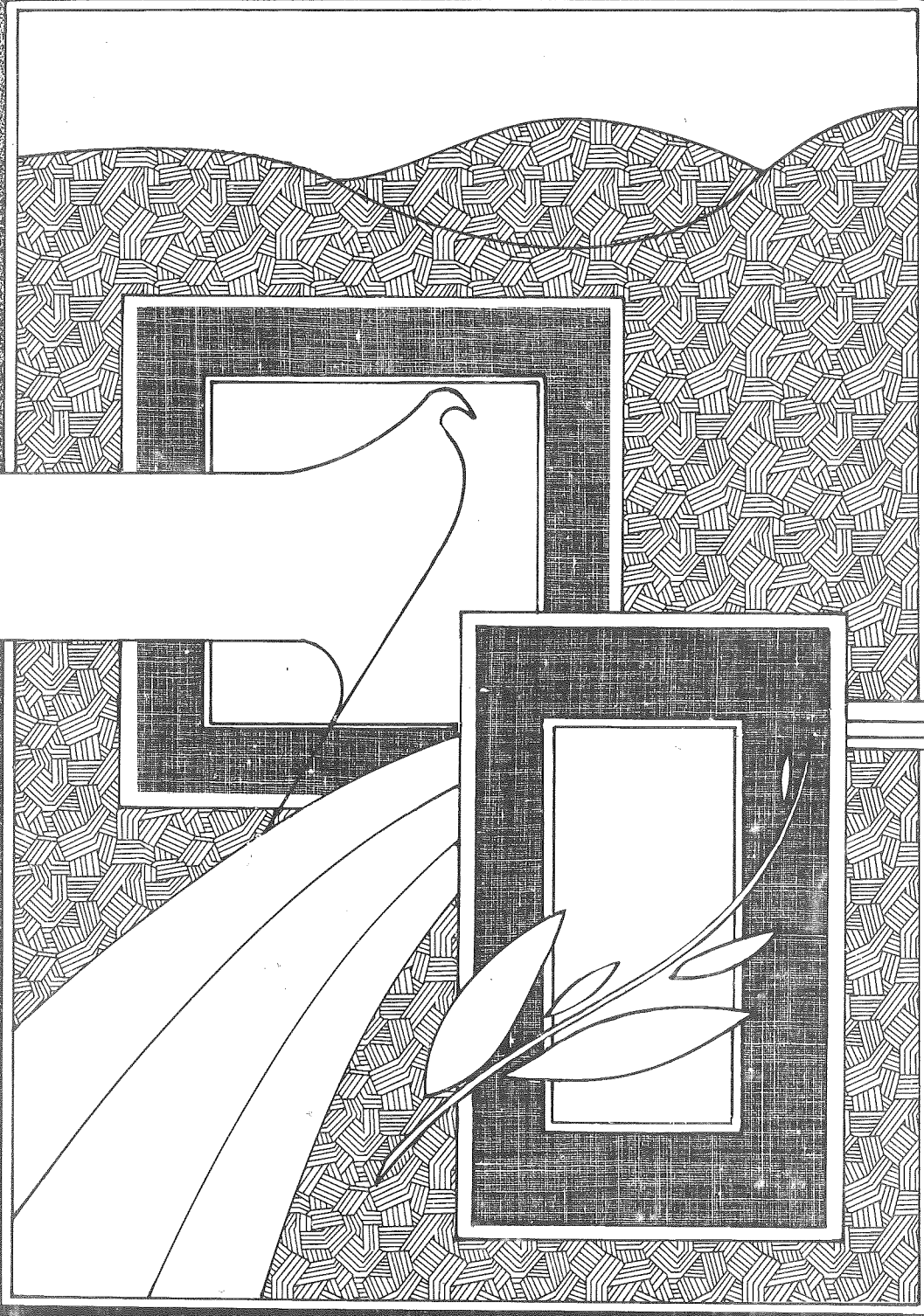


Auckland Conservancy

DEDICATED AREAS REPORT Number 17



Warawara Forest Sanctuary  
& Te Hura Ecological  
Area



WARAWARA FOREST SANCTUARY AND  
TE HURA ECOLOGICAL AREA



NZ FOREST SERVICE  
AUCKLAND CONSERVANCY  
CPO BOX 39  
AUCKLAND

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April 1985

WARAWARA FOREST SANCTUARY AND TE HURA ECOLOGICAL AREA

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### Location (Figure 1)

Warawara Forest Sanctuary and Te Hura Ecological Area occupy the western third of Warawara Forest, which is one of seventeen forests in the Northland State Forest Park. The two reserves are located on the coast, approximately 50 km west of Kaikohe, between the Hokianga and Whangape Harbours. The Sanctuary and Ecological Area occupy 869 ha and 999 ha respectively. Their approximate midpoints are at map references NZMS 1 N14, 790365 and 801340.

The reserves are two of six State Forest scientific reserves in the Maungataniwha Ecological District, which cover a total of 4,634 ha. There are also 14 Scenic Reserves, covering 3,908 ha, in the Ecological District (Department of Lands and Survey, 1984). The most recent aerial photographs of Warawara Forest were taken in 1981 (N.Z. Aerial Mapping, 1981).

### Access (Figure 2)

Foot access to the reserves can be gained by a logging road which enters the north-west of the forest from Pawarenga. This road skirts the northern boundary of the Sanctuary, before travelling some three kilometres into the Ecological Area.

A paper road which could provide future access leads from the end of the road at Mitimiti, to the forest boundary between Taikarawa and Waikare Streams.

### History of Gazettal

Warawara Forest Sanctuary was created in response to mounting public condemnation of the logging of one of the last tracts of virgin kauri forest in New Zealand (see Human History and Influence Section).

The earliest reference discovered to a Sanctuary proposal was made by the Director General of Forests on 12.4.72 (Ak Conservancy file 6/6). On the 24th of April 1978 the Minister of Forests approved in principle the Sanctuary proposal (N.Z.F.S., 1977) made by Auckland Conservancy. Warawara Forest Sanctuary was gazetted on the 17th of May 1979 (N.Z. Gazette no. 42, p 1529).

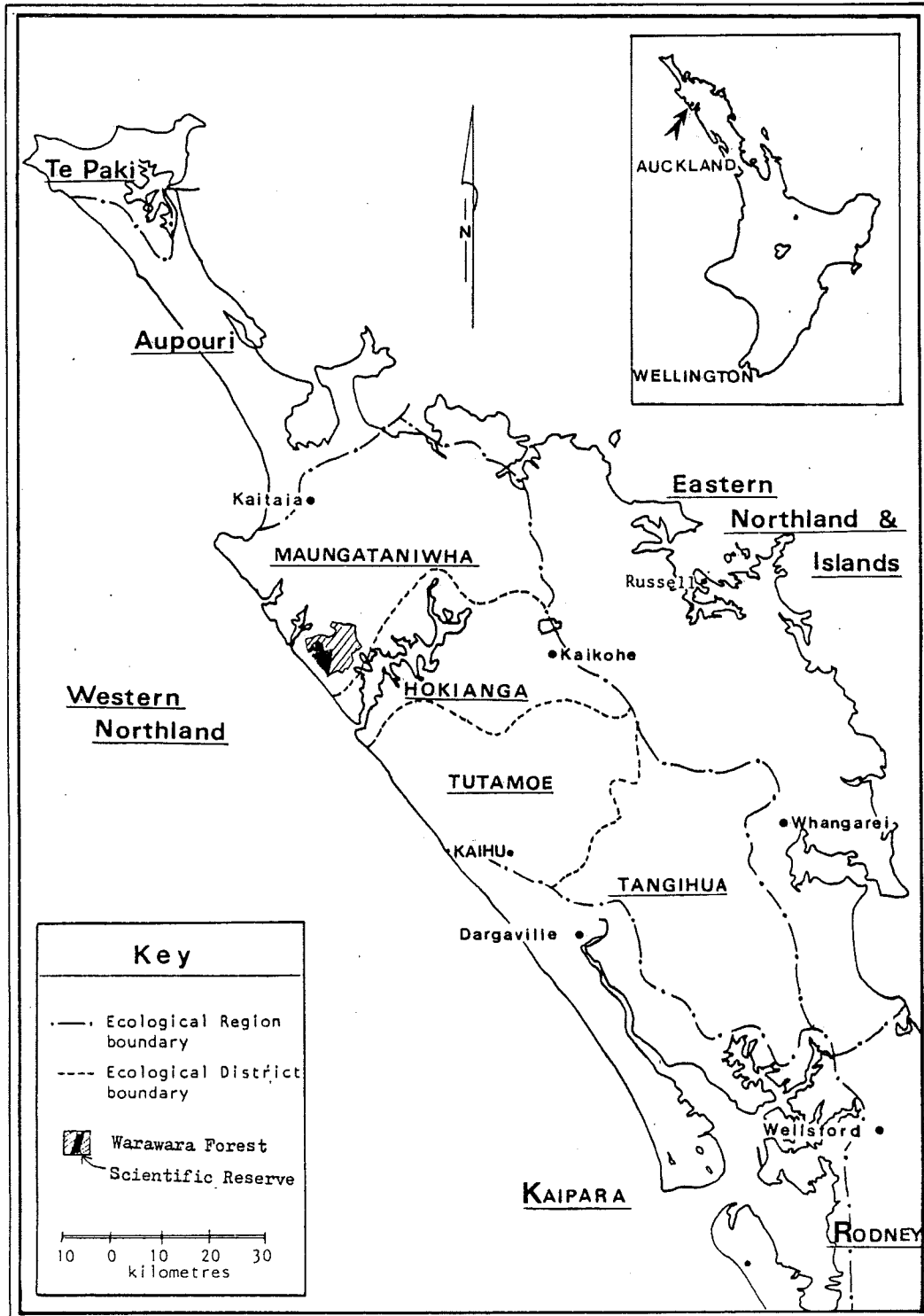
In 1979 the Scientific Co-ordinating Committee (S.C.C.) recommended the dedication of the Te Hura Ecological Area, as proposed by Auckland Conservancy, subject to slight boundary alterations. Approval in principle was given by the Minister of Forests on the 22nd of May 1980. Gazettal occurred in April 1982 (N.Z. Gazette no. 47, p 1392).

Auckland Conservancy is currently considering an extension of the Ecological Area to include the Moetangi catchment.

### Rationale and Objectives of Designation

The reserves do not meet some of the guidelines for selection of reserves suggested by the S.C.C. (1983). The reserves do not have compact shapes bounded by natural features, and the Ecological Area has a logging road in it. However, the combined area of the reserves exceeds the S.C.C.'s minimum suggested size of 1000 ha. The reserves also represent the altitudinal range and soil types of Warawara Forest, and protect vegetation types unreserved elsewhere in the Ecological District.

Fig.1 : Location Map of Warawara Forest



Nicholls (1979) stated that the reserves

"result in the conservation of the whole altitudinal sequence of kauri associations in Warawara Forest with a particularly diverse bird fauna, in total far and away the largest old-growth tract in the Hokianga district\* - and in the whole country outside of Waipoua Forest ..."

### Climate

The nearest climatological station to Warawara Forest is in Waipoua Forest, at 88 m a.s.l. The mean annual rainfall (1928-1970) is 1696 mm. The mean daily maximum and minimum temperatures (1928-1970) are 18.7°C and 9.4°C respectively (N.Z. Meteorological Service, 1973a). A rainfall map of Northland shows Warawara Forest as having a mean annual rainfall of up to 2000 mm (N.Z. Meteorological Service, 1973b).

### Geology

Extrusive volcanic rock comprising basalt and dolerite is the major rock type in the reserves. Some breccia occurs in this type, also rare blocks of sandstone, mudstone and limestone (Petty, 1982). Warawara Forest is one of several ranges in western and central Northland which are comprised of Tangihua volcanics. The volcanics were formed under the sea more than 65 million years ago, before being uplifted in a series of massive earthmovements called the Rangitata Orogeny (Ballance, 1970).

The southern portion of the Sanctuary encompasses an area where igneous rocks are in contact with the surrounding sedimentary Cretaceous shales. This contact area has a proven history of copper occurrence (N.Z. Geological Society report 12 : Copper in Northland).

### Pedology and Erosion

Tutamoe friable clay is found on the high level areas in both reserves, and is moderately to strongly leached. Te Kie steepland soils of stony and reddish clay loam, well to moderately well drained, cover most of the remainder of the reserves and are weakly to moderately leached. In the Ecological Area, Awapuku clay loam is found in association with the Te Kie soils (Sutherland et al., 1980).

On the north and west boundaries of Warawara Forest, sheer rock bluffs form frequent outcrops (N.Z.F.S., 1963). Despite the very steep terrain in places, there is little sign of erosion in either reserve. In an upper branch of the Waikare Stream, the water was a rusty brown colour, possibly because of run-off from the logged area further up the catchment.

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\*The names and boundaries of the Ecological District have since changed (Department of Lands and Survey, 1984).

## Topography

The two reserves occupy the western third of an isolated volcanic massif. The topography varies from high level areas, to a steep coastal drop-over along the side of the massif, over which streams descend via series of waterfalls into broad valleys, then level out before flowing into the sea. The north-west of the Sanctuary covers part of the rugged and dissected Hauturu Stream catchment. To the south-east, the Sanctuary covers part of what is known as the Warawara Plateau. From this, and a smaller plateau in the Ecological Area known as Te Hura Plateau, broad upper valleys with gently graded streams flow to the south-west, and ultimately to the Tasman Sea, via the drop-over.

The altitudinal range of the reserves is circa 30 m to 625 m a.s.l., the highest point being Mt Maungapohatu and the lowest is where Moetangi Stream reaches the forest boundary.

## Vegetation

Nine days fieldwork in early December 1984 provided most of the information used to give the following description. A forest type map (Lloyd, 1962), the Forest Sanctuary proposal (N.Z.F.S., 1977), and 13 plot sheets from two forest surveys (N.Z.F.S., 1954; N.Z.F.S., 1956) provided additional information. A botanical species list giving both scientific and common names is provided in Appendix 1. Common names of plants mentioned in the text are also listed alphabetically in Appendix 1.

Information on the forest structure and composition was collected using a system of recce-type plots recording the vegetation in up to five tiers, separately listing the dominant lianes and epiphytes. The tiers are :

1. Emergent (above canopy height).
2. Canopy.
3. Subcanopy (below canopy height down to 2 m).
4. Shrub (2 m down to 50 cm).
5. Groundcover (50 cm and below).

Further discussion of this technique is given by Burns (1983). The plots are grouped into types based as closely as possible on those classified by Nicholls (1976). Overlay 2 of Figure 2 shows the location of the plots recorded. Generalised stand structures for the types identified are provided in Appendices 3-8.

I have divided the vegetation into six types :

1. high altitude kauri forest (A2, Nicholls 1976),
2. low-mid altitude kauri forest (A1, Nicholls 1976),
3. kauri-podocarp-hardwood forest (B2, Nicholls 1976),
4. low altitude podocarp-hardwood forest,
5. mid altitude podocarp-hardwood forest (E3, Nicholls 1976),
6. high altitude podocarp-hardwood forest (D6, Nicholls 1976).

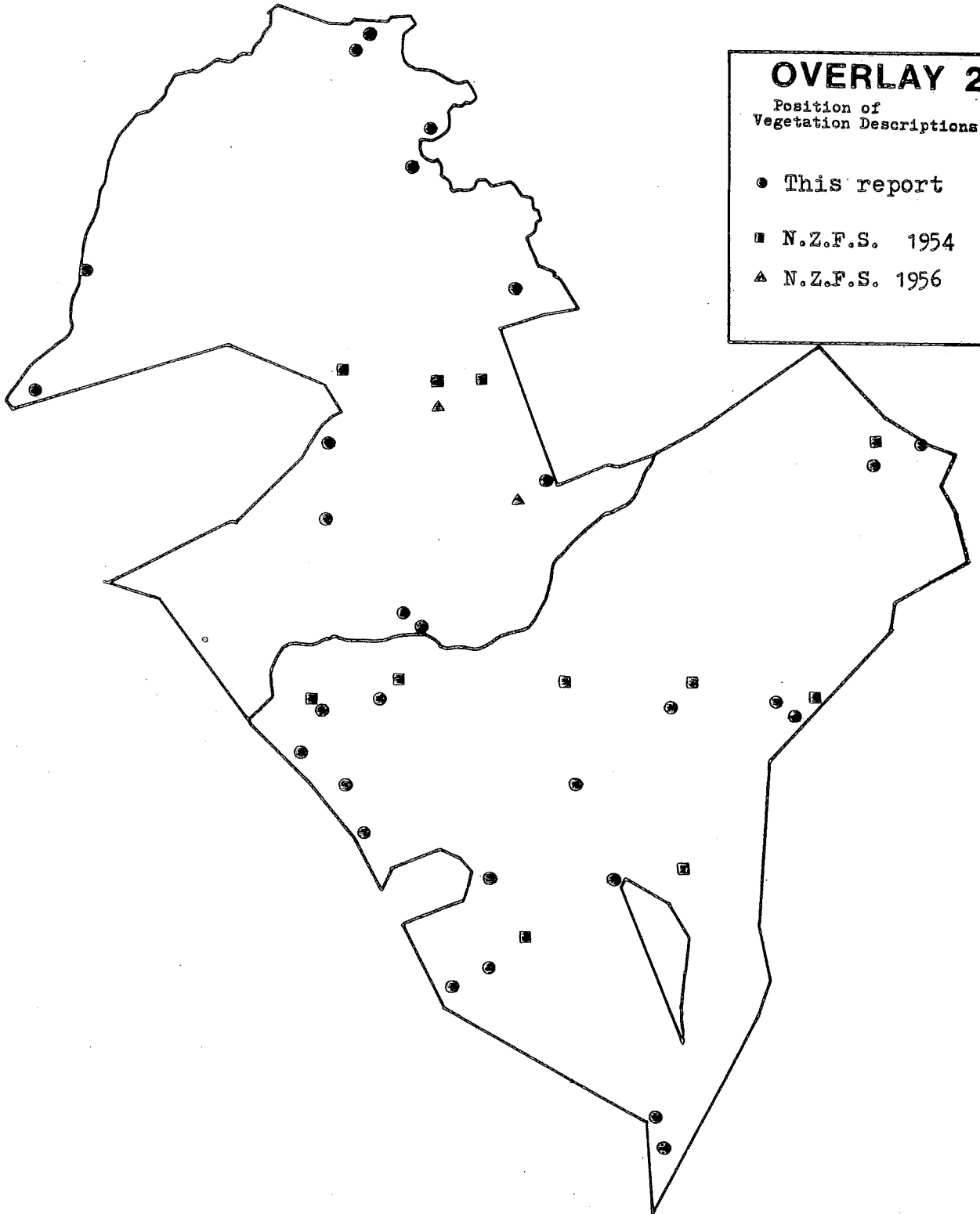
## OVERLAY 2

Position of  
Vegetation Descriptions

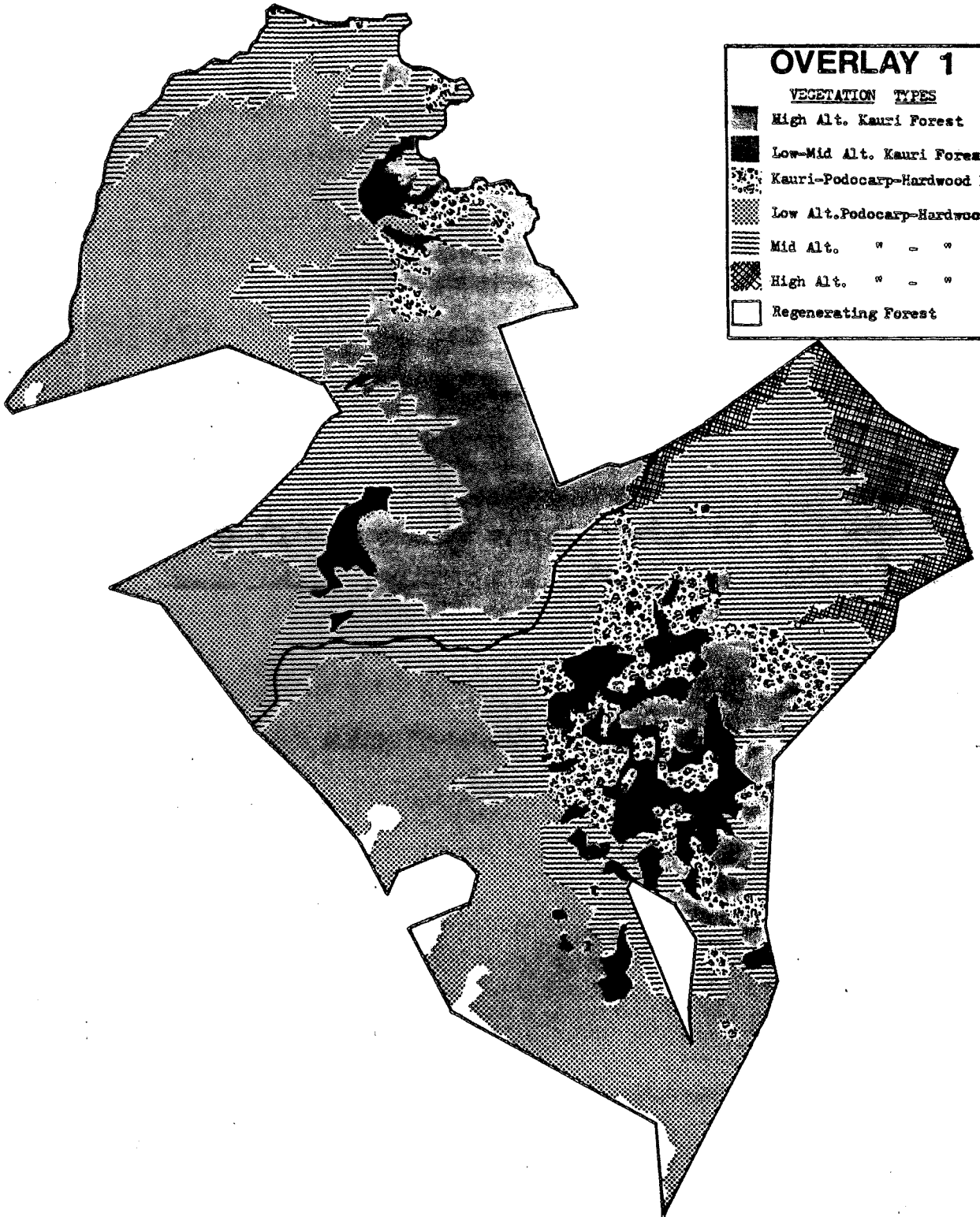
● This report

■ N.Z.F.S. 1954

▲ N.Z.F.S. 1956






















## OVERLAY 1

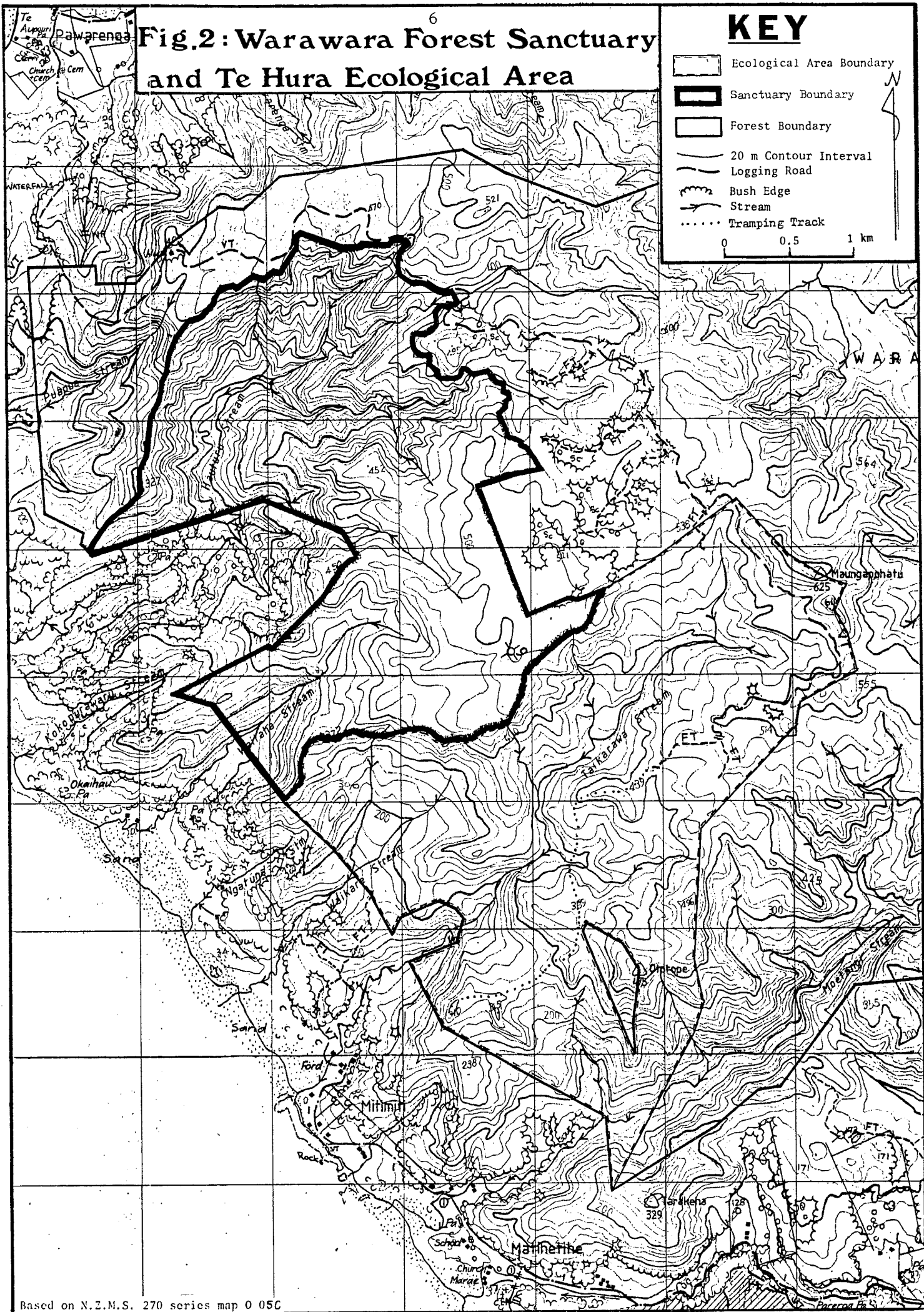
### VEGETATION TYPES

-  High Alt. Kauri Forest
-  Low-Mid Alt. Kauri Forest
-  Kauri-Podocarp-Hardwood Forest
-  Low Alt. Podocarp-Hardwood Forest
-  Mid Alt. " - " Forest
-  High Alt. " - " Forest
-  Regenerating Forest

# Fig.2: Warawara Forest Sanctuary and Te Hura Ecological Area

## KEY

-  Ecological Area Boundary
  -  Sanctuary Boundary
  -  Forest Boundary
  -  20 m Contour Interval
  -  Logging Road
  -  Bush Edge
  -  Stream
  -  Tramping Track
- 0 0.5 1 km

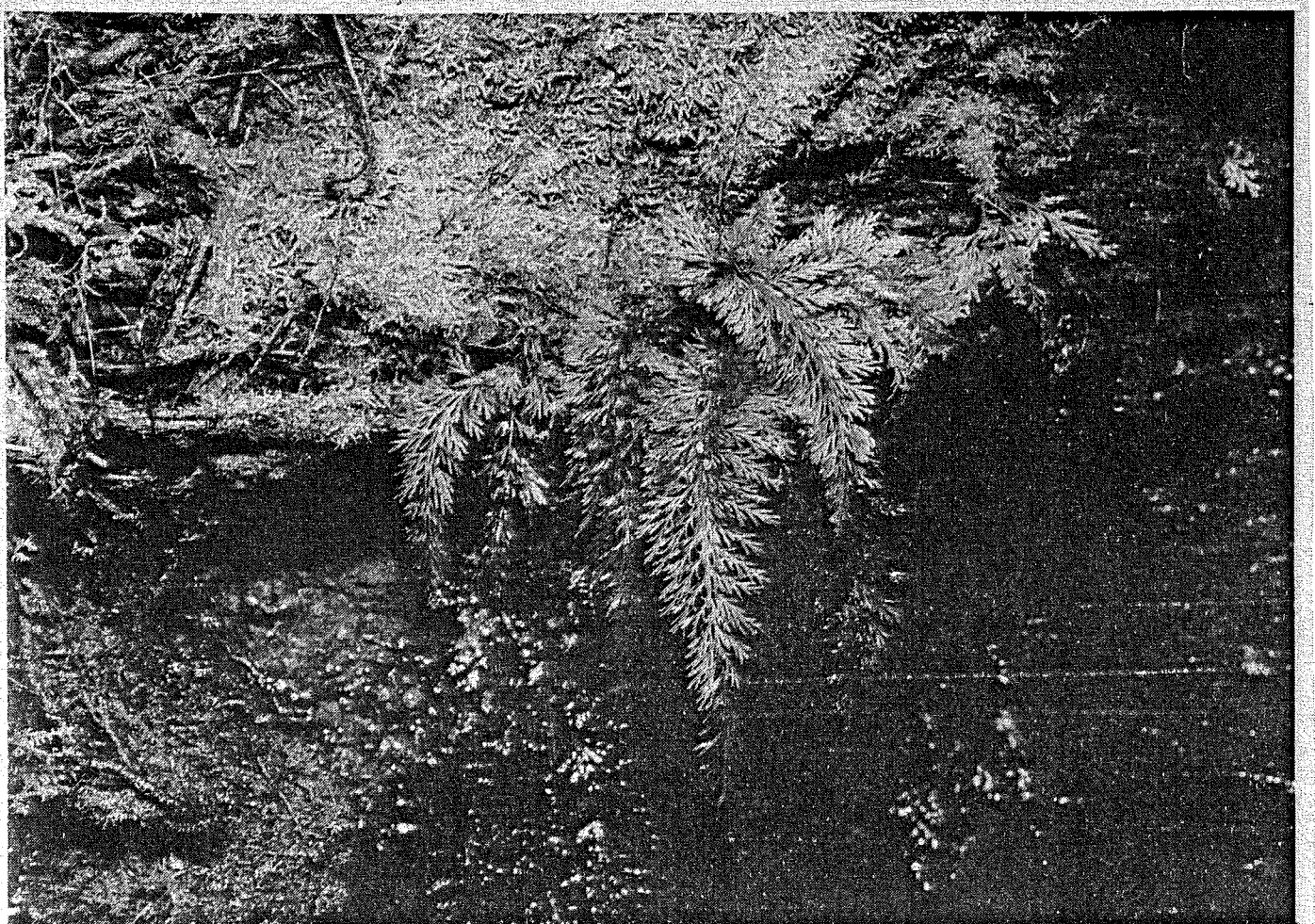


Based on N.Z.M.S. 270 series map 0 05C



Above photo 2 : Edge of Warawara Plateau, above Waitaha Stream (photo by P. Boyack).

Below photo 3 : *Trichomanes strictum* in the headwaters of Waikare Stream  
(Photo by P. Boyack).





The extent of these types is shown on Overlay 1 of Figure 2, which is partly derived from Lloyd's (1962) type map.

High Altitude Kauri Forest (stand structure : Appendix 3).

Nicholls' A2 forest type describes the high altitude kauri forest in Northland. Warawara Forest contains the bulk of this type, although there are a few small areas of high altitude kauri in Herekino Forest.

The high (ca. 500 m a.s.l.) plateau in the Sanctuary is the main area where this forest type is found. Due to the swampy nature of the plateau, some species normally associated with kauri forests (such as tanekaha and kohekohe) are absent, and taraire is rare (N.Z.F.S., 1977). The kauri are comparatively short-boled, of large diameter, with massive interlocking crowns where they are close together. The Ecological Forest Survey (N.Z.F.S., 1956) recorded kauri densities of up to 60 trees/ha.

Beneath the kauri canopy, the density of which is variable, scattered miro, Hall's totara, rimu and smaller kauri overtop a variety of hardwoods; tawheowheo, tawari and towai being the most common. Abundant toi-kiwi, kauri grass and *Dicksonia lanata* create an almost impenetrable shrub layer. Where the shrub tier is open, *Blechnum fraseri* is frequent as groundcover. Several species of orchids occur in season amongst the heavy kauri leaf litter. Where ground conditions are exceptionally swampy, *Astelia grandis* occurs (N.Z.F.S., 1977). Kiekie, mangemange and *Metrosideros albiflora* are common lianes. *Hymenophyllum armstrongii* was found on the fallen branches of a kauri on Warawara Plateau.

Dead standing kauri are found throughout this forest type, especially on swampy ground. Where gaps occur in the canopy, the shrub tier is particularly dense, and is overtopped by scattered hardwoods such as towai, hinau and pukatea (N.Z.F.S., 1977).

Low-Mid Altitude Kauri Forest (stand structure : Appendix 4).

Sites examined in kauri forest below 400 m a.s.l. in the reserves approached Nicholls' A1 type. However, taraire, tawa and kohekohe listed in the A1 type were not common.

The high, variable density canopy consists of frequent kauri and occasional rimu. There is a vertical gap between the canopy and the moderate density softwood-hardwood subcanopy. Hall's totara and miro occur on most sites and tawheowheo is the most common hardwood. Shrubs such as karamu, kanono, *Alseuosmia macrophylla* and *Cyathodes* spp. are scattered through a dense sward of kauri grass, toi-kiwi and kiekie. *Blechnum fraseri* is common and kiokio and piupiu are occasional ground-cover species where the shrub tier is open. Kiekie and climbing rata species are the predominant lianes. Epiphytes are infrequent.

### Kauri-Podocarp-Hardwood Forest (stand structure : Appendix 5).

Rimu and northern rata, with kauri scattered or in small stands, are emergent in this forest type. Where kauri occur, enclaves of kauri associates are present. Elsewhere the forest structure is typical of podocarp-hardwood forest. This description is based on plots where kauri is present, or nearby. Taraire, tawa and towai are the major species in the dense canopy, tawa becoming more common with increasing altitude. In the moderate-to-dense subcanopy, towai, lancewood, heketara and rewarewa are often present.

As in the kauri forest types, kiekie, toi-kiwi and kauri grass form a dense shrub layer, but in this type kiekie is the most abundant species. Scattered kanono, wheki and large-leaved mahoe are also constituents of the shrub tier. *Blechnum fraseri*, hen and chicken fern and hooksedge are common groundcover species. On stream banks, parataniwha and *Pneumatopteris pennigera* predominate. Perching lilies, puka, climbing rata species and kiekie are the most numerous epiphytes and lianes.

The distribution of this forest type, as shown on Overlay 2 of Fig. 2, is based on Lloyd's (1962) type map. The kauri-podocarp-hardwood type is mostly adjacent to areas of kauri forest. Rimu has been described as the dominant tree of this type (N.Z.F.S., 1977). One site at 450 m a.s.l. in the Ecological Area would have fitted Nicholls' B5 type, except for the presence of taraire. No site descriptions were made above 450 m a.s.l. in this type. At higher altitudes the kauri-podocarp-hardwood forest would be better described as type B5 where taraire is absent.

### Low Altitude Podocarp-Hardwood Forest (stand structure : Appendix 6).

This forest type occurs below 300 m a.s.l. in the reserves. On ridges throughout this type, scattered kauri (usually rickers) occur. Frequent northern rata, and on sheltered sites rimu, are emergent. Taraire is predominant in the dense canopy, which also comprises rewarewa, towai, puriri and kohekohe. In the often dense subcanopy nikau is abundant and a variety of hardwoods occur, including rewarewa, mahoe, taraire, towai and kohekohe. The shrub layer is usually more open than the upper tiers, and contains frequent hangehange, nikau, *Coprosma* spp., kiekie and ponga. Groundcover is often light, consisting of hooksedge and ferns such as *Pneumatopteris pennigera* and *Blechnum* spp. Parataniwha is locally abundant on damp sites. Epiphytes and lianes are numerous and varied. Kiekie frequently reaches the subcanopy, covering tree trunks, and *Phymatosorus* spp., *Blechnum filiforme* and perching lilies are common.

Podocarps are not often emergent near the coast, especially on the exposed, wind-shorn coastal ridges. The hardwood vegetation on these ridges and exposed slopes warrants a separate description as a sub-type.

In the sub-type the canopy is low (5-7 m) and dense, comprising frequent karaka and kowhai, with occasional kohuhu, lacebark, taraire, puriri and kanuka. The subcanopy is less dense, often containing *Olearia albida* and a combination of mahoe, hangehange, lancewood, rewarewa, titoki,

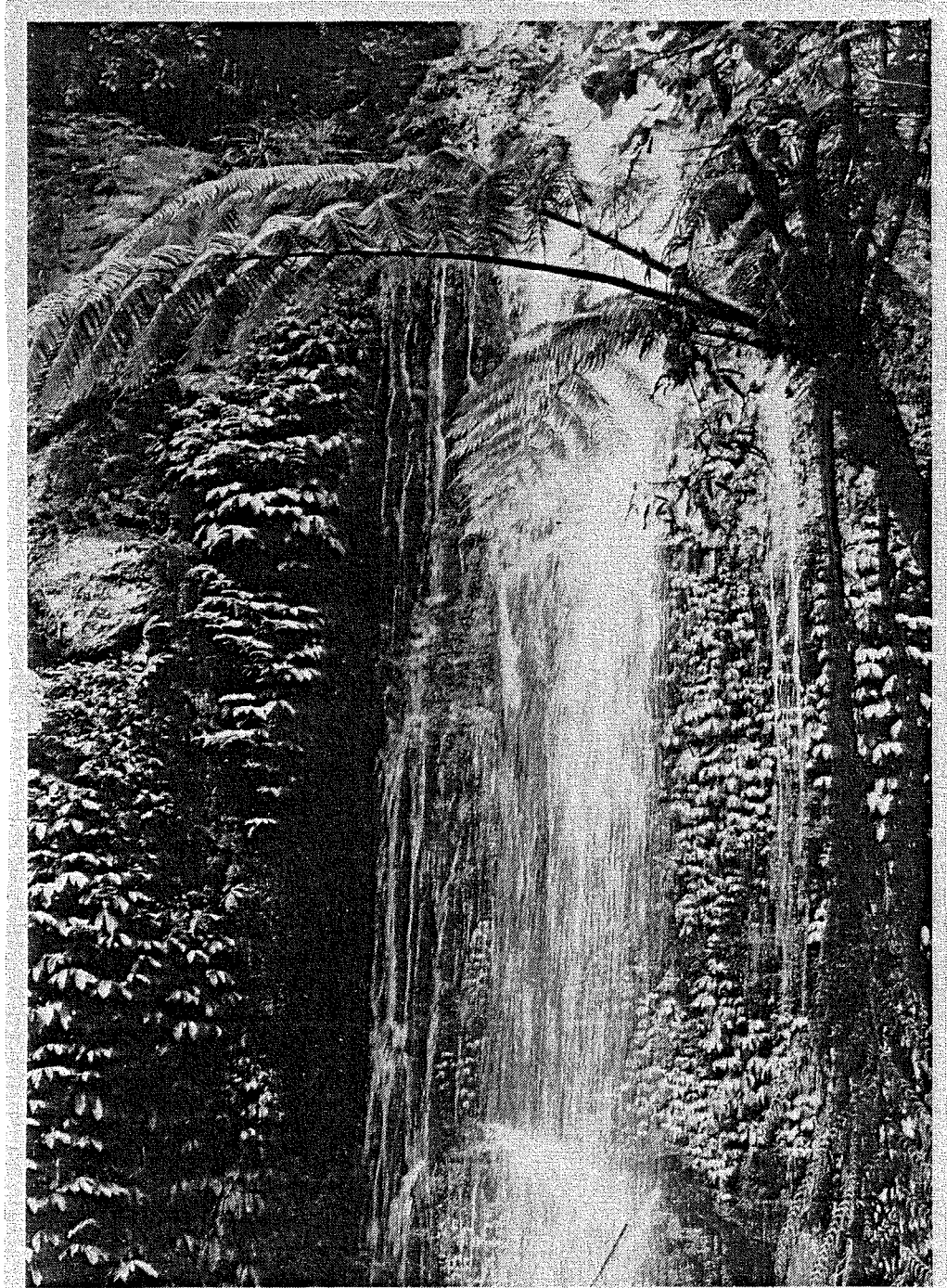


Photo 1 : One of several waterfalls along Taikarawa Stream at the western drop-over (Photo by P. Boyack).

mapou and wharangi. Dense ridge top patches of flax occur in the shrub tier, as well as koromiko, rangiora, *Rhabdothamnus solandri*, *Gahnia lacera* and *Helichrysum aggregatum*. On several steep slopes (e.g. in the Taikarawa catchment) an *Astelia* sp. (possibly *A. banksii*) is common, along with *Pratia physalloides* and *Arthropodium cirratum*. Hooksedge and *Polystichum richardii* are frequent groundcover species. Epiphytes are scarce, but some lianes are found throughout the sub-type, including *Metrosideros perforata*, *Clematis cunninghamii*, *Parsonsia capsularis* and *Rubus squarrosus*.

Numerous small areas of scrub, dominated by *Leptospermum* spp., and areas of more advanced regenerating forest, occur where the reserves adjoin private land. These are mapped on Overlay 1 of Fig. 2.

Mid Altitude Podocarp-Hardwood Forest (stand structure : Appendix 7).

In this forest type, which occurs between 300 and 550 m a.s.l., emergent podocarps are more common than at lower altitudes. Northern rata, and less frequently, rimu, miro, kahikatea and pukatea, are the principal emergents. The dense canopy varies in height from six metres on the very steep exposed slopes in the upper Hauturu catchment, to 18 metres in sheltered valleys such as in the upper Taikarawa catchment. Towai and taraire predominate in the canopy, towai mainly on upper slopes and ridges. Tawa becomes more numerous with increasing altitude, and tawheowheo appears in the subcanopy. Also, katote gains prevalence over ponga. Other common elements in the dense subcanopy are nikau, kanono and taraire.

Locally abundant kiekie and young nikau fill out an otherwise uncrowded shrub tier. The moderate groundcover includes frequent *Blechnum fraseri* and hen and chicken fern, with occasional *Lastreopsis hispida*, hooksedge, *Asplenium* spp., kiokio and *Pneumatopteris pennigera*. The most numerous epiphytes and lianes are *Hymenophyllum* spp., kiekie and supplejack.

High Altitude Podocarp-Hardwood Forest (stand structure : Appendix 8).

A relatively small area, above 500 m a.s.l. in the north-east of the Ecological Area, consists of this forest type. Rimu and northern rata are numerous and large, except on the highest ridges where they tend to be shorter, as does the dense hardwood canopy. Tawa, towai and at higher altitudes heketara and tawari, are frequent in the canopy. The prevalent species of the dense subcanopy are katote, towai, kanono and tawa, with a variety of less numerous hardwoods such as tree fuchsia, tawheowheo and tawari. Saplings of the canopy species are common in the more open shrub tier, as are kiekie and kanono. *Blechnum fraseri* and hooksedge were present at all sites examined, with occasional bush rice grass, piupiu and hen and chicken fern. Filmy ferns are abundant as epiphytes, with supplejack, kiekie and mangemange the predominant lianes.

## Introduced Animals and Forest Condition

Scientific names for the animals mentioned in the text are provided in Appendix 2.

During the field inspection for this report, 100 circular 4 m<sup>2</sup> plots were examined for animal droppings. Three (3%) contained cattle droppings, and three (3%) contained pig droppings. A small pile of chewed seeds was seen, which is characteristic rat sign.

Cattle sign, mostly not recent, is widespread in the reserves. Cattle browse was recorded on a variety of species, including nikau, hangehange, kanono and mahoe. During the National Forest Survey (N.Z.F.S., 1954), cattle sign was recorded on every plot in the reserves, and several cattle were shot. The Minister of Forests gave his approval to remove or destroy cattle in Warawara Forest on 25.5.53 (Ak Conservancy file 6/6). Cattle trespass has been a long-term problem in the reserves. Letters on the matter date back to 1932 (Ak Conservancy file 6/6/).

Pig sign is also throughout the reserve, but appears to be thinly spread. Several smashed kauri snail shells, which are indicative of pig predation (Ogle, 1982), were seen.

There is thought to be only a light population of possums in Warawara Forest (Julian, 1984). No possum sign was seen during the fieldwork, although some was seen in late 1984 in the upper Moetangi Stream (L. Burns, N.Z.F.S. Kaikohe, pers. comm.).

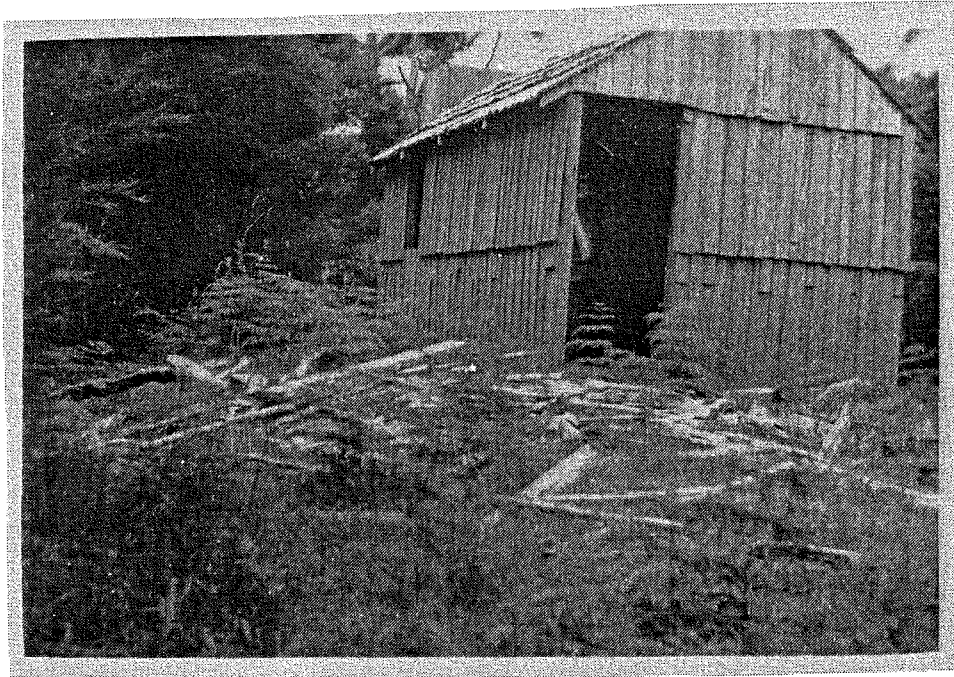
Goat browse was only noticed near the forest boundary between the Waitaha and Taikarawa Streams. On the ridge west of Waikare Stream, goats had chewed the bark on several kowhai trees. A goat carcass was seen beside Waitaha Stream. Since the field inspection, Forest Service cullers have visited the area, and nine goats were killed. (Forest Ranger, K. Purdon, pers. comm.). Hopefully, there are no goats remaining in the area.

In 1937 the forest caretaker reported the illegal release of a stag. There is no indication as to whether the animal was recaptured (Ak Conservancy file 6/6). In the Forest Sanctuary Proposal (N.Z.F.S., 1977) introduced frogs are reported as having come in after logging.

In order to assess forest condition, the regeneration of canopy species, openness of different tiers, and the presence of dead or dying trees was noted. To the south and west of Ototope, dead kauri were logged prior to the land passing to State ownership. Hence the canopy is very open in the kauri forest areas there.

The Forest Sanctuary Proposal describes the kauri in the Sanctuary as mature-to-overmature, with negligible regeneration of the principle trees. The proposal also mentions numbers of dead standing kauri on swampy parts of the plateau. Lloyd (1962) was of the opinion that the kauri forest in Warawara Forest was doomed to extinction. However, Wardle (1984) has studied some areas in Northland where kauri regeneration has been described as inadequate. She concludes that the replacement ability of kauri, over a long period of time,





Above photo 4 : Paling shelter on the track north-west of Ototope (Photo taken by forest caretaker in 1943 just after the shelter's completion).

Below photo 5 : Approx. 41 years later, the shelter is surrounded by kanuka, kiokio, and sapling rewarewa and towai (Photo by P. Boyack).



is not as inadequate as it appears. The aspect of kauri regeneration in Warawara Forest needs to be carefully researched before conclusions can be made about the survival or otherwise of the kauri forest type.

In the Te Hura Ecological Area, Ranger Murray reported "good regeneration of kauri along ridges and spurs in Moetangi and Taikarawa watersheds" (Ak Conservancy file 6/6, 19.10.22). An internal Forestry report by Johnson (1972) supports this observation.

During the field inspection scattered kauri at all stages of regeneration were found. Softwood poles were numerous in the kauri forest types. In the podocarp-hardwood types, seedlings and saplings of canopy species are numerous. The shrub tier and the groundcover layer are more open than the overstorey. This may be due to the lack of light penetrating the dense upper tiers. Palatable species such as five finger, mahoe and *Pratia physaloides* are still numerous in the reserves, which is not the case in some other forests in Northland, where browsing mammals are common.

However there is no guarantee that the reserves will stay in their relatively good condition in the future. Cattle trespass is still occurring, and there is a real risk of goats colonising the area from their present locations in the north of the forest (K. Purdon, pers. comm.). Possum numbers have not yet reached the levels found in other Northland forests. Boundary fencing is the exception rather than the rule along the boundaries of the reserves which adjoin private land. Where boundary fencing was seen during the field work, it was in poor repair.

#### Presence of Exotic Plants

Exotic plants are included in the botanical species list in Appendix 1.

Exotic species have invaded a number of sites in the reserves e.g. the logging road in the Ecological Area, scrub areas near the forest boundary and open places along stream beds. Pasture species extend into the Ecological Area on grassy flats beside Moetangi Stream. Introduced plants are common within the Sanctuary near adjoining farmland in the Hauturu Stream catchment. Weeds could become a problem where grazing animals impair forest regeneration.

#### Native Fauna

A faunal species list giving both scientific and common names is provided in Appendix 2, and is based on surveys made by the Wildlife Service in 1978 and 1979.

The Wildlife Service rates Warawara Forest as outstanding wildlife habitat and is ranked second in Northland for native bird diversity (Ogle, 1982). Notable fauna include N.I. kaka and red-crowned parakeet, both rare in Northland. The N.I. brown kiwi and pied tit are also present; the N.I. kokako was recorded last in 1965. Bats have also been reported in the forest (Ogle, 1982). There have been no surveys of invertebrates in the reserves, to my knowledge.

## Human History and Influence

The Historic Places Trust (1982) has records of over 25 archaeological sites on the strip of land coastal to Warawara Forest. The sites include several pa (Fig. 2), terraces, pit/terrace complexes, middens, ditches and a drain. A pit is recorded in the Ecological Area, near Mt Maungapohatu at map ref. N.Z.M.S. 1 N14 825356. Surrounded by the Ecological Area is a small area of Maori land (Ototope Block C) which contains an urupa (burial ground). A pa outside State Forest at the mouth of the Hauturu Stream is said to be one of the first places occupied by Maori people when they came to New Zealand (L. Forester, N.Z.F.S. Kaikohe, pers. comm.).

The bulk of Warawara Forest was bought by the Crown for 2/4d per acre in 1875. The Forest Service has administered the forest since 1922. A Mr Dysart leased the Te Hura kauri stand prior to 1921, and the trees were damaged by overbleeding (letter from Forest Caretaker dated 6.2.21 on Ak Conservancy file 6/6). Dysart also apparently illegally bled kauri in the Warawara stand, but only up to approx. two metres.

Forest Caretakers were successively stationed at Mitimiti from prior to 1921 (the earliest records found) until the late 1950s. During that time a number of tracks were cut and maintained through Warawara Forest. The caretakers' other duties included removing wild cattle, some releasing of regenerating kauri, cutting a road line in the Waikare catchment, and preventing pigeon poaching.

Early in 1938, some dead standing kauri were extracted from stands adjacent to Ototope Block C, in what is now the Ecological Area. Further logging in Warawara Forest did not start until 1967. Due to increasing public concern, the government stepped in and logging ceased in May 1974, by which time the most accessible third of the rare kauri forest type had been destroyed. Much of the north-east boundary of the Sanctuary follows Sawmill Area boundaries. Four hectares of logged forest is included in the Forest Sanctuary (N.Z.F.S., 1977). Within what is now the Ecological Area, podocarps were extracted from Sawmill Area 513 from February to May 1974. This area is in the headwaters of Taikarawa Stream.

Two Mineral Prospecting Warrant Applications (no.s 68/70 and 118/70), covering portions of what is now Ecological Area, were granted in 1971 to Waihi Exploration and Mining Ltd. The licenses expired in 1976 (Ak Conservancy file 20/6/0). In a submission on the Sanctuary proposal, J.R. Carlson, geologist, reported: "In 1972 Pacminex Pty Ltd carried out sampling and reconnaissance geological work, in particular geochemical stream sediment sampling for copper and base metals." (Ak Cons. file 34/1/6/0, 31.10.77).

In 1977, three kauri which are among the 20 largest known, were discovered in the Moetangi catchment to the east of the Ecological Area. The largest of the three (the 4th largest known) is called the Ward kauri, after its discoverer, John Ward.

The logged area adjacent to and east of the Sanctuary is zoned for silviculture and salvage logging, under the Northland Forest Park Management Plan. The remainder of Warawara Forest, excluding the reserves, is zoned Natural Environment.

### Recreational Facilities and Opportunities

The legal status of the Forest Sanctuary precludes any development in it. The Forest Service intends to do little development in the rest of Warawara Forest for recreational purposes (J. Beachman, Evtl Ranger, pers. comm.). Thus the forest will provide visitors with the opportunity to experience a remote and relatively undisturbed tract of bush. The logging road which skirts the Sanctuary and enters the Ecological Area is a good access for trampers.

From the road end a route marked with permalat has been cut to the forest boundary near Mitimiti. Access across private land to the coast is being sought. There is a camping ground at the end of the road at Mitimiti.

One further track is planned, skirting the Sanctuary boundary from the logging road down the ridge west of Hauturu Stream (J. Beachman, pers. comm.).

### Research Carried Out and Suggested

The earliest report on Warawara State Forest was written by J. Boscawen (1912). In 1954 11 plots in the reserves were recorded during the National Forest Survey (N.Z.F.S., 1954). Further plots were done in the Sanctuary during the Ecological Forest Survey (N.Z.F.S., 1956).

Mr D. Robinson was granted permission to study pattern determining factors on kauri in Warawara Forest by the Conservator on 2.10.67 (Ak Conservancy file 6/6). A report on a prostrate form of *Cyathea dealbata* found in Warawara Forest was written by Rawling (1969).

The Wildlife Service surveyed the reserves in 1978 and 1979. Their findings form the basis of the Faunal Species List in Appendix 2. A further survey is planned to look for kokako, which were last recorded in the forest in 1965.

M. Ahmed (1984) surveyed 1 ha of kauri forest on Warawara Plateau as part of his Ph.D. thesis on the dendrochronology and ecology of kauri.

Warawara Forest Sanctuary contains the largest stand of this type of high altitude kauri in New Zealand (Ogle, 1982; p 36). There have been suggestions e.g. Lloyd (1962), that there is inadequate regeneration of kauri here. This would be an important topic for study, as the purpose of the Sanctuary is to protect this forest type.

The forest is floristically diverse with a strong coastal influence in the western parts. The reserves would be a good site for studies of western Northland vegetation. Very little is known about invertebrates in the reserves, so further research is needed in this field.

### Summary, Discussion and Recommendations

Located 50 km west of Kaikohe, Warawara Forest Sanctuary and Te Hura Ecological Area form a contiguous reserved area of 1868 ha in Warawara Forest. Access can be gained to the reserves via a logging road past Pawarenga, to the north-west of the forest. The Sanctuary and Ecological Area were gazetted in 1979 and 1982, respectively.

The reserves have high values in the Maungataniwha Ecological District, as they preserve the largest old-growth tract of kauri in the District. Tangihua volcanics constitute the rock type of Warawara Forest, which covers an isolated volcanic massif featuring two high plateaux. Soils in the reserves are mainly Te Kie steepland soils and Tutamoe friable clay. There is a distinct "drop-over" on the coastal flanks of Warawara Forest, hence waterfalls are numerous.

The vegetation on the drop-over has a strong coastal element, featuring species such as akeake, *Machaerina sinclairii*, *Olearia albida*, kowhai and *Arthropodium cirratum*. I have divided the vegetation in the reserves into six types: two dense kauri forest types, kauri-podocarp-hardwood forest and three podocarp-hardwood types. The reserves are notably diverse floristically including several species not recorded so far in other State Forest Scientific Reserves in Northland. Examples are *Cheilanthes sieberi*, *Machaerina sinclairii*, *Australina pusilla*, *Corokia cotoneaster*, and several *Dracophyllum* species.

Pigs are widespread through the reserves, as is cattle sign, although most of it is fairly old. The most recent cattle sign seen was at the end of the left fork of the logging road in the Ecological Area. A small recently introduced population of goats has hopefully been exterminated in the reserves by a recent culling operation. An inspection of the area should be made in late 1985, in case some goats were missed. Several scattered areas around the periphery of Warawara Forest are known to contain goats (K. Purdon, pers. comm.). Periodic culling is needed to control these populations.

Fencing along the coastal boundary of the forest is generally either absent or inadequate for the prevention of stock trespass. Adequate fencing of this boundary is important as the coastal ridges provide the easiest means of access to the reserves for straying stock.

Gum bleeding has damaged all the kauri over 50 cm d.b.h. in the Te Hura Stand (Johnson, 1972), and some trees in the Sanctuary. However, Johnson does not believe that the widespread bleeding has caused a serious deterioration to the Te Hura stand.

Warawara Forest has been rated as outstanding wildlife habitat, with the presence of kakas, kiwis, pied tits, parakeets and bats reported. The high number of archaeological sites fringing the forest show that the region has been settled by the Maori for a long time. The pit site near Maungapohatu and the urupa provide evidence that they made wide use of the forest's resources.

About 500 ha of Warawara Forest was logged between 1967 and 1974, including small parts of both reserves. It is intended that only a few tracks will be developed in Warawara Forest, so as to provide a fairly rugged and remote tract of bush for the more adventurous recreationalist. While recognising that the Sanctuary has greater legal protection than the Ecological Area, for management purposes both reserves should be treated as one large protected area.

Based on the above discussion, the following management recommendations are made, in order of priority :

1. That N.Z.F.S. periodically inspect the forest for goats, and prevent them spreading into the reserves.
2. That N.Z.F.S. instigate a fencing programme along the coastal boundary of Warawara Forest.
3. That cattle in the forest be removed or destroyed.
4. That the possum population and their effects on the vegetation be monitored.
5. That N.Z.F.S. encourage studies of flora and fauna in the reserves.

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APPENDIX 1 : BOTANICAL SPECIES LIST - WARAWARA FOREST SANCTUARY  
AND TE HURA ECOLOGICAL AREA

B = Species recorded in Warawara Forest by P.J. Bellingham, NZFS  
Botanist, pers. comm.

A = Adventive

FERN ALLIES

<i>Lycopodium cernuum</i>	club moss
<i>L. deuterodensum</i>	"
<i>L. varium</i> (incl. <i>L. billardieri</i> )	"
<i>L. volubile</i>	"
<i>Imesipteris elongata</i> ssp. <i>elongata</i>	
<i>T. lanceolata</i>	
<i>T. sigmatifolia</i>	
<i>T. tannensis</i>	

FERNS

<i>Adiantum cunninghamii</i>	maidenhair fern
<i>A. fulvum</i> agg.	black maidenhair
<i>A. hispidulum</i>	rosy maidenhair
<i>Anarthropteris lanceolata</i>	
<i>Asplenium bulbiferum</i>	hen & chicken fern, manamana
<i>A. flaccidum</i> ssp. <i>flaccidum</i>	raukatauri, hanging spleenwort
<i>A. oblongifolium</i>	shining spleenwort
<i>A. polyodon</i>	
<i>Blechnum chambersii</i>	
<i>B. discolor</i>	piupiu, crown fern
<i>B. filiforme</i>	climbing sweetfern
<i>B. fluviatile</i>	
<i>B. fraseri</i>	Fraser's hardfern
<i>B. membranaceum</i>	thin hardfern
<i>B. nigrum</i>	black hardfern
<i>B. sp.</i> ( <i>Lomaria latifolia</i> )	
<i>B. sp.</i> ( <i>B. capense</i> agg., common lowland sp.)	kiokio
<i>Cardiomanes reniforme</i>	kidney fern
<i>Cheilanthes sieberi</i>	
<i>Ctenopteris heterophylla</i>	
<i>Cyathea dealbata</i>	ponga, silverfern
<i>C. medullaris</i>	mamaku, black tree fern
<i>C. smithii</i>	katote, soft tree fern
<i>Deparia peterseni</i> (= <i>Athyrium japonicum</i> )	
<i>Dicksonia lanata</i>	
<i>D. squarrosa</i>	wheki
<i>Diplazium</i> (= <i>Athyrium</i> ) <i>australe</i>	
<i>Doodia media</i> ssp. <i>australis</i>	
<i>Gleichenia cunninghamii</i>	tapuwae kotuku, umbrella fern
B <i>G. dicarpa</i>	waewae-kaka, tangle fern
B <i>G. microphylla</i>	waewae-kaka, tangle fern
B <i>Grammitis billardieri</i>	strap fern

<i>G. pseudociliata</i>	strap fern
<i>Histiopteris incisa</i>	swamp fern
<i>Hymenophyllum armstrongii</i>	filmy fern
<i>H. demissum</i>	"
<i>H. dilatatum</i>	"
<i>H. ferrugineum</i>	"
<i>H. flabellatum</i>	"
<i>H. flexuosum</i>	"
<i>H. lyallii</i>	"
<i>H. multifidum</i>	"
<i>H. rarum</i>	"
<i>H. revolutum</i>	"
<i>H. sanguinolentum</i>	" , piripiri
<i>H. scabrum</i>	"
<i>Hypolepis ambigua</i>	
<i>H. distans</i>	
<i>Lastreopsis glabella</i>	
<i>L. hispida</i>	
<i>L. microsora</i>	
<i>Leptopteris hymenophylloides</i>	crepefern, heruheru
<i>Lindsaea trichomanoides</i>	
<i>Lygodium articulatum</i>	mangemange
<i>Paesia scaberula</i>	ringfern, pigfern, hardfern
<i>Pellaea rotundifolia</i>	
<i>Phymatosorus diversifolius</i>	kowaowao, hounds tongue, maratata
<i>P. scandens</i>	moki, fragrant fern
<i>Pneumatopteris pennigera</i>	pakauroharoha
<i>Polystichum richardii</i>	tutoke, shore shield fern
<i>Pteridium esculentum</i>	bracken
<i>Pteris macilenta</i>	
<i>P. tremula</i>	shaking bracken
<i>Pyrrosia serpens</i>	leather-leaf fern
<i>Rumohra adiantiformis</i>	climbing shield fern
<i>Trichomanes elongatum</i>	filmy fern
<i>T. endlicherianum</i>	filmy fern
<i>T. strictum</i>	filmy fern
<i>T. venosum</i>	filmy fern

GYMNOSPERMS

A <i>Agathis australis</i>	kauri
<i>Cryptomeria japonica</i>	Japanese cedar
<i>Dacrycarpus dacrydioides</i>	kahikatea
<i>Dacrydium cupressinum</i>	rimu
<i>Libocedrus plumosa</i>	kawaka
<i>Phyllocladus glaucus</i>	toatoa
<i>P. trichomanoides</i>	tanekaha
<i>Podocarpus hallii</i>	Hall's totara
<i>P. totara</i>	totara
<i>Prumnopitys ferruginea</i>	miro
<i>P. taxifolia</i>	matai

DICOTYLEDONS

	<i>Acaena anserinifolia</i>	
	<i>Ackama rosaeifolia</i>	makamaka
	<i>Alectryon excelsus</i>	titoki
	<i>Alseuosmia macrophylla</i>	karapapa
	<i>A. banksii</i> x <i>A. macrophylla</i>	NZ honeysuckle
	(i) <i>A. x quercifolia</i>	
	(ii) linear-leaved type	
A	<i>Anagallis arvensis</i>	scarlet pimpernel
	<i>Aristotelia serrata</i>	wineberry, makomako
B	<i>Ascarina lucida</i>	
	<i>Australina pusilla</i>	
	<i>Beilschmiedia tarairi</i>	taraire
	<i>B. tawa</i>	tawa
	<i>Brachyglottis repanda</i>	rangiora
	<i>Callitriche muelleri</i>	starwort
	<i>C. stagnalis</i>	
	<i>Calystegia marginata</i>	
	<i>C. sepium</i>	greater bindweed
	<i>C. turguriorum</i>	
	<i>Carmichaelia aligera</i>	native broom
	<i>Carpodetus serratus</i>	putaputaweta
A	<i>Centaureum erythraea</i>	centaury
B	<i>Centella uniflora</i>	
A	<i>Cirsium arvense</i>	Californian thistle
A	<i>C. vulgare</i>	Scotch thistle
	<i>Clematis cunninghami</i> (= <i>C. parviflora</i> )	
	<i>C. paniculata</i>	puawhanganga
A	<i>Conyza floribunda</i>	broad leaved fleabane
	<i>Coprosma arborea</i>	mamangi
	<i>C. areolata</i>	
	<i>C. grandifolia</i>	kanono
	<i>C. lucida</i>	karamu
	<i>C. parviflora</i> s.s.	
	<i>C. propinqua</i>	
	<i>C. rhamnoides</i>	
	<i>C. robusta</i>	karamu
	<i>C. spathulata</i> s.s.	
	<i>C. tenuicaulis</i>	
	<i>C. propinqua</i> x <i>C. robusta</i>	
	<i>Coriaria arborea</i>	tutu
	<i>Corokia buddleioides</i>	korokio
	<i>C. cotoneaster</i>	
	<i>Corynocarpus laevigatus</i>	karaka
	<i>Cyathodes fasciculata</i>	mingimingi
	<i>C. juniperina</i>	"
A	<i>Daucus carota</i>	wild carrot
	<i>D. glochidiatus</i>	NZ carrot
A	<i>Digitalis purpurea</i>	foxglove
	<i>Dodonaea viscosa</i>	akeake
	<i>Dracophyllum latifolium</i>	neinei
B	<i>D. lessonianum</i>	
	<i>D. sinclairii</i>	

B	<i>Drosera peltata</i> ssp. <i>auriculata</i>	sundew
	<i>Dysoxylum spectabile</i>	kohekohe
	<i>Elaeocarpus dentatus</i>	hinau
	<i>E. hookerianus</i>	pokaka
	<i>Elatostema rugosum</i>	parataniwha
	<i>Entelia arborescens</i>	whau
	<i>Epilobium rotundifolium</i>	
A	<i>E. riparium</i>	Mexican devil
A	<i>Eupatorium adenophorum</i>	mist grass
	<i>Fuchsia excorticata</i>	fuchsia, kotukutuku
	<i>Galium propinquum</i>	
B	<i>Gaultheria antipoda</i>	
	<i>Geniostoma rupestre</i> var. <i>crassum</i>	hangehange
A	<i>Geranium homealum</i>	
	<i>G. pontentilloides</i>	
	<i>Gnaphalium gymmocephalum</i>	
	<i>G. keriense</i>	
A	<i>G. spicatum</i>	
	<i>Griselinia lucida</i>	puka, shining broadleaf
	<i>Haloragis erecta</i> var. <i>erecta</i>	
B	<i>Hebe macrocarpa</i> var. <i>macrocarpa</i>	
	<i>H. stricta</i> var. <i>stricta</i>	koromiko
	<i>Hedycarya arborea</i>	pigeonwood
	<i>Helichrysum aggregatum</i>	
	<i>Hoheria populnea</i> var. <i>populnea</i>	lacebark
	<i>Hydrocotyle dissecta</i>	
	<i>H. elongata</i>	
A	<i>Hypochoeris radicata</i>	catsear
	<i>Ixerba brexioides</i>	tawari
	<i>Knightia excelsa</i>	rewarewa
	<i>Lagenifera pumila</i>	
	<i>Laurelia novae-zelandiae</i>	pukatea
	<i>Leptospermum ericoides</i>	kanuka
	<i>L. scoparium</i>	manuka
	<i>Litsea calicaris</i>	mangeao
	<i>Lobelia anceps</i>	
	<i>Lophomyrtus bullata</i>	ramarama
A	<i>Lupinus arboreus</i>	yellow tree lupin
	<i>Macropiper excelsum</i> var. <i>excelsum</i>	kawakawa
	<i>Melicope ternata</i>	wharangi
	<i>Melicytus macrophyllus</i>	large-leaved mahoe
	<i>M. micranthus</i>	
	<i>M. ramiflorus</i>	mahoe
	<i>Metrosideros albiflora</i>	akatea, climbing rata
	<i>M. carminea</i>	climbing rata
	<i>M. diffusa</i>	" , akakura
	<i>M. fulgens</i>	" , akatorotoro
	<i>M. perforata</i>	"
	<i>M. robusta</i>	northern rata
	<i>Mida salicifolia</i>	willow-leaved maire
	<i>Muehlenbeckia australis</i>	
	<i>Myoporum laetum</i> var. <i>laetum</i>	ngaio
	<i>Myrsine australis</i>	mapou, red matipo
	<i>M. salicina</i>	toro
	<i>Neomyrtus pedunculata</i>	rohutu
	<i>Nertera depressa</i>	
	<i>Nertera dichondraefolia</i> s.s.	

	<i>Nestegis cunninghamii</i>	black maire
	<i>N. lanceolata</i>	white maire
	<i>N. montana</i>	narrow-leaved maire
A	<i>Oenanthe pimpinelloides</i>	parsley dropwort
	<i>Olearia albida</i>	
	<i>O. furfuracea</i>	
	<i>O. rani</i>	heketara
	<i>Oxalis lactea</i>	
	<i>Paratrophis microphylla</i>	turepo
	<i>Parsonsia capsularis</i>	aka-kiore
	<i>Pennantia corymbosa</i>	kaikomako
	<i>Peperomia urvilleana</i>	
	<i>Phebalium nudum</i>	maire hau
A	<i>Physalis peruviana</i>	cape gooseberry
A	<i>Phytolacca octandra</i>	inkweed
	<i>Pittosporum cornifolium</i>	karo
(1)	<i>P. eugenioides</i>	lemonwood
	<i>P. kirki</i>	
	<i>P. tenuifolium</i>	kohuhu
A	<i>Plantago lanceolata</i>	narrow-leaved plantain
A	<i>P. major</i>	broad-leaved plantain
B	<i>Polygonum</i> sp. (c.f. <i>P. decipiens</i> )	
	<i>Pratia physaloides</i>	
A	<i>Prunella vulgaris</i>	selfheal
	<i>Pseudopanax anomalus</i>	
	<i>P. arboreus</i>	five-finger
	<i>P. crassifolius</i>	lancewood
	<i>P. edgerleyi</i>	raukawa
	<i>Pseudowintera axillaris</i>	horopito
	<i>Quintinia serrata</i>	tawheowheo
	<i>Ranunculus hirtus</i>	buttercup
	<i>Rhabdothamnus solandri</i>	waiu-atua
	<i>Rubus australis</i>	bush lawyer
	<i>R. cissoides</i>	"
	<i>R. squarrosus</i>	"
	<i>Schefflera digitata</i>	pate
A	<i>Seigesbeckia orientalis</i>	
A	<i>Senecio bipinnatisectus</i>	Australian fireweed
A	<i>S. jacobaea</i>	ragwort
	<i>S. kirki</i>	Kirk's tree fern
	<i>S. minimus</i>	
A	<i>S. quadridentatus</i>	cotton fireweed
A	<i>Solanum nodiflorum</i>	
A	<i>Sonchus oleraceus</i>	puha, sow thistle
	<i>Sophora microphylla</i> var. <i>microphylla</i>	kowhai
	<i>Stellaria parviflora</i>	
	<i>Syzygium maire</i>	maire tawake, swamp maire
A	<i>Torilis arvensis</i>	hedge parsley
	<i>Toronia toru</i>	toru
A	<i>Veronica plebeja</i>	Australian speedwell
	<i>Vitex lucens</i>	puriri
	<i>Wahlenbergia gracilis</i>	
	<i>Weinmannia silvicola</i> var. <i>silvicola</i>	towai

(1) Seen on private land adjacent to Forest Sanctuary.

MONOCOTYLEDONS

	<i>Acianthus fornicatus</i> var. <i>sinclairii</i>	
A	<i>Agropyron littoralis</i>	perennial beard grass
A	<i>Anthoxanthum odoratum</i>	sweet vernal
	<i>Arthropodium cirratum</i>	renga lily, rock lily
	<i>Astelia ?banksii</i>	
B	<i>A. fragrans</i>	
	<i>A. grandis</i>	
B	<i>A. sp.</i> (c.f. <i>A. nervosa</i> )	
	<i>A. solandri</i>	kowharawhara, perching lily
	<i>A. trinervia</i>	kauri grass
B	<i>Baumea tenax</i>	
	<i>Bulbophyllum pygmaeum</i>	epiphytic orchid
	<i>Caladenia catenata</i> var. <i>carnea</i>	
	<i>Carex dissita</i>	
A	<i>C. lambertiana</i>	
A	<i>C. longebrachiata</i>	Australian sedge
	<i>C. spinirostris</i>	
	<i>Collospermum hastatum</i>	perching lily
	<i>C. microspermum</i>	"
	<i>Cordyline australis</i>	cabbage tree, ti
	<i>C. banksii</i>	ti ngahere
	<i>C. pumilio</i>	ti koraha
	<i>Cortaderia fulvida</i>	toetoe
	<i>Corybas oblongus</i>	
	<i>C. orbiculatus</i>	
	<i>C. rivularis</i>	
	<i>C. trilobus</i>	
A	<i>Cyperus eragrostis</i>	
B	<i>C. ustulatus</i>	
A	<i>Dactylis glomerata</i>	cocksfoot
	<i>Dendrobium cunninghamii</i>	epiphytic orchid
A	<i>Deyeuxia avenoides</i>	mountain oat grass
	<i>Dianella nigra</i>	turutu, blueberry
	<i>Earina autumnalis</i>	Easter orchid
	<i>E. mucronata</i>	
B	<i>Eleocharis sphacelata</i>	
A	<i>Festuca arundinacea</i>	tall fescue
A	<i>F. sp.</i>	slender fescue
	<i>Freycinetia baueriana</i> ssp. <i>banksii</i>	kiekie
	<i>Gahnia lacera</i>	
	<i>G. pauciflora</i>	
	<i>G. setifolia</i>	
	<i>G. xanthocarpa</i>	toi-kiwi
A	<i>Gastridium ventricosum</i>	nit grass
A	<i>Holcus lanatus</i>	Yorkshire fog
A	<i>Juncus articulatis</i>	jointed rush
A	<i>J. effusus</i>	soft rush
	<i>J. gregiflorus</i>	
	<i>J. pallidus</i>	
	<i>J. planifolius</i>	
	<i>J. prismatocarpus</i>	
A	<i>J. tenuis</i>	
	<i>Lachnagrostis filiformis</i>	
B	<i>Lemna minor</i>	
	<i>Lepidosperma australe</i>	

	<i>L. laterale</i>	
	<i>Libertia grandiflora</i>	native iris
	<i>L. pulchella</i>	native iris
A	<i>Linum bienne</i>	
A	<i>Lotus angustissimus</i>	
A	<i>L. suaveolens</i>	
	<i>Machaerina sinclairii</i>	
	<i>Microlaena avenacea</i>	bush rice grass
	<i>M. polynoda</i>	
	<i>M. stipoides</i>	meadow rice grass
	<i>Microtis unifolia</i>	
	<i>Oplismenus imbecillis</i>	
A	<i>Paspalum paspaloides</i>	paspallum
	<i>Phormium cookianum</i>	mountain flax
	<i>P. tenax</i>	flax
	<i>Polypogon monspeliensis</i>	beard grass
A	<i>Potamogeton cheesmanii</i>	
	<i>Pterostylis banksii</i>	
	<i>P. graminea</i> var. <i>rubricaulis</i>	
	<i>Rhopalostylis sapida</i>	nikau
	<i>Ripogonum scandens</i>	supplejack
	<i>Rytidosperma</i> sp.	
	<i>Schoenus apogon</i>	
	<i>S. maschalinus</i>	
	<i>S. tendo</i>	
	<i>Scirpus inundatus</i>	
	<i>S. nodosus</i>	
B	<i>S. prolifer</i>	
	<i>S. reticularis</i>	
A	<i>Sporobolus africanus</i>	rats tail
	<i>Thelymitra longifolia</i>	
B	<i>T. pulchella</i>	
A	<i>Trifolium repens</i>	white clover
	<i>Typha orientalis</i>	raupo
	<i>Uncinia banksii</i>	hook grass
	<i>U. distans</i>	"
	<i>U. uncinata</i>	"
A	<i>Videns</i> sp.	

Common Names of Plants Mentioned in the Text

akeake	<i>Dodonaea viscosa</i>
bush rice grass	<i>Microlaena</i> spp.
filmy ferns	Family Hymenophyllaceae
flax	<i>Phormium</i> spp.
Hall's totara	<i>Podocarpus hallii</i>
hangehange	<i>Geniostoma rupestre</i>
heketara	<i>Olearia rani</i>
hen and chicken fern	<i>Asplenium bulbiferum</i>
hinau	<i>Elaeocarpus dentatus</i>
hooksedge	<i>Uncinia</i> spp.
kahikatea	<i>Dacrycarpus dacrydioides</i>
kanono	<i>Coprosma grandifolia</i>
kanuka	<i>Leptospermum ericoides</i>
karaka	<i>Corynocarpus laevigatus</i>
karamu	<i>Coprosma lucida</i> , <i>C. robusta</i>
katote	<i>Cyathea smithii</i>
kauri	<i>Agathis australis</i>
kauri grass	<i>Astelia trinervia</i>
kiekie	<i>Freycinetia baueriana</i> ssp. <i>banksii</i>
kiokio	<i>Blechnum</i> sp. ( <i>B. capense</i> agg.)
kohekohe	<i>Dysoxylum spectabile</i>
kohuhu	<i>Pittosporum tenuifolium</i>
koromiko	<i>Hebe stricta</i> var. <i>stricta</i>
lacebark	<i>Hoheria populnea</i> var. <i>populnea</i>
lancewood	<i>Pseudopanax crassifolius</i>
large-leaved mahoe	<i>Meliccytus macrophyllus</i>
mahoe	<i>M. ramiflorus</i>
mangemange	<i>Lygodium articulatum</i>
mapou	<i>Myrsine australis</i>
miro	<i>Prumnopitys ferruginea</i>
nikau	<i>Rhopalostylis sapida</i>
northern rata	<i>Metrosideros robusta</i>
parataniwha	<i>Elatostema rugosum</i>
perching lilies	<i>Collospermum</i> spp., <i>Astelia solandri</i>
piupiu	<i>Blechnum discolor</i>
ponga	<i>Cyathea dealbata</i>
pukatea	<i>Laurelia novae-zelandiae</i>
puriri	<i>Vitex lucens</i>
rangiora	<i>Brachyglottis repanda</i>
rewarewa	<i>Knightea excelsa</i>
rimu	<i>Dacrydium cupressinum</i>
supplejack	<i>Ripogonum scandens</i>
tanekaha	<i>Phyllocladus trichomanoides</i>
taraire	<i>Beilschmiedia tarairi</i>
tawa	<i>B. tawa</i>
tawari	<i>Ixerba brexioides</i>
tawheowheo	<i>Quintinia serrata</i>
titoki	<i>Alectryon excelsus</i>
toi-kiwi	<i>Gahnia xanthocarpa</i>
towai	<i>Weinmannia silvicola</i> var. <i>silvicola</i>
tree fuchsia	<i>Fuchsia excorticata</i>
wharangi	<i>Melicope ternata</i>
wheki	<i>Dicksonia squarrosa</i>



APPENDIX 2 : FAUNAL SPECIES LIST - WARAWARA FOREST SANCTUARY AND  
TE HURA ECOLOGICAL AREA

\* Recorded by the Wildlife Service (pers. comm.) on 8 October 1978,  
18 January 1979 or 30 January 1979.

+ Recorded by myself and P. Boyack during field work in December 1984.

Native Birds

* <i>Apteryx australis mantelli</i>	N.I. brown kiwi
+ <i>Chalcites lucidus</i>	shining cuckoo
+ <i>Circus approximans</i>	harrier hawk
* <i>Cyanoramphus novaeseelandiae</i>	red-crowned parakeet
*+ <i>Gerygone igata</i>	grey warbler
*+ <i>Halcyon sancta</i>	kingfisher
*+ <i>Hemiphaga novaeseelandiae</i>	N.Z. pigeon
*+ <i>Hirundo neoxena</i>	welcome swallow
*+ <i>Nestor meridionalis</i>	N.I. kaka
*+ <i>Petroica macrocephala</i>	pied tit
*+ <i>Prothemadera novaeseelandiae</i>	tui
*+ <i>Rhipidura fuliginosa</i>	fantail
*+ <i>Zosterops lateralis</i>	silvereve

Introduced Birds

*+ <i>Acridotheres tristis</i>	myna
* <i>Carduelis carduelis</i>	goldfinch
* <i>Fringilla coelebs</i>	chaffinch
+ <i>Phasianus colchicus</i>	pheasant
*+ <i>Platycercus eximius</i>	eastern rosella
* <i>Prunella modularis</i>	dunnock
*+ <i>Turdus merula</i>	blackbird

Other Native Animals

* <i>Hoplodactylus granulatus</i>	forest gecko
* <i>Mystacina</i> sp.	native bat
+ <i>Paranephrops planifrons</i>	freshwater crayfish
*+ <i>Paryphanta busbyi busbyi</i>	kauri snail

Other Introduced Animals

*+ <i>Bos taurus</i>	cattle
+ <i>Capra hircus</i>	feral goat
(1) ? <i>Hyla aurea</i>	Australian frog
+ <i>Rattus</i> sp.	rat

\*+ *Sus scrofa*  
(2) *Trichosurus vulpecula*

wild pig  
brush-tailed possum

- (1) N.Z.F.S., (1977).
- (2) L. Burns, pers. comm.

APPENDIX 3 : GENERALISED STAND STRUCTURE FOR HIGH ALTITUDE KAURI FOREST  
(A2, NICHOLLS 1976)

TIER	← INCREASING DOMINANCE →				
	HEIGHT (m)	ABUNDANT	FREQUENT	OCCASIONAL	RARE
EMERGENT					
CANOPY	20-30		kauri	rimu northern rata	kahikatea
SUB- CANOPY	2-18		tawheowheo miro tawari neinei Hall's totara towai	tawa lancewood northern rata kauri rimu toro <i>Nestegis montana</i>	<i>Neomyrtus pedunculata</i> pokaka kawaka
SHRUB <sup>(1)</sup>	0.5-2	toi-kiwi kauri grass <i>Dicksonia lanata</i>	kiekie kanono mingimingi	five finger <i>Coprosma</i> spp. mahoe large-leaved mahoe	<i>Astelia grandis</i>
GROUND- COVER	0-0.5		<i>Blechnum fraseri</i>	ground orchids common lindsaea umbrella fern	<i>Trichomanes strictum</i>
EPIPHYTES AND LIANES			kiekie mangemange <i>Metrosideros albiflora</i>	<i>Astelia solandri</i> <i>Metrosideros diffusa</i> puka <i>Collospermum hastatum</i>	

DISTRIBUTION: Above approx. 400 m a.s.l. in the reserves.

NOTES: (1) Shrub species often also occur in the lower subcanopy.

APPENDIX 4 : GENERALISED STAND STRUCTURE FOR LOW-MID ALTITUDE KAURI FOREST  
(A1, NICHOLLS 1976)

TIER	← INCREASING DOMINANCE →				
	HEIGHT (m)	ABUNDANT	FREQUENT	OCCASIONAL	RARE
EMERGENT					
CANOPY	20-25		kauri	rimu	
SUB-CANOPY	2-14		tawheowheo Hall's totara lancewood	miro northern rata tawari tanekaha Kirk's daisy kanuka mingimingi	toatoa (1)
SHRUB	0.5-2	toi-kiwi kauri grass	kiekie kanono	<i>Coprosma lucida</i> mingimingi large-leaved mahoe <i>Alseuosmia</i> <i>macrophylla</i>	<i>Cyathodes</i> <i>juniperina</i>
GROUND-COVER	0-0.5		<i>Blechnum</i> <i>fraseri</i>	kiokio piupiu	
EPIPHYTES AND LIANES			kiekie <i>Metrosideros</i> spp.	<i>Dendrobium</i> <i>cunninghamii</i>	

DISTRIBUTION: Below 400 m a.s.l. in the reserves.

NOTES: (1) Seen in Te Hura Ecological Area.

APPENDIX 5 : GENERALISED STAND STRUCTURE FOR KAURI-PODOCARP-HARDWOOD FOREST  
(B2, NICHOLLS 1976)

TIER	← INCREASING DOMINANCE →				
	HEIGHT (m)	ABUNDANT	FREQUENT	OCCASIONAL	RARE
EMERGENT	18-30		rimu northern rata	kauri (1) miro Hall's totara	
CANOPY	8-15		taraire towai tawa	rewarewa tawari kohekohe	
SUB-CANOPY	2-8		towai lancewood heketara rewarewa	tawari kanono taraire ponga nikau mamaku neinei	<i>Nestegis montana</i>
SHRUB	0.5-2	kiekie	kauri grass (2) toi-kiwi (2) kanono wheki	large-leaved mahoe softwood saplings hangehange	
GROUND-COVER	0-0.5		<i>Blechnum fraseri</i>	hen and chicken fern hooksedge	
EPIPHYTES AND LIANES			kiekie <i>Collospermum hastatum</i> <i>Astelia solandri</i>	puka mangemange <i>Phymatosorus</i> spp.	

DISTRIBUTION: Usually fringing kauri forest types.

NOTES: (1) locally frequent.  
(2) locally abundant.

APPENDIX 6 : GENERALISED STAND STRUCTURE FOR LOW ALTITUDE PODOCARP-HARDWOOD FOREST

TIER	← INCREASING DOMINANCE →				
	HEIGHT (m)	ABUNDANT	FREQUENT	OCCASIONAL	RARE
EMERGENT	12-18		northern rata	rimu	kauri pukatea
CANOPY	8-12	taraire	towai rewarewa puriri kohekohe	mamaku karaka lancewood	tanekaha
SUB-CANOPY	2-8	nikau	rewarewa towai mahoe taraire kohekohe	<i>Coprosma arborea</i> ponga rimu heketara (2) kowhai <i>Olearia albida</i> (2) kiekie <i>Astelia banksii</i> (2)	<i>Myoporum laetum</i> (2) var. <i>laetum</i> (2) black maire
SHRUB	0.5-2		<i>Coprosma</i> spp. hangehange nikau ponga (2) flax kiekie	ramarama wheki mahoe <i>Rhabdothamnus solandri</i> large-leaved mahoe pate	<i>Helichrysum aggregatum</i> (2)
GROUND-COVER	0-0.5	parataniwha (1)	<i>Pneumatopteris pennigera</i> hooksedge <i>Blechnum</i> spp.	<i>Oplismenus imbecillis</i> <i>Asplenium polyodon</i> <i>Carex dissita</i> <i>Adiantum</i> spp. <i>Polystichum richardii</i> (2)	<i>Microlaena polynoda</i> (2)
EPIPHYTES AND LIANES			kiekie <i>Blechnum filiforme</i> <i>Collospermum</i> spp. <i>Astelia solandri</i>	supplejack <i>Pyrrosia serpens</i> mangemange <i>Metrosideros perforata</i> <i>Parsonsia capsularis</i>	<i>Metrosideros carminea</i>

DISTRIBUTION: Below 300 m a.s.l. in the reserves.

NOTES: (1) Usually occurs on damp areas near streams  
(2) Occur mainly on coastal ridges.

APPENDIX 7 : GENERALISED STAND STRUCTURE FOR MID ALTITUDE PODOCARP-HARDWOOD FOREST  
(E3, NICHOLLS 1976)

TIER	← INCREASING DOMINANCE →				
	HEIGHT (m)	ABUNDANT	FREQUENT	OCCASIONAL	RARE
EMERGENT	18-25		northern rata	rimu pukatea miro kahikatea	
CANOPY	10-15	towai taraire	tawa rewarewa	kohekohe hinau swamp maire	
SUB-CANOPY	2-9		tawa katote ponga nikau kanono taraire	rewarewa heketara tawheowheo mamaku mahoe lacebark kohekohe	mangeao
SHRUB	0.5-2		nikau kiekie (1)	wheki ponga hangehange large-leaved mahoe	
GROUND-COVER	0-0.5		<i>Blechnum fraseri</i> hen and chicken fern	<i>Lastreopsis hispida</i> <i>Uncinia uncinata</i> <i>Asplenium</i> spp. <i>Pneumatopteris pennigera</i> kiokio	
EPIPHYTES AND LIANES			supplejack kiekie <i>Hymenophyllum</i> spp.	<i>Collospermum hastatum</i> <i>Blechnum filiforme</i> <i>Astelia solandri</i> puka <i>Metrosideros diffusa</i>	

## DISTRIBUTION:

Between 300 m and 500 m a.s.l. in the reserve, wherever kauri is absent.

## NOTES:

(1) Locally abundant.

APPENDIX 8 : GENERALISED STAND STRUCTURE FOR HIGH ALTITUDE PODOCARP-HARDWOOD FOREST  
(D6, NICHOLLS 1976)

TIER	← INCREASING DOMINANCE →				
	HEIGHT (m)	ABUNDANT	FREQUENT	OCCASIONAL	RARE
EMERGENT	15-20		rimu northern rata	Hall's totara miro rewarewa pukatea	
CANOPY	7-12		towai heketara tawa	tawheowheo five finger tawari hinau mangeao rewarewa	
SUB-CANOPY	2-7		towai katote tawa kanono kiekie	tawheowheo tree fuchsia lancewood mahoe tawari pigeonwood	pokaka
SHRUB	0.5-2		kanono kiekie	katote Hall's totara miro	
GROUND-COVER	0-0.5		<i>Blechnum fraseri</i> hooksedge	bush rice grass piupiu hen and chicken fern	
EPIPHYTES AND LIANES		filmy ferns	supplejack kiekie mangemange	<i>Astelia solandri</i> <i>Collospermum hastatum</i> <i>Metrosideros</i> spp.	

DISTRIBUTION: Above 500 m a.s.l. in Te Hura Ecological Area.