



FLORA OF NEW ZEALAND
FERNS AND LYCOPHYTES

MARSILEACEAE



P.J. BROWNSEY & L.R. PERRIE

Fascicle 8 – MARCH 2015

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CATALOGUING IN PUBLICATION

Brownsey, P.J. (Patrick John), 1948-

Flora of New Zealand [electronic resource] : ferns and lycophytes. Fascicle 8, Marsileaceae / P.J. Brownsey and L.R. Perrie. -- Lincoln, N.Z. : Manaaki Whenua Press, 2015.

1 online resource

ISBN 978-0-478-34777-7 (pdf)

ISBN 978-0-478-34761-6 (set)

1.Ferns -- New Zealand - Identification. I. Perrie, L.R. (Leon Richard). II. Title. III. Manaaki Whenua-Landcare Research New Zealand Ltd.

UDC 582.394.75(931)DC 587.30993

DOI: 10.7931/B1RP48

This work should be cited as:

Brownsey, P.J. & Perrie, L.R. 2015: Marsileaceae. *In*: Breitwieser, I.; Heenan, P.B.; Wilton, A.D. *Flora of New Zealand — Ferns and Lycophytes*. Fascicle 8. Manaaki Whenua Press, Lincoln.
<http://dx.doi.org/10.7931/B1RP48>

Cover image: *Marsilea mutica*, leaves divided into four variegated flabellate segments, floating on the surface of a farm pond.

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Introduction

The family Marsileaceae is represented in New Zealand by one native and one naturalised genus, each with a single species. *Pilularia novae-hollandiae* is an indigenous species which grows submerged in or around lakes in both the North and South Islands. *Marsilea mutica* is an Australian and New Caledonian species commonly grown in aquaria and garden ponds, which has become temporarily established in a few localities, mainly in the North Island. Both genera are rooted, aquatic ferns with long-creeping rhizomes; they are characteristically heterosporous, producing mega- and microsporangia in hardened sporocarps. The plants are highly modified for their aquatic habitat, and are morphologically very different to most terrestrial ferns. *Marsilea* has four-lobed leaves that float on the surface of the water, whereas *Pilularia* lacks lamina segments and is recognisable vegetatively as a fern only by its coiled young leaves.

Marsileaceae Mirb. in Lamarck & Mirbel, *Hist. Nat. Vég.* 5, 126 (1802)

Type taxon: *Marsilea* L.

Aquatic ferns, or ferns of periodically wet places. Rhizomes short- to long-creeping, branching, bearing roots at nodes, bearing septate hairs or almost glabrous. Leaves monomorphic, not articulated to rhizome, arising at nodes, with 2 (not NZ) or 4 segments terminating a long stalk, or consisting of stalk only and lacking segments, herbaceous or coriaceous, hairy (not NZ) or glabrous at maturity, circinate when young. Veins anastomosing, or greatly reduced. Sporocarps globose to ellipsoidal, sessile or stalked, hardened, usually hairy (not NZ) or glabrous, attached at or near the base of the leaf stalks, or on the rhizome near the base of the leaf stalks, opening with two valves, each containing at least two sori. Each sorus containing both mega- and microsporangia. Annulus absent. Heterosporous, spores trilete, lacking chlorophyll; one megaspore in each megasporangium and many microspores in each microsporangium. Megaspores spheroidal to slightly ellipsoidal, plain to slightly undulate; microspores spheroidal, and plain, papillate or rugulate.

Taxonomy: A family of three genera and about 50 species (Nagalingum et al. 2008). The Marsileaceae comprises ferns that are rooted aquatic plants, either growing in water, or occupying areas that are periodically or seasonally wet. They have creeping rhizomes, and leaves with long stalks that either lack lamina segments, have just two segments, or resemble a four-leaved clover. Mega- and micro-sporangia are borne in hardened sporocarps and give rise to mega- and microspores. Spores have considerable longevity (Johnson 1985), but germination and fertilisation occur very rapidly. When moistened, the sporocarp swells and bursts, liberating a worm-like mass of gelatine carrying the sori. Spores germinate into greatly reduced gametophytes still attached to the parent spore, and fertilisation occurs within days.

Pryer (1999) and Pryer et al. (2004) showed that the heterosporous ferns, Salviniales, are one of three major lineages of “core leptosporangiate” ferns, along with tree ferns and polypod ferns. Nagalingum et al. (2008) subsequently confirmed that Salviniales is divided into two strongly supported families, the Marsileaceae and Salviniaceae, and that within Marsileaceae, there is strong support for recognition of three genera, *Marsilea*, *Regnellidium* and *Pilularia*. Schneider & Pryer (2002) also demonstrated that the spores of Marsileaceae are markedly different to those of Salviniaceae and all homosporous ferns. The morphology of the reproductive structures in heterosporous water ferns has been critically examined by Nagalingum et al. (2006).

The family is represented in New Zealand by one indigenous genus (*Pilularia*) and one fully naturalised genus (*Marsilea*).

- 1 Leaves terminated by four fan-shaped lamina segments *Marsilea*
 Leaves stalk-like, lacking lamina segments *Pilularia*

Distribution: Widely distributed in tropical and warmer temperate regions, and, except for *Pilularia*, absent from most cool temperate regions and oceanic islands. One native and one naturalised genus in New Zealand, each with a single species; none endemic.

Biostatus: Indigenous (Non-endemic).

Table 1: Number of species in New Zealand within *Marsileaceae* Mirb.

Category	Number
Indigenous (Non-endemic)	1
Exotic: Fully Naturalised	1
Total	2

***Marsilea* L., *Sp. Pl.*, 1099 (1753)**

Type taxon: *Marsilea quadrifolia* L.

Etymology: Named in honour of Luigi Ferdinando Marsigli (1656-1730), an Italian soldier and naturalist.

Vernacular names: four-leaved water clover; nardoo

Aquatic ferns, or ferns of periodically wet places. Rhizomes short- (not NZ) to long-creeping, branching, bearing roots at nodes, bearing septate hairs or almost glabrous (not NZ). Leaves monomorphic, not articulated to rhizome, arising at nodes, with 4 obovate or flabellate segments terminating the stalks, herbaceous or coriaceous, glabrous or hairy (not NZ). Veins anastomosing, without free included veinlets. Sporocarps globose to ellipsoidal, sessile (not NZ) or stalked, hardened,

usually hairy (not NZ) or glabrous, attached at or near the base of the leaf stalks, or on the rhizome near the base of the leaf stalks, opening with two valves, each containing at least two sori. Each sorus containing both mega- and microsporangia. Megaspores spheroidal to slightly ellipsoidal, plain to slightly undulate; microspores spheroidal, and plain, papillate or rugulate.

Distribution: A genus of c. 45 species (Nagalingum et al. 2008) widespread in tropical and warmer temperate regions, with the greatest diversity in Africa and nine species in Australia. One naturalised species in New Zealand.

Biostatus: Exotic; fully naturalised.

Table 2: Number of species in New Zealand within *Marsilea* L.

Category	Number
Exotic: Fully Naturalised	1
Total	1

Cytology: The base chromosome number in *Marsilea* is $x = 20$ (Smith et al. 2006).

Notes: The New World species of *Marsilea* have been monographed by Johnson (1986), and the Australian species described by Jones (1998). The phylogeny of *Marsilea* has been investigated by Nagalingum et al. (2007) and Whitten et al. (2012). Spores are illustrated by Tryon & Lugardon (1991).

Marsilea mutica* Mett., *Ann. Sci. Nat. Bot. sér. 4 15: 88 (1861)

Holotype: lieux inondés à Kanala [flooded ground around Kanala], New Caledonia, *E. Vieillard*, 1855-1860, P 00636716 (online!)

Etymology: From the Latin *muticus* (blunt, without a point), a reference to the shape of the lamina segments.

Vernacular names: nardoo; smooth nardoo

Aquatic fern. Rhizomes submerged, long-creeping, 1–2 mm in diameter, rooting at nodes, straw-coloured, bearing colourless septate hairs up to 2 mm long near the apex. Leaves solitary at each node, 90–330 mm long, glabrous; stalks 70–300 mm long, each terminating in 4 flabellate segments; segments broadly obovate to flabellate, 10–38 mm long, 9–38 mm wide, green or sometimes streaked brown with false veins between the true veins on the underside; distal margin rounded, entire. Sporocarps solitary, almost globose, each 4–5 mm long, glabrous, on unbranched stalks 3–15 mm long.

Distribution: North Island: Auckland, Southern North Island

South Island: Canterbury

Altitudinal range: 5–140 m.

An Australian and New Caledonian species commonly grown in aquaria and garden ponds, and known to have become established temporarily in four North Island localities, the Waitākere Ranges, Hūnua, Pukekohe and Paekakariki, and one South Island locality near Kaiapoi, Canterbury.

Biostatus: Exotic; fully naturalised.

Habitat: Recorded from farm ponds, standing water and swampy ground, sometimes growing with *Callitriche stagnalis*, *Lemna* sp., and *Azolla rubra*, or in *Juncus articulatus* turf.

First record: Brownsey (1988, p. 27). Voucher: WELT P013485, P020044, 1986.

Recognition: *Marsilea mutica* is a distinctive plant whose creeping rhizomes root on the bottom of ponds or standing water, and produce 4-lobed leaves on long stalks that float on the surface of the water. In New Zealand the leaves are uniformly green, or with streaks of brown running between the veins, but in Australia they often have horizontal brown markings. Sporocarps are usually produced as the habitat dries out.

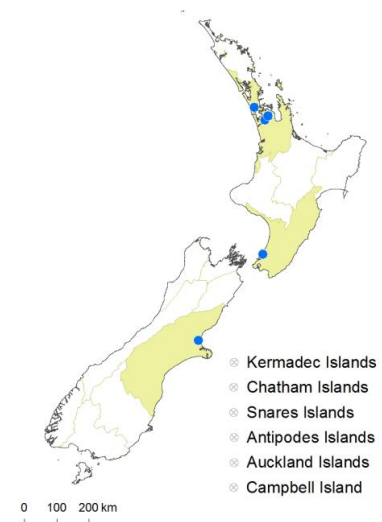


Fig. 1: *Marsilea mutica* distribution map based on databased records at AK, CHR and WELT.

Notes: *Marsilea mutica* is considered potentially poisonous to horses, cattle and sheep in Australia because of the presence of thiaminase (McKenzie 2012). However, the species is too sporadic to cause any problem in New Zealand.



Fig. 2: *Marsilea mutica*: leaves divided into four variegated flabellate segments, floating on the surface of a farm pond.



Fig. 3: *Marsilea mutica*: herbarium specimen from Hunua, Auckland, WELT P013485/A, showing the circinate vernation of the young leaves.



Fig. 4: *Marsilea mutica*: herbarium specimen from Hunua, Auckland, WELT P013485/C, showing creeping rhizomes, leaves with four flabellate segments, and sporocarps on short stalks.



Fig. 5: *Marsilea mutica*: herbarium specimen from Hunua, Auckland, WELT P013485/C, showing the short-stalked, glabrous, globose sporocarps arising from the rhizome.

***Pilularia* L., Sp. Pl., 1100 (1753)**

= *Calamistrum* L. ex Kuntze, *Revis. Gen. Pl.* 2, 822 (1891) nom. illeg.

Type taxon: *Pilularia globulifera* L.

Etymology: From the Latin *pilularis* (having globular structures), a reference to the shape of the sporocarps.

Vernacular name: pillwort

Aquatic ferns, or ferns of periodically wet places. Rhizomes short- to long-creeping, branching, bearing roots at nodes, bearing septate hairs or almost glabrous (not NZ). Leaves monomorphic, not articulated to rhizome, arising at nodes, with long stalks lacking lamina segments, herbaceous, glabrous. Veins greatly reduced, undivided. Sporocarps globose, sessile or stalked, hardened, hairy, attached to the rhizome at the base of the leaf stalks, opening with two valves, each containing at

least two sori. Each sorus containing both mega- and microsporangia. Megaspores spheroidal to slightly ellipsoidal, plain to slightly undulate; microspores spheroidal, and plain, papillate or rugulate.

Distribution: A genus of 6 species (Nagalingum et al. 2008) in temperate regions; one species in North and South America, two in Europe, one in Australia and New Zealand, and two in southern Africa (Crouch et al. 2011). One species in New Zealand; none endemic.

Biostatus: Indigenous (Non-endemic).

Table 3: Number of species in New Zealand within *Pilularia* L.

Category	Number
Indigenous (Non-endemic)	1
Total	1

Cytology: The base chromosome number in *Pilularia* is $x = 10$ (Smith et al. 2006).

Notes: Based on analysis of five different genes, Nagalingum et al. (2008) showed that *Pilularia* comprises two highly supported groups – *P. minuta* and *P. globulifera* from Europe, and *P. americana* and *P. novae-hollandiae* from North America, Australia and New Zealand. The two subsequently described African species (Crouch et al. 2011) were not included in the phylogeny.

***Pilularia novae-hollandiae* A.Br., Monatsber. Königl. Preuss. Akad. Wiss. Berlin 1863: 435 (1864)**

≡ *Calamistrum novae-hollandiae* (A.Br.) Kuntze, *Revis. Gen. Pl.* 2, 822 (1891)

Lectotype (selected by Brownsey & Perrie 2014): Swan River [Western Australia], *J. Drummond* 991, Herb. Hookerianum, K 000883641; isolectotypes: BM, E

= *Pilularia novae-zealandiae* Kirk, *Trans. & Proc. New Zealand Inst.* 9: 547, t. 29 (1877) — as *novae-zealandiae*

≡ *Calamistrum novae-zealandiae* (Kirk) Kuntze, *Revis. Gen. Pl.* 2, 822 (1891)

Lectotype (selected by Allan 1961): Lake Pearson, *T. Kirk*, 2 Feb. 1876, WELT P008482!

Etymology: *novae-hollandiae* (Latin) - from Australia.

Vernacular name: pillwort

Aquatic or subaquatic fern, forming spreading clumps. Rhizomes long-creeping, c. 0.2 mm in diameter, rooting at nodes, straw-coloured, almost glabrous. Leaves solitary at each node, 10–60 mm long, rarely up to 90 mm long, 0.2–0.5 mm in diameter, tapering to the apex, lacking flattened segments, glabrous. Sporocarps solitary, globose, 2–4 mm in diameter, densely hairy, sessile or on stalks 1–4 mm long.

Distribution: North Island: Auckland, Volcanic Plateau, Gisborne, Southern North Island.

South Island: Marlborough, Westland, Canterbury, Otago, Southland, Fiordland.

Altitudinal range: 0–1100 m.

In the North Island, *Pilularia novae-hollandiae* occurs from 0–950 m in the Waikato River and around Lakes Whāngāpē, Waahi, Aratiatia, Kaitawa, Waikaremoana, Waikareiti, Taupō and Wairarapa. In the South Island it is found along the Southern Alps from Lake Rotorua to Lake Monowai at 10–1100 m, in lakes along the west coast, and in outlying populations at Falls Dam near St Bathans and Lake Onslow north of the Lammerlaw Range.

Also Australia (Western Australia, South Australia, NSW, Victoria, Tasmania).

Biostatus: Indigenous (Non-endemic).

Habitat: Grows submerged on stony or muddy bottoms in water up to 1 m deep, and on mud and silt left around lakes when the water level drops in dry periods. Sporocarps are produced in summer as the lakes begin to dry out and the water level recedes.

Recognition: An easily over-looked and unfern-like plant, often only recognised by the coiling of the young leaves, and by the sporocarps when they are present.

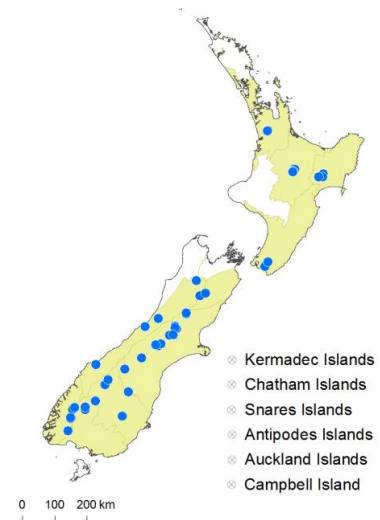


Fig. 6: *Pilularia novae-hollandiae* distribution map based on databased records at AK, CHR and WELT.

Cytology: $2n = c. 20$ (Large & Braggins 1989)

Notes: *Pilularia novae-zealandiae* was described from New Zealand by Kirk (1877), and distinguished from *P. novae-hollandiae* by the number of sori and megaspores. Cheeseman (1925) and Allan (1961) both accepted *P. novae-zealandiae* as an endemic species. However, Large & Braggins (1989) compared the morphology of *P. americana*, *P. novae-hollandiae* and *P. novae-zealandiae* and concluded that they were extremely similar. Nagalingum et al. (2008) investigated the phylogenetic relationships of these species using five different gene markers. They concluded that there was no sequence divergence between *P. novae-hollandiae* and *P. novae-zealandiae* and that the two were conspecific. The name *P. novae-hollandiae* has nomenclatural priority and is therefore adopted here for the New Zealand plant.

Kirk used the name *P. novae zealandiae* for his new species, but Webb & Edgar (1999) suggested that the specific epithet should take a hyphen.



Fig. 7: *Pilularia novae-hollandiae*: herbarium specimen from Lake Pearson, Canterbury, WELT P024077, showing the creeping rhizome, undivided leaves, and one sessile, hairy sporocarp. Scale bar = 5 mm.



Fig. 8: *Pilularia novae-hollandiae*: herbarium specimen from Lake Pearson, Canterbury, WELT P008482/A, showing the circinate vernation of one young leaf. Scale bar = 5 mm.

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Acknowledgements

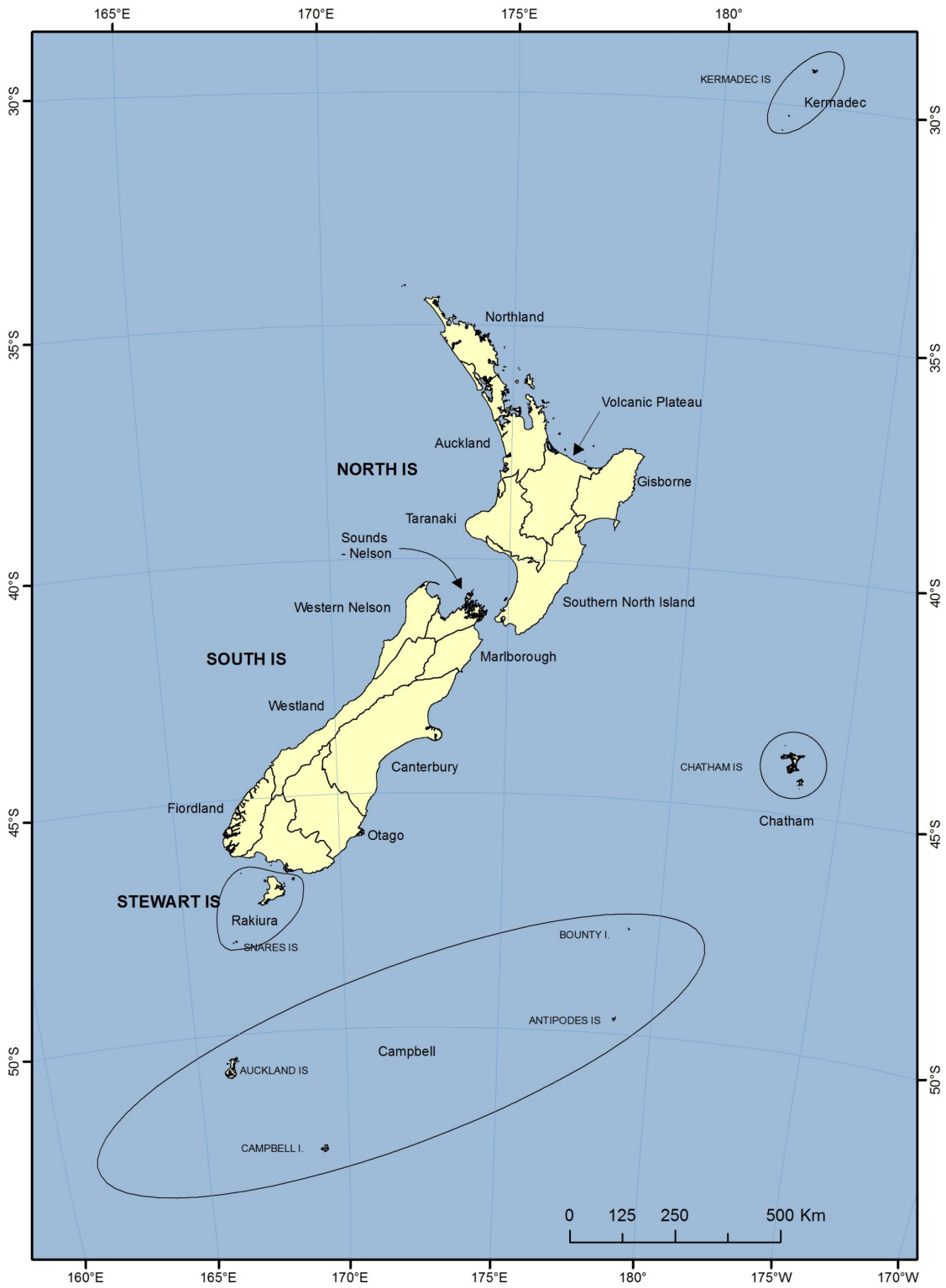
We thank the staff at AK, CHR and WELT for loans of specimens and for databasing and providing spreadsheets of collection data. We are grateful to staff at CHR for the preparation of maps and for assistance in editing and formatting the text, and to Nathalie Nagalingum for reviewing the manuscript.

P.J. Brownsey and L.R. Perrie

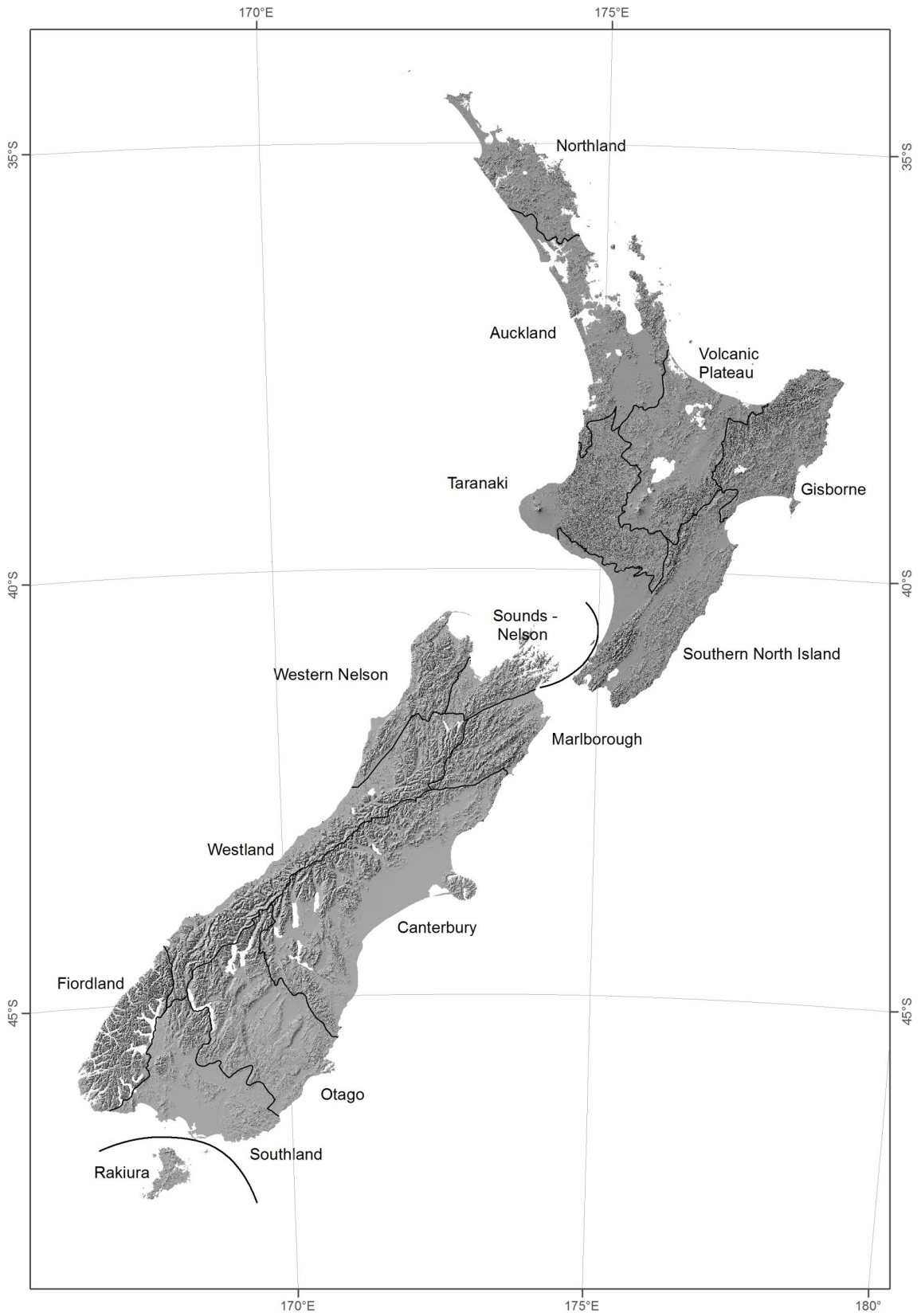
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Map 1: Map of New Zealand and offshore islands showing Ecological Provinces



Map 2: Map of New Zealand showing Ecological Provinces

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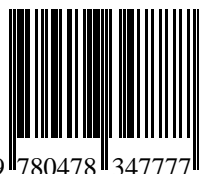
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