Dicot trees and shrubs	
Dracophyllum palustre	✓
Epacris pauciflora	✓
Gaultheria antipoda	
Kunzea ericoides agg.	
Leptospermum scoparium	✓
Ulex europaeus *	✓

Dicot herbs	
Actinotus novae-zealandiae	✓
Celmisia alpina	✓
Celmisia "Taurua"	✓
Centella uniflora	
Donatia novae-zelandiae	✓
Drosera binata	✓
Drosera spatulata	✓
Euphrasia disperma	✓
Gentianella townsonii	
Gonocarpus micranthus	✓
Hypochaeris radicata *	
Leontodon taraxacoides [*L. saxatilis*] *	
Liparophyllum gunnii	✓
Lobelia anceps	
Lobelia angulata	
Nertera depressa	
Utricularia dichotoma	

Appendix 3: Species List – Birds. Observed or heard during the Auckland Botanical Society visit to the Westport area in January 2018, compiled by Paul Asquith.

Australian gannet	blue duck	NZ pigeon/kereru	NZ fantail
black shag	grey teal	long tailed cuckoo	rifleman
pied shag	brown teal	shining cuckoo	magpie
little shag	mallard/hybrid	kingfisher	blackbird
spotted shag	weka	welcome swallow	song thrush
black backed gull	SI pied oystercatcher	tui	starling
red billed gull	variable oystercatcher	bellbird	skylark
Caspian tern	spur winged plover	NZ pipit	yellowhammer
white fronted tern	pied stilt	fernbird	chaffinch
Royal spoonbill	Australasian harrier	NZ robin	greenfinch
black swan	morepork	brown creeper	house sparrow
Canada goose	kea	tomtit	goldfinch
feral goose	eastern rosella	silvereye	
paradise shelduck	parakeet (yellow crowned?)	grey warbler	

Vegetation and threatened plants of Hauturu Little Barrier Island

Ian Atkinson and Bec Stanley

The vegetation of Hauturu changes enormously from place to place, a consequence of altitudinal, topographic and geological differences that control the island's climate and soils. Another major factor influencing the vegetation is disturbance, both natural processes such as landsliding and human-induced changes, particularly fires. This article is based on the mapping and description of the island's vegetation published by Hamilton and Atkinson (1961) but incorporates soil information from Wright (1961) and results from further field work by the authors between 1998 and 2004.

1. Paspalum–Microlaena grassland

Grassland covers a relatively small part of the Te Maraeroa alluvial flat which lies behind the boulder banks that converge at Te Titoki Point. It once supported forest. *Paspalum dilatatum* is characteristic but many other grasses are present. The grassland is associated with silty and gravelly clay loams that formerly carried forest that was cleared and the land cultivated by Maori for kumara (*Ipomoea batatas*) and other crops. Parts of the flat near the ranger's house and the bunkhouse, as well as the main tracks crossing the flat, are mown regularly.

2. Cyperus–Carex sedgeland

The more poorly drained parts of Te Maraeroa flat, which also once supported forest, now carries a community dominated by *Cyperus ustulatus* and *Carex virgata*. Much of Te Maraeroa was grazed by sheep and cattle during the first 60 years of the 20th century although none remain. A variety of herbaceous weeds are present but most are unlikely to become problems in other parts of the island.

3. Coastal forest and scrub

Coastal forest and scrub are associated with sea cliffs and valley mouths on the island, a zone in which wind-carried salt and wave splash have direct effects on plants. In the northern half of the island, the hard rocks forming the cliffs along this coast are largely devoid of plant cover. Sea cliffs of the more

weathered rocks above the south-western and southern coasts often produce deposits of coarse talus and finer material behind the shoreline. A rather open forest of pohutukawa (*Metrosideros excelsa*), kawakawa (*Piper excelsa*), coastal karamu (*Coprosma macrocarpa*), karaka (*Corynocarpus laevigatus*) and, more rarely, kohekohe (*Dysoxylum spectabile*) and puriri (*Vitex lucens*), can develop on these sites. A stand of parapara (*Pisonia brunoniana*), with some tawapou (*Planchonella costata*), wharangi (*Melicope ternata*) and kohekohe has developed on talus behind the shoreline stretching between the mouths of Tirikakawa Stream and Lamb Bay Creek.

Coastal forest is also associated with one of the most striking geological features of the island: the Hingaia rockfall at the north-eastern corner of the island. This resulted from collapse of the andesite cliffs above the fall which, at that point, are 427 m high. Kear (1961) suggests that this rockfall was caused by either an earthquake or a tsunami. House-sized blocks of rock are tumbled at all angles, some of them still unstable. A deposit of much finer material, both alluvial and fallen from the cliff, has accumulated behind the rockfall at the base of the cliff. Pohutukawa has established on the rockfall itself, some relatively tall and straight but other trees, growing on large blocks of rock, very stunted. Tall forest, including some kauri (*Agathis australis*), has established on the fine deposits at the foot of the cliff. The vegetation of Hingaia, as it appeared in 1954, is described by Bieleski (1954).

4. Kanuka forest

Streams radiating from the island's centre have cut deep valleys and gorges through the main slopes of the volcano. Above c.300 m altitude, all that remains of these slopes are very steep and narrow ridges. Below c.300 m, the original slopes of the volcano can be discerned as moderately sloping and roughly triangular-shaped surfaces called planezes. Their pre-human vegetation has invariably been burnt, enabling kanuka (*Kunzea robusta*) seedlings to establish and kanuka forest to spread over almost one third of the island. Many of the more recent fires were related to gum-digging and felling of kauri between 1870 and 1894 (when the island was made a reserve); most of the kanuka forest is unlikely to be older than 100 to 150 years. Kanuka forests in the northern half of the island may be older but no ageing of these forests has been attempted.

Regeneration of kanuka within this forest is negligible and, as a result of continuing collapse of old trees, particularly during storms, it is steadily being replaced by other species. Haekaro (*Pittosporum umbellatum*) and kauri are the commonest trees replacing kanuka on ridges. On moderately steep slopes, puriri, kohekohe, mapou (*Myrsine australis*), *Coprosma arborea* and haekaro are the most widespread trees replacing kanuka. On alluvial and colluvial sites in valleys, taraire (*Beilschmiedia tarairi*), rewarewa (*Knightia excelsa*), puriri and kohekohe are replacing kanuka. Replacement of kanuka is most advanced on ridges and least advanced on midslopes but between-site variability is enormous. On some planezes, soil chemical and physical conditions are so limiting that manuka scrub has developed. A manuka (*Leptospermum scoparium*) stand of this kind, that scarcely showed any measurable change between 1954 and 2001, is described on the "Shag Track" by Atkinson (2004). More extreme examples of "gumland communities", containing manuka and the rushes *Schoenus tendo* and *Lepidosperma laterale*, are present on some of the western planezes.

5. Kauri and kauri–hard beech forests

Kauri is regenerating throughout the island between 100 and 500m altitude and some kauri can be found within 30m of height above sea-level. Much of this recovery is associated with slopes cleared of forest by fires. However, a second important process that favours kauri regeneration on the island is landsliding or 'slips' associated with steep-sided valleys. For example, many kauri stands mapped in valleys by Hamilton and Atkinson (1961) are elongated parallel with the line of greatest slope, e.g. the Ohakiri, Waitoki, upper Orau and Tawaroa valleys. Closer inspection of the often uneven ground surface within these stands points to these trees having established on debris from massive landslides triggered either by high-intensity rainfalls or possibly earthquakes.

Successional stages within kauri or kauri-hard beech stands on ridge-sides or steep valley-sides can be identified. Kanuka is often the primary colonizer of landslide debris. Both kauri and hard beech (*Nothofagus truncata*) establish within the developing kanuka stands and subsequently overtop them. Kauri later overtops the hard beech and almost certainly outlives it; annual ring data are needed to confirm the latter supposition. In a few places on eastern and southern ridges of the island, hard beech forms small single-dominant stands although young kauri and sometimes tawa (*Beilschmiedia tawa*) and tawhero (*Weinmannia sylvicola*) may be present in the understorey.

6. Northern rata/puriri-tawa-pukatea forest

This forest is more varied in plant composition than any other kind of forest recognised on the island. It includes most of the valley-side forests, growing either on relatively stable convex slopes (including spurs), or on unstable, often concave slopes where land-sliding is frequent. Huge northern rata trees (*Metrosideros robusta*), which have almost invariably established as epiphytes on trees such as puriri and pukatea (*Laurelia novae-zelandiae*), tower above the rest of the canopy. Miro (*Prumnopitys ferruginea*) and very occasionally kahikatea (*Dacrycarpus*

dacrydioides) are minor constituents of this forest. Tawa, taraire, and sometimes kauri, have established on the most stable valley-sides. Some kauri stands extend downslope nearly to the valley bottom. Colluvial sites, where material from numerous debris-slides and slumps has accumulated in a valley bottom, are also frequently affected by flash-flooding of streams. Such sites support a continually changing pattern of fast-growing species such as mahoe (*Melicytus ramiflorus*), mamaku and nikau (*Rhopalostylis sapida*), and, where light is sufficient, fuchsia (*Fuchsia excorticata*), makomako (*Aristotelia serrata*), rangiora (*Brachyglottis reranda*), heketara (*Olearia rani*), and pate (*Schefflera digitata*).

7. Tawhero-tawa forest

This kind of forest is dominant in forests above an altitude of 450 m with tawhero forming almost pure stands on steep-sided ridges. Nevertheless, tawhero-tawa forest is rich in plant species including horopito (*Pseudowintera axillaris*), tawari (*Ixerba brexioides*), mountain fivefinger (*Pseudopanax colensoi*), fivefinger (*P. arboreus*), heketara, pate, toro (*Myrsine salicina*) and the root parasite *Mida salicifolia*. Tawhero-tawa forest, together with quintinia-tawari-southern rata (*Metrosideros umbellata*) forest and scrub grow in the wettest and most frequently cloud-covered zone of the island. The steep terrain here is subject to repeated land-sliding with debris-avalanches descending deep into the valleys below.

8. Quintinia-tawari-southern rata forest and scrub

Mineral soils here are generally shallower than those at lower altitudes but contain a high peat content with some pockets of deep peat. The outstanding feature of this "moss forest" is the density of epiphytic mosses, liverworts, ferns and sometimes asteliads, carried by the branches. The canopy, as seen on aerial photographs, is in places striated in fan-like patterns. Apparently these result from high intensity, but low humidity, salt storms driven by southerly winds. These kill buds and young shoots and thus "train" the uppermost branches and foliage into a furrowed canopy, the "furrows" mostly oriented in a north-south direction. In addition to the three main trees (*Quintinia serrata*, tawari and southern rata) in this community, Hall's totara (*Podocarpus laetus*), kauri and miro are moderately common. Toatoa (*Phyllocladus toatoa*) is present in a few places and one site supports two small clusters of *Metrosideros parkinsonii* (Atkinson et al. 1962).

The soils of this uppermost community on the island receive substantial annual inputs of nutrients as a direct consequence of the area being the breeding ground of a large colony of Cook's petrel (*Pterodroma cookii*). This is by far the largest colony of this petrel in New Zealand, estimated by Imber et al. (2003) to support more than 50,000 breeding pairs. Now that both cats and rats have been eradicated on the island, it is possible that the size of the colony may increase. A much smaller colony of the much larger black petrel (*Procellaria parkinsoni*) is also present in this forest (Imber 1987). Several other species of petrel, likely to have once bred in considerable numbers on the island, for example grey-faced petrels (*Pterodroma macroptera gouldi*), can now be expected to re-establish and increase. Where this happens, soil nutrient levels will also increase and at least local effects can be expected on the vegetation pattern.

Fungi, lichens and bryophyte flora

There are no published accounts of the fungi of Hauturu although several collecting trips have been made on the island (not formally written up, Ross Beever pers. comm., 2005). There are no published accounts of the bryophytes of Hauturu though 128 species are known from the island (Beveridge & Beever 2003). No rare mosses are recorded but the moss flora is regarded as very important for its large area and varied habitat which correlates with higher diversity of bryophytes e.g. cloud forest which typically has a high biomass of bryophytes (Jessica Beever pers. comm., 2005). There are 251 lichens recorded from the island (Hayward & Wright 1991) which represented 20% of the country's total lichen flora known at the time. The island has many examples of lichens that reach their northern limit on Hauturu. The diverse habitats present on Hauturu are the key reason underlying this high diversity of lichens.

Climatic and geological catastrophes

The vegetation of an island like Hauturu is not wholly controlled by continuous changes in weather, interactions between plants and between plants and animals, and the slower processes of soil formation. Superimposed on these changes are events such as cyclonic storms and earthquakes. The Hingaia rockfall has already been mentioned. The rainstorm that hit the island between 7 and 9 a.m. on the 14th March 1998, triggered many landslides in the upper third of the island including one that closed the uppermost section of the Hamilton Track. The floor of the ranger's home went under water and floods in many of the island's streams eroded hundreds of well grown trees from stream-banks and adjacent alluvial flats. Some huge puriri trees were wrenched out of the ground, stripped of their branches, and carried down the stream to become wedged as "bridges" across it, or stacked in heaps beside it. A fisherman on the north side of the island reported "full-size kauri trees" being "shot-out" above waterfalls in the higher part of the island. He also reported a giant raft of floating logs stretching from the east coast of the island towards Great Barrier Island for a distance of 6km. It was impossible to pass through this raft in his fishing boat [Ian notes he had never seen so much wood washed up on the southern shore of the island as that which followed this storm].

Rat effects on plants

Studies on the effects of kiore (*Rattus exulans*) on native tree species found on northern offshore islands have shown that at least 25 species are adversely affected by these rats eating seeds or seedlings (Campbell and Atkinson (1999, 2002). Two of these species, milk tree (*Streblus banksii*) and coastal maire (*Nestegis apetala*) have not been found on Hauturu, notwithstanding that a great deal of botanical work has been done on the island. Both species are present on many rat-free islands. They are also present on some islands where rats are, or have been present, although not necessarily for as long as rats may have been on Hauturu. Further intensive searches for these trees are needed but, if they cannot be found, there is a case for re-establishing such species on Hauturu. Many other threatened plants probably have reduced density ecause of kiore e.g. *Pisonia brunoniana* (Campbell and Atkinson 1999). Kiore certainly browsed *Dactylanthus taylorii* preventing seed set and are thus likely to have affected its density on Hauturu. Kiore also eat seedlings, seed and possibly flowers of *Carmichaelia williamsii*.

The removal of kiore has removed the direct threat to these species but their recovery has been compromised by changes in vegetation composition e.g. dactylanthus hosts are more uncommon than they would have been because their regeneration e.g. *Coprosma arborea* has also been suppressed by rats.

Threatened Plants of Hauturu

There are no endemic plants on Hauturu. Why Hauturu has no endemic species and Great Barrier does cannot be explained, nor can the presence of two beech species on Hauturu (no beech is present on Great Barrier Island). There has been no paleo-ecological work to help guide us in this regard. With the presence of kiore for an unknown period it is unclear how many species (those reliant on seabirds, or large-fruited species) may have disappeared and are therefore unrecorded, nor how many of the uncommon and threatened plants today were once more common.

Hauturu is the only site in the Auckland region for three formerly more widespread plants: *Peraxilla tetrapetala, Dactylanthus taylorii*, and *Carmichaelia williamsii*. Hauturu is also the only site in the region where black beech (*Nothofagus solandri* var. *solandri*) is found (and only around 30 trees are known). Five plants have not been seen on Hauturu for some time: *Epilobium chionanthum, Lepidium oleraceum, Rorippa divaricata, Daucus glochidiatus* and *Senecio scaberulus*. At least two of these (*L. oleraceum and R. divaricata*) are probably related to the decline in seabird activity on the island as a result of kiore predation.

The most notable plant recovery project on Hauturu is of *Dactylanthus taylorii* which is found at six locations on the island. Kiore destroyed many inflorescences of this species each year and likely reduced seed output and recruitment of *Dactylanthus* and of its host trees (as they too were browsed by kiore). Plants at Tirikakawa were fenced with solid aluminium 'chimneys' c. 1 m tall in the mid-1990s to prevent kiore browse. In 1997 the chimneys were replaced with galvanised steel mesh cages which were the recommended exclusion method by the Department of Conservation Recovery Group. Additional *Dactylanthus* plants located at Orau in April 1998 were covered by mesh cages when discovered. Cages prevented access by bats and so hand-pollination was required. This was never wholly successful due to the difficulties of accessing these remote sites at the exact time suitable for hand pollination. Cages were removed in 2004. The Hauturu *Dactylanthus* populations are the only place in New Zealand where *Dactylanthus* and its primary pollinator, the short-tailed bat, co-exist in a predator-free environment.

Post script

This article was prepared by the authors in 2005 under the direction of Dr Dave Towns (then at the Department of Conservation) for a plan of Hauturu that was never published. Ian Atkinson visited Hauturu intermittently from 1952 and we felt (Dave Towns and Bec Stanley) that it would be appropriate to record Ian's observations formally in a published report as a record of his visits and knowledge of the island.

Editor's note – the Auckland Botanical Society has published a vouchered checklist of the flowering plants, conifers, ferns, and bryophytes of Hauturu by Beever et al. (2012).

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Vegetation of Motuarahi Island, Paihia, Bay of Islands

Ben Goodwin

Motuarahi is a 1.6 ha island, located a short distance off the Paihia foreshore, in the Bay of Islands. I visited the island on three occasions whilst on holiday in 2016 and 2017 and, on each excursion, explored and recorded its flora (see Appendix). Two trips occurred in winter (July 2016, July 2017) and one in summer (December 2016). Geologically, the island is formed of palaeozoic – mesozoic Waipapa terrane greywacke, with soils of Marua light-brown clay loam (Northland Regional Council 2014). Most of the coast is rocky and steep, with short, intertidal rock platforms (Fig.1). There is a small beach on the southern edge of the island, which permits comfortable landing. Motuarahi is administered as a 'Scenic Reserve' by the Department of Conservation.

Flora

The only beach area, formed of shell, pebble and sand, is situated at the southern edge of the island. Above the high tide mark, vegetation consists of scattered plants of fennel (*Foeniculum vulgare*), pohuehue (*Muehlenbeckia complexa*) and toatoa (*Haloragis erecta* subsp. *erecta*), with patches of Indian doab (*Cynodon dactylon*) and Bermuda buttercup (*Oxalis pes-caprae*). A rope barrier, used to reduce disturbance for breeding New Zealand dotterels (*Charadrius obscurus*), prohibited a thorough survey of this area on two of the three excursions. Shortly back from the beach, the island's three most significant invasive plants are evident, *Cotoneaster glaucophyllus*, sweet pea shrub (*Polygala myrtifolia*) and the African olive (*Olea europaea* subsp. *cuspidata*). These three shrubs, particularly the latter, take up much of the space from the spring high tide mark, back to the foot of the steep slopes, which rise to the interior of the island. African olive is readily identified from the more familiar European or Mediterranean subspecies, *Olea europaea* subsp. *europaea,* by its leaves, which, in the African taxon, are typically larger, with pale green or yellowish undersides, as opposed to white or silver grey in *O. europea* subsp. *europaea* (Cuneo & Leishman, 2006). These leaf characteristics were sufficient for field identification purposes. Other characteristics are discussed by Cameron (2017).

Heading northwards from the beach, the steep upward slope toward the interior of the island has a dense ground-cover of ferns. Rasp fern (*Doodia*

Fig 1. Eastern coastline, December 2016. All photos by author.