes of natural ecosystems ...". Ecological units are used in the survey phase to determine the biological and physical composition of the Study Areas.

EXOTIC Introduced from abroad.

HABITAT The part of the environment in which a plant or animal lives. An organism usually has adaptations which allow it to live in that particular part of the environment, and it may be more or less restricted to that habitat.

HYDROLOGIC CLASS One of 6 descriptive categories used in classifying the influence of water on the character of the biotic elements. If water is not a significant influence, a site is considered terrestrial. On sites where water is a major feature the characteristics of the soils and biota will be strongly influenced by the nature of the water body (e.g., palustrine, lacustrine, riverine, estuarine, marine).

terrestrial: free water has an insignificant role in the ecological character of these areas.

palustrine: a wetland community/environment characterised by emergent vegetation which may or may not have free-standing water present.

lacustrine: a lake community/environment lacking persistent emergent vegetation.

riverine: a system of flowing fresh water.

estuarine: an environment of salt or brackish water, partially enclosed but permanently open to the sea, with diurnal or less frequent inundation.

marine: wetlands formed as a result of marine deposition or changes in sea level such as the post-glacial rise.

INDIGENOUS Native to, and occurring naturally in New Zealand. All those features which in the aggregate originally gave New Zealand its own distinctive character. It is important at the regional, district, and species level.

LANDFORM All the physical, recognisable, naturally formed features of land having a characteristic shape, e.g., hill, valley, or alluvial fan. In the PNA Programme, classification of a landform emphasises its ecological significance rather than its geomorphological or geological significance.

LANDFORM DEFINITIONS

alluvial terrace: flat to gently sloping area of alluvium of variable height above river level. May be periodically flooded

alluvium: rock or soil material that has been transported primarily by flowing water

basin: concave to flat area on hillside; site of water accumulation

- cliff: very steeply sloping to vertical rock face at inland locations (cf. sea cliff)
- colluvial hillslope: foot of hillslope with accumulated colluvium
- colluvium: rock or soil material that has been transported primarily by gravity to foot of hillslope
- foredune: a coastal dune parallel to the shoreline at the landward margin of the beach
- hillslope: slope unit on which drainage lines are predominantly parallel
- rear dune: a coastal dune parallel to the shoreline and landward of the foredune
- sea cliff: very steeply sloping to vertical rock face on the coast
- tidal flat: flat area around river mouth regularly inundated and exposed by the tides
- toeslope: predominantly alluvial material that has been deposited by water movement below hillslopes

LANDSCAPE UNIT Distinct, large-scale physiographic units; see introductory section in this report.

NATIVE Not known to have been introduced by human agency.

NATURAL AREA A place characterised by indigenous species or ecosystems, or a place or landform not or scarcely modified from an indigenous condition. Some natural areas will be identified as suitable for evaluation of ecological quality and representativeness, and hence will also be study areas (q.v). Some of these may be of sufficient quality to become Recommended Areas for Protection (RAPs). In some instances one natural area may embrace more than one study area.

NATURE CONSERVATION VALUE A value assessment for nature conservation purposes based on scientific criteria derived from ecological and biogeographical theory (diversity, naturalness, rarity, etc.) and on the social value placed on those criteria.

PROTECTED NATURAL AREA (PNA) A legally protected area, characterised by indigenous species or ecosystems, in which the principal purpose of management is retention of the indigenous state.

RECOMMENDED AREA FOR PROTECTION (RAP) An area identified as having priority for protection because it contains the best example or examples of its type or class of natural ecosystem and/or landscape in an ecological district. An RAP is intended to be the basis for a proposal for a new protected natural area that would supplement the existing system of PNAs, making it more fully representative of New Zealand's ecological diversity.

RAP SELECTION CRITERIA

Several selection criteria are used for identifying Recommended Areas for Protection in the PNA Programme: representativeness, natural diversity, pattern, rarity and special features, naturalness, long-term ecological viability, size and shape, buffering, and surrounding landscape.

representativeness: The extent to which an area represents or exemplifies the components of the natural diversity of a larger reference area, e.g., representation in reserves of the current natural diversity of an ecological district, or representation of the original natural landscape. The identification and evaluation of the key representative natural areas in all ecological districts is the principal objective of the PNA Programme.

natural diversity: Refers to the range of the natural physical and biotic components in the landscape, including species, plant and animal communities, ecosystems, landforms, soil sequences, and dynamic systems and processes.

pattern: An ecological term describing the arrangement of species, communities, and habitats according to spatial and environmental gradients.

rarity: A measure of the paucity of numbers or occurrences of elements of natural diversity (e.g., species, communities).

naturalness: Involves assessment of the degree to which an area (e.g., vegetation ecosystem) has been free from the effects of human disturbance and intervention. It is also an assessment of the indigenous content of the area.

viability: The ability of an area's plant communities (or in some instances a particular species) to maintain themselves in the long term, in the absence of any **special** effort to perpetuate them. Regeneration and vigour of a particular species, and the size and stability of communities, are important factors for evaluation.

buffering: Protection of an area (or a particular community) from outside modifying influences, given by natural features (catchment boundaries, rock barriers, surrounding vegetation) or, in some cases, fences or other artificial structures.

surrounding landscape: The land which surrounds and influences a particular natural area, and is influenced by the same set of physical parameters as the natural area.

site: An area of land surface for which a specific statement can be made as to aspect, slope, exposure, ground water, underlying geological material, and vegetation. The size of a site may vary quite widely, depending on the degree of uniformity required for sampling.

STUDY AREA A tract of land with indigenous vegetation delineated as suitable for survey in rapid field inventory in order to identify the ecological patterns and the natural diversity of an ecological district. It is an arbitrary unit, defined as appropriate to circumstances - perhaps by the boundary of a remnant forest stand, a catchment, a legal title, or, in largely undifferentiated environments, by grid squares or other manageable, arbitrarily bound areas.

SUCCESSION The process of change in the appearance, composition, and structure of a community, usually over a number of years. Change may be due to biotic factors, site factors, or both.