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Lomatia fraseri (Proteaceae), an Australian tree newly documented as naturalised in New Zealand

Leon Perrie* and Lara Shepherd

Museum of New Zealand Te Papa Tongarewa, PO Box 467, Wellington 6011, New Zealand
*Corresponding author: leon.perrie@tepapa.govt.nz

ABSTRACT: The Australian tree *Lomatia fraseri* was recently reported as naturalised on 'Mowlem Ridge', near Wainuiomata in the Wellington region of the North Island of New Zealand. Here, we provide more details about this discovery and the presence of the species in New Zealand. The identification of these plants as *L. fraseri* is supported by the abundant hairs on the underside of the leaves (although these are absent in some plants), hairy flower tepals (also absent in some plants) and the narrowly ovate or narrowly elliptic, dentate leaves of the adults. Occasional juveniles have pinnatifid rather than the usual unlobed leaves, a variation consistent with Australian reports. *Lomatia fraseri* clearly fulfils the criteria for the Naturalised category in New Zealand. It is intensively established on Mowlem Ridge, where many thousands of plants extend over more than 2 km on a ridgeline firebreak through regenerating forest dominated by *Leptospermum scoparium* (mānuka). Scattered plants have also been found at least 2.5 km to the east. In addition, self-sown seedlings of *L. fraseri* have been reported near Christchurch in the South Island. Currently, the Wainuiomata population of *L. fraseri* is not being actively controlled. We suggest this may be regretted given that *L. fraseri* has the potential to establish widely throughout New Zealand, based on its demonstrated invasiveness and its broad indigenous distribution in southeastern Australia. Furthermore, that *L. fraseri* remained undetected for long enough to become so well established, despite being so close to a major population centre and being an utterly distinctive tree, raises the question of whether governmental agencies should be doing more biosecurity surveillance.

KEYWORDS: Biosecurity, exotic plants, *Lomatia ilicifolia*, *Lomatia myricoides*, weeds.

Introduction

Among the bigger environmental changes in New Zealand since European settlement has been the introduction and establishment of many exotic plants. The vascular plant species that have been recorded as self-propagating here now well outnumber indigenous species – 2851 compared to 2372, respectively (Schönberger et al. 2020a,b). Indeed, the numbers of exotic plant species established outside of cultivation on New Zealand's North and South Islands are higher than on any other islands worldwide, and the temporal rate of naturalisation is several times higher than for other regions (Hulme 2020). About 20 new plant naturalisations are being discovered annually (Howell 2008), with most of these coming from the 20,000-plus additional species of exotic plants already cultivated in New Zealand (Williams & Cameron 2006; Hulme 2020).

In July 2019, Michele Dickson of the Wellington Botanical Society and Tararua Tramping Club gave the lead author a sample of a plant that she had recognised as being

exotic. She had found a large population of these plants near Wainuiomata during a Tararua Tramping Club outing. As described below, we have identified this as *Lomatia fraseri* R.Br. This discovery was first published when an email that the lead author had sent to the committee of the Wellington Botanical Society was included in the *Wellington Botanical Society Newsletter* (Perrie 2019). Additional details of the site were given by McAlpine (2020), while Schönberger et al. (2020a) newly listed *L. fraseri* as Naturalised in their annual checklist of New Zealand plants. Here, we provide further information about *L. fraseri* in New Zealand, including its identification and distribution.

The genus *Lomatia* R.Br. belongs to the Proteaceae, which is essentially a southern hemisphere family with centres of greatest species diversity in southern Africa and particularly Australia; the latter is home to some 1100 species (McCarthy 1995). New Zealand has only two extant indigenous species (Schönberger et al. 2020a): rewarewa, *Knightia excelsa* R.Br.; and toru, *Toronia toru* (A.Cunn.) L.A.S.Johnson & B.G.Briggs. Fossils indicate that the family's diversity was once considerably greater in New Zealand, but it has been winnowed since the Miocene epoch, perhaps due to global cooling (Carpenter et al. 2012). Since European settlement in New Zealand, several exotic Proteaceae genera have either naturalised (*Banksia* L.f., *Embothrium* J.R.Forst. & G.Forst., *Grevillea* Knight, *Hakea* Schrad. & J.C.Wendl., *Leucadendron* R.Br., *Lomatia*, and *Macadamia* F.Muell.) or been recorded with a 'Casual' status (*Protea* L. and *Stenocarpus* R.Br.) (Schönberger et al. 2020a). Among these, *Banksia integrifolia* L.f., *Embothrium coccineum* J.R.Forst. & G.Forst., *Hakea drupacea* (C.F.Gaertn.) Roem. & Schult. (= *H. suaveolens* R.Br.), *H. gibbosa* (Sm.) Cav., *H. salicifolia* (Vent.) B.L.Burtt, and *H. sericea* Schrad. & J.C.Wendl. are sufficiently problematic to be regarded as environmental weeds (Howell 2008).

Lomatia itself comprises 12 species of trees and shrubs, with three endemic to South America and the remainder endemic to eastern Australia, where they range from northern Queensland to Tasmania (Wilson et al. 1995). In Australia, most species overlap with congeners, and hybridisation is frequent, even between species with quite different leaf morphologies (Milner et al. 2013; McIntosh et al. 2014). A study sequencing DNA of two nuclear and one chloroplast loci found the genetic variation in southeastern mainland Australia more congruent with geography rather than the morphologically based taxonomy (Milner et al. 2015). *Lomatia fraseri* occurs in New South Wales and Victoria, overlapping with *L. ilicifolia* R.Br., *L. myricoides* (C.F.Gaertn.) Domin and *L. silaifolia* (Sm.) R.Br. Colloquial names for *L. fraseri* include tree lomatia, forest lomatia and silky lomatia (Wilson et al. 1995; Stajsic 2019; Harden 2020).

The only species of *Lomatia* previously recorded as self-propagating in New Zealand is *L. ilicifolia* (holly lomatia and, in an Australian context, native holly), with a status of 'exotic, occasional' in Schönberger et al. (2020a), which is equivalent to the Casual category of Heenan et al. (2004; see 'Methods'). This record was based on the specimen of a seedling collected at Christchurch Botanic Gardens, with the label noting 'seedlings underneath adult plants': *Barwick s.n.*, 7 April 2003, CHR 567253.

Methods

The categorisation of exotic plants in New Zealand follows Heenan et al. (2004: 797). Namely, a species is considered Naturalised if 'populations are self-maintained by seed or vegetative reproduction, or they occur repeatedly in natural or semi-natural habitats or in urban environments'. The species is considered Casual if it is '(1) passively regenerating only in the immediate vicinity of the cultivated parent plant, or more widespread but only known as isolated or few individuals; (2) garden escapes persisting only 2–3 years; (3) garden discards persisting vegetatively but not spreading sexually or asexually'.

Plants were identified using the *Flora of Australia* (Wilson et al. 1995), the New South Wales Flora Online (Harden 2020) and the online VICFLORA – Flora of Victoria (Stajsic 2019), along with a review of online images of all *Lomatia* species. The description given in the Results is based on the cited New Zealand wild specimens, following the format of Stajsic (2019). Herbarium codes follow Thiers (2021). The Australasian Virtual Herbarium was searched for specimens of *Lomatia* collected in New Zealand,[1] with direct approaches also made to AK and CHR. All cited herbarium vouchers have been examined by us. The citizen science website iNaturalist was searched for observations of *Lomatia* in New Zealand.[2]

We made four visits (August 2019, September 2020, December 2020 and January 2021) to the population reported by Michele Dickson. This is on the ridge between

Wainuiomata's Arakura suburb and the valley with Moores Valley Road at its southern end. This ridge is unnamed on the Topo50 map series, but is hereafter referred to as Mowlem Ridge because it has a peak named Mowlem towards its southern end. During the September 2020 visit, we counted *Lomatia fraseri* plants alongside 10 m of track towards the northern end of the main infestation. When in the wider area, we have looked for *L. fraseri*, but we have not systematically surveyed the surrounds for it. The distribution of *L. fraseri* around Wainuiomata was mapped using QGIS 3.10.2,[3] with a base map from Land Information New Zealand.[4]

Results

***Lomatia fraseri* R.Br.**

Tree lomatia, forest lomatia, silky lomatia

DESCRIPTION: Shrub or small tree to at least 4 m high. Bark grey-brown, lenticulate. Branchlets reddish brown to purplish grey, distally retaining some hairs from the buds but otherwise glabrous. Buds with orange-brown or white strigose hairs. Leaves alternate, unlobed except occasionally pinnatifid in juveniles and rarely heteromorphic, narrowly ovate or narrowly elliptic, or occasionally elliptic for pinnatifid leaves; apex acute; margins often prominently dentate but occasionally shallowly dentate, or rarely nearly entire in adults; lamina 75–145 mm long and 16–32 mm wide in adults, but up to 185 mm long and 85 mm wide in juveniles; green or yellowish green, abaxial surface lighter in colour than adaxial surface; veins reticulate, more obvious on abaxial surface but sometimes obscured; glabrous on adaxial surface, abaxial surface often with *c.* 0.3 mm-long, appressed, white, usually dense but often inconspicuous hairs, but sometimes glabrous, particularly with pinnatifid leaves; petiole 10–25 mm long. Inflorescence usually axillary, rarely terminal, usually a raceme but rarely a panicle with proximal branching, 45–120 mm long; pedicles 6–10 mm long. Tepals 7–8 mm long, cream, with appressed reddish hairs, often dense, occasionally sparse or glabrous. Follicle 15–27 mm long (excluding the style remnant), leathery, black; seeds *c.* 8 per follicle, to *c.* 23 mm long, including wing. Flowering Dec.–Feb. (–Mar.?).

FIRST RECORD OF NATURALISATION: Perrie (2019).

EARLIEST VOUCHER OF NATURALISATION: Wainuiomata Water Catchment, *Dalton s.n.*, 13 August 2010, CHR 614064.

ADDITIONAL VOUCHERS OF NATURALISED PLANTS: all Wainuiomata: ridge to northeast of Wainuiomata, *Dickson s.n.*, 29 July 2019, WELT SP109576; ridge east of Arakura, *Perrie 8210, 8211, 8214 A, 8214 B, 8214 C, 8214 D, 8215 & Shepherd*, 10 August 2019, WELT SP109577 (AK, CHR, NZFRI), SP109578 (AK, CHR), SP109579, SP109580, SP109581, SP109582, SP109583; Brookfield Camp, *Perrie 8885, 8886 et al.*, 4 July 2020, WELT SP109155, SP109157; ridge to east of Arakura, *Perrie 8946, 8947 & Shepherd*, 12 September 2020, WELT SP109736, SP109735 (AK, CHR, MPN, NZFRI); ridge to east of Arakura, *Perrie 9535 & Shepherd*, 19 December 2020, WELT SP110451; ridge to east of Arakura, *Perrie 9627, 9628, 9629, 9630 & Shepherd*, 22 January 2020, WELT SP110928 (AK, CHR), SP110929 (AK, CHR), SP110930 (NZFRI), SP110931 (AK, CHR).

VERIFIABLE OBSERVATIONS OF WILD PLANTS FROM ADDITIONAL SITES: Christchurch [Port Hills, near Victoria Park], iNaturalist observations 24354632 and 32495426.

During the initial identification of the *Dickson s.n.* collection, the resemblance of its coriaceous follicle fruits to those of *Grevillea* indicated Proteaceae. We then searched the Plant Names Database for Proteaceae genera that had self-sown in New Zealand.[5] Consultation of Australian identification resources (cited above) gave a match to *Lomatia fraseri*.

Following the Australian identification keys, a significant characteristic for identifying the Wainuiomata plants as *Lomatia fraseri* was the abundant, albeit inconspicuous, hairs on the underside of the leaves (Fig. 1). However, these hairs are sparse in some individuals and absent in others, particularly but not exclusively those with pinnatifid leaves. Similarly, many individuals had hairy flower tepals (Fig. 2), but individuals with glabrous flowers were also noted. Another important character was the narrowly ovate or narrowly elliptic leaves of the adults and their marginal dentation (Fig. 3). Juveniles among the Mowlem Ridge plants exhibit considerable variation in leaf shape (Fig. 4); they are usually unlobed but some are pinnatifid and a few are heteromorphic. Such variation in leaf form is consistent with Australian descriptions of *L. fraseri*.

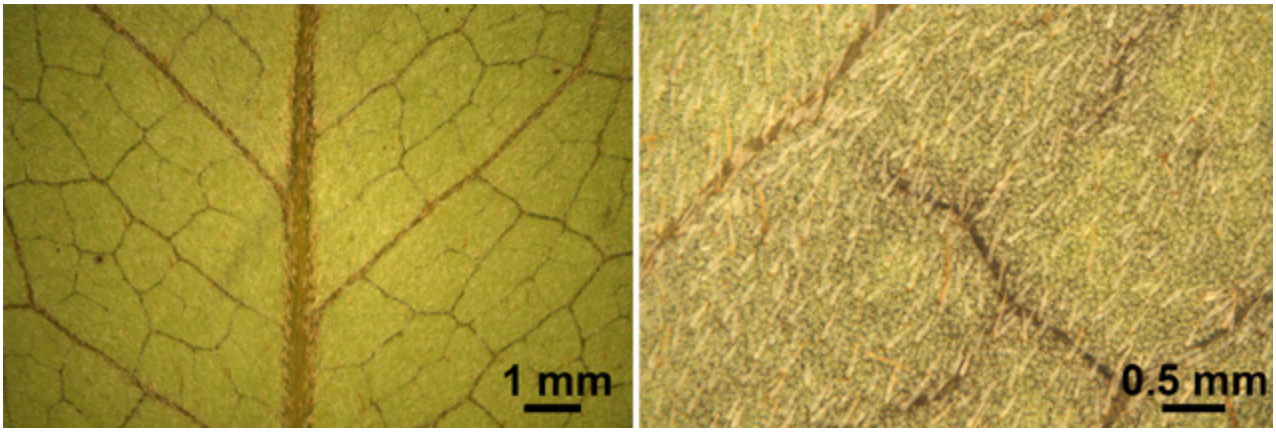

Fig. 1 Indumentum on the abaxial surface of a leaf of *Lomatia fraseri* from Mowlem Ridge, near Wainuiomata (both images: *Perrie 9535 & Shepherd*, WELT SP110451/A).

Fig. 2 *Lomatia fraseri* flowers. A, open flowers; B, an unopened flower with appressed red hairs on the abaxial surface of the tepals; C, flowers in racemes (photos: Leon Perrie).

Fig. 3 *Lomatia fraseri*, adults on Mowlem Ridge, near Wainuiomata. A, one of the taller individuals; B, an adult with the usual prominently dentate leaves; C, an adult with more shallowly dentate leaves (photos: Leon Perrie).

Fig. 4 *Lomatia fraseri* from Mowlem Ridge, near Wainuiomata. A, variation in leaf morphology among seedlings and saplings; B, a heteromorphic sapling with both unlobed and pinnatifid leaves (photos: Leon Perrie).

Searches of the New Zealand herbaria revealed only two earlier specimens of *Lomatia* growing wild in New Zealand. One of these is the *Barwick s.n.* collection (CHR 567253, cited in the Introduction as the basis for the Casual status of *L. ilicifolia*) (Fig. 5A). This seedling has broader, ovate leaves compared to *L. fraseri*, and in our opinion is correctly identified. The other – *Dalton s.n.*, CHR 614064 – was also identified as *L. ilicifolia*, but is better attributed to *L. fraseri* (Fig. 5B). It was collected in 2010, making it the earliest wild voucher for this species (see above) from the 'Wainuiomata Water Catchment'.

The population of *Lomatia fraseri* on Mowlem Ridge occurs along a ridge-top vehicle track from about 41.2211°S 174.9620°E to at least as far south as 41.2410°S 174.9647°E, a straight-line distance of about 2.2 km. Abundance and ecological details are given in the Discussion. During a Wellington Botanical Society trip in July 2020, we found *L. fraseri* in the Brookfield (Scout) Camp (see 'Additional vouchers of naturalised plants', above). The Wainuiomata populations of *L. fraseri* are mapped in Fig. 6. We have not seen *L. fraseri* during several walks along the 'ECNZ' track on the ridgeline to the north and west of Arakura, or in the area north of Wainuiomataiti Stream and Crowthers Creek, north of Brookfield.

Elsewhere in Wellington, *Herbert s.n.*, February 2010, WELT SP089380, vouchered four plants of *Lomatia fraseri*, 2–4 m tall, seemingly cultivated in Tawa's Charles Duncan Reserve. The specimen's label records that no saplings or seedlings were seen. However, more recently Mark McAlpine (2020), Senior Biosecurity Officer – Pest Plants for the Greater Wellington Regional Council (GWRC), reported the species seeding at this site. There are no corresponding herbarium vouchers or verifiable public-domain images (such as those on iNaturalist) for these seedlings, nor for McAlpine's report that '[GWRC] had previously controlled a few plants in a reserve in Kelson', with the latter being seedlings (Mark McAlpine, pers. comm., 6 January 2021). Searching iNaturalist revealed that *L. fraseri* has also self-sown at one site on the Port Hills, where several saplings occurred near a planted adult (see 'Verifiable observations of wild plants from additional sites', above).

During our January 2021 visit to Mowlem Ridge, many plants of *Lomatia fraseri* were in flower and, on a still, sunny morning, were noticeably fragrant. Visitors to the flowers, observed over a 30-minute period, included honey bees (*Apis mellifera*), buff-tailed bumblebees (*Bombus terrestris*), click beetles (Elateridae), weevils (*Rhopalomerus* sp.), dance flies (*Phyllodromia flexura*) and a large black hunting wasp (*Priocnemis monachus*).

Fig. 5 A, *Lomatia ilicifolia* self-sown seedling from Christchurch Botanic Gardens (*Barwick s.n.*, CHR 567253); B, the earliest voucher of a wild plant of *L. fraseri* in New Zealand, collected in 2010 from 'Wainuiomata Water Catchment' (*Dalton s.n.*, CHR 614064) (photos: Manaaki Whenua – Landcare Research, CC BY 4.0).

Discussion

Identification

We believe that Wainuiomata (and Port Hills) plants are best identified as *Lomatia fraseri*. We nevertheless acknowledge a degree of uncertainty, because (1) not all individuals have hairy leaf undersides or hairy tepals; and (2) the species boundaries among Australian *Lomatia* are not clear, as emphasised in the literature (Wilson et al. 1995; Milner et al. 2013; McIntosh et al. 2014; Harden 2020). The last point means little would be achieved by genetically testing New Zealand plants to verify their identity, given currently available data from Australia. Moreover, it is possible that the plants introduced to New Zealand were derived from a hybrid swarm. In any case, in the words of Daniel Ohlsen, Flora Botanist at the Royal Botanic Gardens Victoria, on seeing pictures of plants from Mowlem Ridge: 'If it was in Victoria I would have instantly recognised it as *L. fraseri*' (pers. comm., August 2019).

During our investigations, we learnt of a third species of *Lomatia* self-sowing in New Zealand. *Lomatia myricoides*, or river lomatia, was recorded by Tim Park in a suburban setting in Belmont, Lower Hutt, with a few self-sown seedlings (iNaturalist observations 45053968 and 45053928) and saplings (iNaturalist observation 66458772) near a cultivated adult (iNaturalist observation 44357297; *Park s.n.*, May 2020, AK 381467, CHR 658268, WELT SP109009). This species consequently should have a Casual status in New Zealand. Like *L. ilicifolia*, *L. myricoides* has glabrous leaf undersides, but while *L. ilicifolia* has broader, ovate leaves compared to *L. fraseri*, *L. myricoides* has narrower, linear leaves.

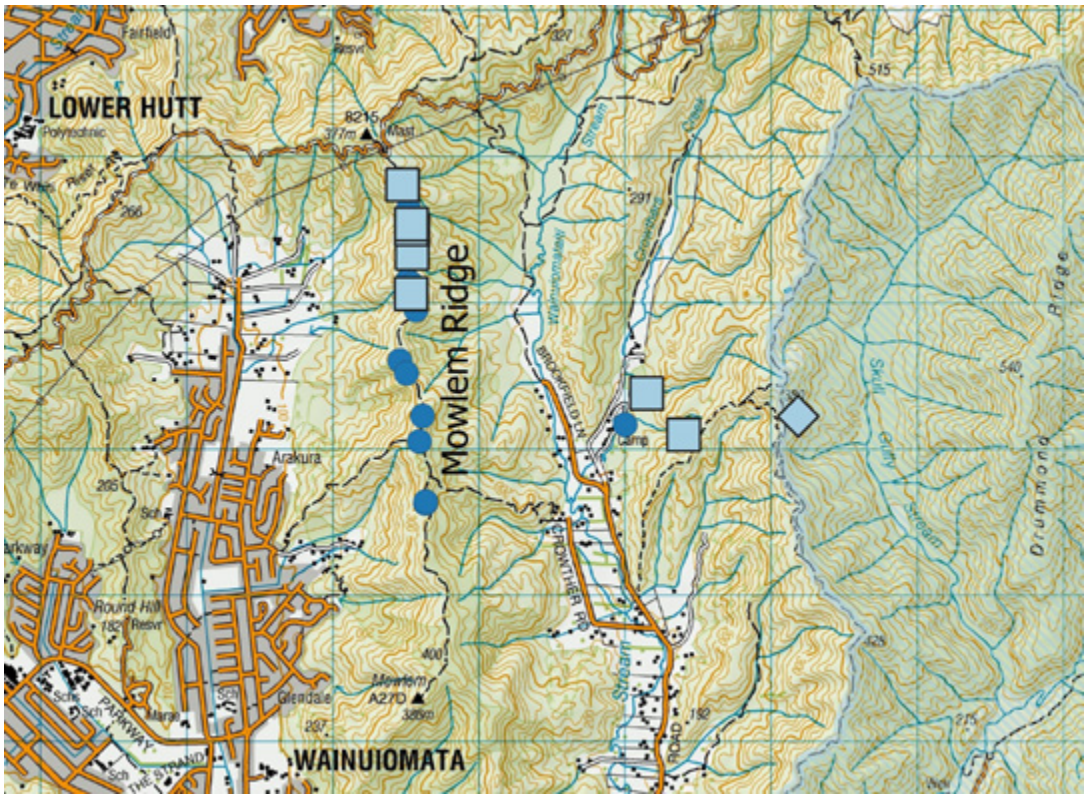

Fig. 6 Distribution of *Lomatia fraseri* in the Wainuiomata area. Blue squares are herbarium specimens in WELT. Blue circles are verifiable observations on iNaturalist made by us. The blue diamond is the herbarium specimen CHR 614064 from 'Wainuiomata Water Catchment'. We have conservatively mapped the specimen at the western boundary of the Wainuiomata/Orongorongo Water Collection Area (shaded blue in the eastern part of the map), but it is likely from further east. The base map is Topo50 BQ32 (LINZ CC BY), with a kilometre grid. The label 'Mowlem Ridge' is our addition.

Distribution and ecology

As indicated by Fig. 6, *Lomatia fraseri* occurs fairly widely near Wainuiomata, and as shown in Fig. 7, it is also intensively established at some sites on Mowlem Ridge. It clearly passes the threshold for the Naturalised category of Heenan et al. (2004). McAlpine (2020) wrote, 'There are approximately 10,000 plants covering 2.4 km of fire break. About 860 m of track is heavily infested with at least 10 plants per linear metre.' We noted (e.g. in the collection details of *Perrie 8210 & Shepherd*) during our August 2019 visit: 'Thousands of plants, with >100 fruiting. Seedlings abundant.' During our September 2020 visit, along 10 m of track and extending up to 10 m on either side, we counted 510 plants, with all except the three larger individuals removed by two people in 20 minutes.

The Mowlem Ridge population occurs along a ridgeline firebreak used as a vehicle track. The vegetation is principally mānuka (*Leptospermum scoparium* J.R.Forst. & G.Forst.), with kānuka (*Kunzea robusta* de Lange & Toelken), gorse (*Ulex europaeus* L.) and tree heath (*Erica arborea* L.), along with scattered kāmahi (*Weinmannia racemosa* L.f.) and rewarewa (*Knightia excelsa*). McAlpine (2020) recorded that 'The oldest plant sampled was between 14–17 years so the species has had time to spread. It does not seem to have spread into the regenerating native forest (mainly Manuka), largely dispersing along the fire break.' We noted (e.g. *Perrie 8210 & Shepherd*) that it was 'Mostly on track margins, but extending under manuka–kanuka in at least some places.' We found seedlings up to 10 m from the track, sometimes under relatively heavy shade. However, the adults (*Perrie 8885 et al.*) seen in regenerating scrub near the valley floor at Brookfield Camp were about 1.5 km from the Mowlem Ridge population, while we also found a (single) seedling under closed regenerating forest on the opposite hillside, about 1.8 km from Mowlem Ridge (*Perrie 8886 et al.*). Still further east is the *Dalton s.n.* collection, made in 2010 from somewhere in the 'Wainuiomata Water Catchment', at which point only a 'Single stem [was] located in bush reserve'. The western boundary of the Wainuiomata/Orongorongo Water Collection Area is about 2.5 km from the top of Mowlem Ridge, but this imprecisely located collection was likely from even further east. We have not searched for *Lomatia fraseri* within the Wainuiomata/Orongorongo Water Collection Area.

Fig. 7 *Lomatia fraseri* is intensively established in some places on Mowlem Ridge, near Wainuiomata, with many adults, and numerous saplings and seedlings (photos: Leon Perrie).

McAlpine (2020) suspected that *Lomatia fraseri* was introduced to Mowlem Ridge 'via machinery clearing the fire break'. Whatever the ultimate source of the Mowlem Ridge population, *L. fraseri* has clearly been cultivated in New Zealand, as far apart at least as the Wellington and Christchurch areas; it is now self-sowing in both. Murray Dawson, a member of the National Executive of the Royal New Zealand Institute of Horticulture, has confirmed that '*Lomatia fraseri* has been sold at nurseries in the past' (pers. comm., 4 November 2019). More broadly, *Lomatia* has a long history of cultivation in New Zealand, with Mason (1896) recording the cultivation of *L. milnerae* Olde (as its synonym *L. fraxinifolia* Benth. nom. illeg.), *L. myricoides* (as its synonym *L. longifolia* R.Br. nom. illeg.; with a height of '15ft.'), *L. silaifolia*, and the South American *L. ferruginea* (Cav.) R.Br. in a Hutt Valley garden. A fifth listed species,

L. bidwillii R.Hogg, is now placed in the unrelated genus *Akania* Hook.f. as *A. bidwillii* (R.Hogg) Mabb. The plant catalogues of Duncan & Davies,[6] one of New Zealand's largest nurseries, include *L. ilicifolia* (earliest mention 1927), *L. silaifolia* (1940s), *L. tinctoria* (Labill.) R.Br. (1952), *L. myricoides* (as *L. longifolia*; 1956 only), and *L. ferruginea* (1971), but seemingly not *L. fraseri*.

Lomatia fraseri has winged seeds (Fig. 8), which aid wind dispersal and would seem a boon given Wellington's weather. The seeds are similar to those of the related *Hakea*, some species of which have become widely established as problematic environmental weeds in the northern North Island and the northernmost South Island. While *L. fraseri* seems to grow mostly on the track margins at Mowlem Ridge, the seedling at Brookfield shows that not only can the species establish at distant sites (perhaps at least 1.8 km), but it can also do so under closed canopies (albeit in regenerating forest). It may be noteworthy that *L. fraseri* has not been found on the ridge to the north and west of Mowlem Ridge; there, the regenerating forest contains more māhoe (*Melicytus ramiflorus* J.R.Forst. & G.Forst.) and māpou (*Myrsine australis* (A.Rich.) Allan, along with gorse. This may be chance, it may reflect the region's predominantly northerly winds or it may be that *L. fraseri* has a preference for *Leptospermum* forest. In any case, there are still plenty of *Leptospermum*-dominated areas in the Wellington region and neighbouring areas, and indeed throughout New Zealand. In eastern Australia, indigenous populations of *L. fraseri* range from nearly 28ºS to around 39ºS. *Lomatia fraseri* has also naturalised in Tasmania (Fern Tree Bushcare 2018; Baker et al. 2019), near Hobart at about 43ºS. This latitude range of the Australian distribution encompasses all of New Zealand's North Island and the northern third or so of the South Island, while the documented self-sowing of *L. fraseri* near Christchurch is even further south (43.6ºS). This suggests that *L. fraseri* may have the capacity to establish itself throughout much of New Zealand.

Control of *Lomatia fraseri*

Responsibility for managing *Lomatia fraseri* in the Wellington region appears to rest primarily with the GWRC. McAlpine (2020) wrote: '[GWRC's] recent awareness of the spread of [*L. fraseri*] locally has created a healthy discussion around the policy and protocols we should follow when a newly recorded naturalised plant is found in our region.' GWRC (2020a), in its *Operational Plan Report 2019/20* against the Regional Pest Management Plan 2019–2039, wrote: 'GW will control this species in KNEs [key native ecosystems]

Fig. 8 Four follicles of *Lomatia fraseri*. The second from right in the main image is open, showing several seeds. The inset at bottom left shows two winged seeds; the scale bar is 1 cm (photos: Leon Perrie).

if it is found and is a priority, but beyond that we are not currently planning to take any other action.' This mirrors an email to the first author from Katrina Merrifield, Biosecurity Advisor at GWRC: 'we would control *Lomatia* if it is found in KNEs and other significant areas we work in, but currently it appears to be an invader of disturbed areas, and we can't justify controlling it in such areas unless there is evidence (or research available) that does present an invasion threat to established native areas. Unfortunately, I've struggled to find any relevant research' (pers. comm., 6 July 2020; quoted here with permission). KNEs are those ecosystems identified by GWRC as representing 'the best and most threatened examples of our native ecosystems. In these top priority areas we work to protect native plants and animals' (GWRC 2020b). While Mowlem Ridge is not a KNE, the Wainuiomata/Orongorongo Water Collection Area (within which *L. fraseri* has already been collected), Hayward Scenic Reserve and East Harbour Northern Forest are, and all are within 4 km of the local *L. fraseri* population.

Our summary of the GWRC position is that even after having seen and documented the infestation of *Lomatia fraseri* at Mowlem Ridge (and with consequent knowledge of its potential weediness), the council is not controlling it because weedy regenerating forest is not sufficiently valued among competing priorities and limited budgets. It may be that *L. fraseri* will be limited in New Zealand to regenerating forest (currently unknown, but it is not in Australia), and weeds of regenerating forest are eventually smothered by succession, which lowers their prioritisation for control (Hulme 2020). However, not only is that both a gamble on the ecology of *L. fraseri* in New Zealand and a discounting of the natural values of regenerating indigenous forest, but it also ignores the potential impact on the currently lucrative mānuka honey industry where, at the least, *L. fraseri* could occupy space otherwise taken by mānuka.

Our experience suggests that *Lomatia fraseri* would be relatively easy to control, given that two people removed some 500 plants in 20 minutes (although admittedly this was only along 10 m of trackside). Seedlings and saplings are easily pulled out by hand, leaving bigger plants to be cut and poisoned (see also Fern Tree Bushcare (2018)). An offer to GWRC of volunteer assistance from the Wellington Botanical Society has not been taken up, possibly because of ambiguity over land tenure. A caveat for anyone weeding *L. fraseri* is the similarity of its seedlings to those of rewarewa (Fig. 9). The leaves of rewarewa seedlings are narrower, have more and smaller marginal teeth, and are usually yellower when compared side by side with those of *L. fraseri* and have a darker midrib.

Fig. 9 The seedlings of *Lomatia fraseri* and *Knightia excelsa* are superficially similar and occur together on Mowlem Ridge. A, the bigger seedling at centre is *L. fraseri*, with a seedling of *K. excelsa* at right of centre; B, a seedling of *K. excelsa* (photos: Leon Perrie).

Implications

One of the key strategic directions of the *Biosecurity 2025: direction statement* by the Ministry for Primary Industries (MPI 2016) was 'A biosecurity team of 4.7 million', the then population of New Zealand. While *Lomatia fraseri* was first found by a member of the public, it is nevertheless remarkable that it went undetected for so long, to the point of establishing such a dense infestation on Mowlem Ridge. *Lomatia fraseri* is not a microbe, insect or herb, but a tree. Its adult leaves are utterly distinctive, at least among the plants of the Wellington region. Its follicles (present on adults throughout the year) and white flowers (present during summer) also make it unmissable. The Mowlem Ridge population is not in a remote part of the country, but neighbours the nation's capital city and lies above a major suburb and less than 20 km from the seat of central government. The firebreak on Mowlem Ridge may not be among the most popular tracks in the area, but it is frequented often enough to make it passable for four-wheel-drive vehicles. Consequently, this *L. fraseri* infestation must call into question the effectiveness of New Zealand's biosecurity surveillance. What degree of reliance should be placed on the general public to detect new weeds around New Zealand, and should governmental agencies be doing more?

Moreover, the extent to which the will and resources exist to actively manage newly established exotic species when they are detected is open to question. One of the reasons we have documented *Lomatia fraseri* in such detail here is to allow future generations to better evaluate how the New Zealand of 2021 dealt with this incursion. We believe that the presence of *L. fraseri* on and around Wainuiomata's Mowlem Ridge has clearly demonstrated the species' ability to both intensively invade a New Zealand site and to spread to new sites. Based on this and its Australian distribution, we suggest there is a strong likelihood that *L. fraseri* will, if left unchecked, spread widely throughout New Zealand and become a prominent part of (regenerating) forests in at least some areas. While acknowledging the uncertainties, biases and difficulties (including limited resourcing) of controlling plant invasions as outlined by Hulme (2020), it is also clear that 'Weed management is most cost-effective at the early stages of weed invasion' (Sheppard et al. 2016). In 50–100 years' time, we hope that we, the authors of this paper, are judged to have suffered from 'intervention bias', i.e. the desire to do something (Hulme 2020). However, with regard to *L. fraseri*, we fear that by leaving yet another exotic species to establish itself in New Zealand, we (the New Zealand of 2021) will be shown to have been negligent in our kaitiakitanga of the taonga that are the indigenous plants, animals, fungi and other biota of Aotearoa.

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Notes

1 Australasian Virtual Herbarium, https://avh.ala.org.au, retrieved in August 2019 and December 2020.

2 iNaturalist, https://inaturalist.nz, retrieved in August 2019 and December 2020.

3 Retrieved during 2020 from http://qgis.osgeo.org.

4 Retrieved on 11 January 2021 from https://data.linz.govt.nz.

5 Retrieved in August 2019 from https://nzflora.landcareresearch.co.nz.

6 Retrieved on 6 January 2021 from http://www.rnzih.org.nz/pages/nurserycatalogues.html.

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