Assessment of Vegetation Effects: Maungarei exotic tree removal consent application

[redacted].

Contents

Contents

Introduction

This report:

1. assesses the ecological values of current vegetation on Maungarei (Mt Wellington)
2. assesses potential effects on these ecological values from proposed removal of exotic trees from this site
3. recommends mitigation measures that will allow potential negative effects on ecological values to be avoided, remedied or mitigated.

Proposed project - overview

The applicant is applying to control approximately 180 exotic trees over 3m in height within Maungarei. The approximate species break down of the trees proposed for removal is:

66	***Pinus radiata***
2	***Cupressus macrocarpa***
21	***Eucalyptus* sp.**
61	***Fraxinus excelsior*- european ash**
20	***Quercus rubra***
10	***Poplar deltoides***

These species are all exotic; no removal of mature native trees is proposed.

None of the species proposed for removal have legal status as pest plants under the operative Auckland Regional Pest Management Strategy 2007-2012.

The location of trees to be removed is shown in figure 1, below. Note that this groups trees together in order to fit all the data on one map.

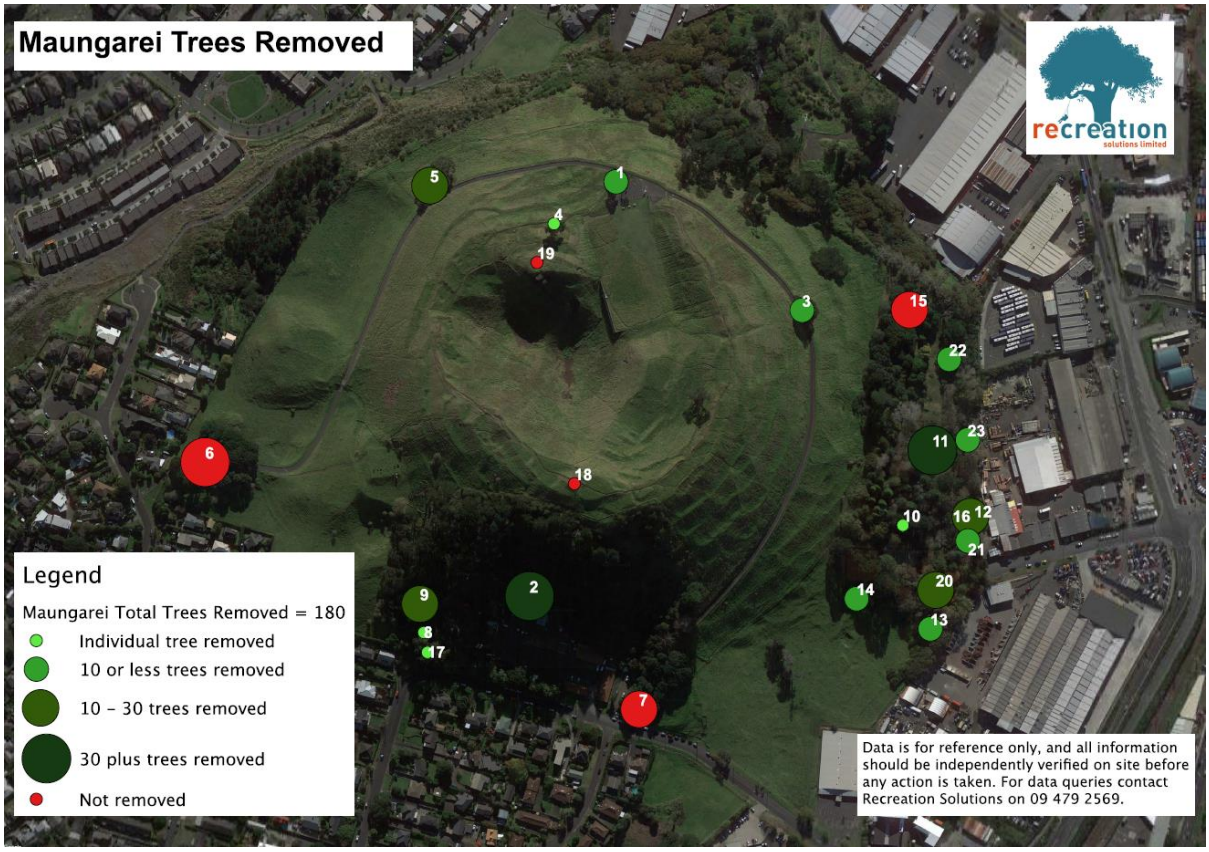


Figure 1: Location of areas trees are proposed for removal

Scope of this report

Ecological values considered relevant to this application include biodiversity values (indigenous genetic and ecosystem type diversity) and site-specific ecosystem services (erosion control).

This report excludes assessment of:

- cultural values (for example, of the native species within the urupa site)
- historic values (for example, of memorial trees within the Winifred Huggins memorial grove)
- landscape values (for example, the visual value of the exotic trees proposed for removal).

Methodology

The ecological value of the trees proposed for removal were assessed through a combination of site visits, review of available literature, review of past vegetation on this site, and site reports relating to threatened species.

Five main areas were identified and assessed:

1. Isolated exotic trees in kikuyu-dominated grassland

2. Winifred Huggins Memorial Grove
3. The native planted area contiguous with Winifred Huggins Memorial Grove
4. The quarry slope above the depot
5. Locations where populations of threatened species are extant or recently known to be present

Site background

Maungarei / Mt Wellington is a volcanic cone in the Auckland volcanic field. The application site is approximately 26.7ha and located on the Auckland isthmus centred between the suburbs of Mt Wellington, Stonefields, Glen Innes, Tamaki and Panmure (see figure 2, below). This part of the volcanic cone was returned to Maori in a 2014 Treaty settlement and is governed by the Tūpuna Maunga Authority under a co-governance arrangement legislated under the Ngā Mana Whenua o Tāmaki Makaurau Collective Redress Act 2014.

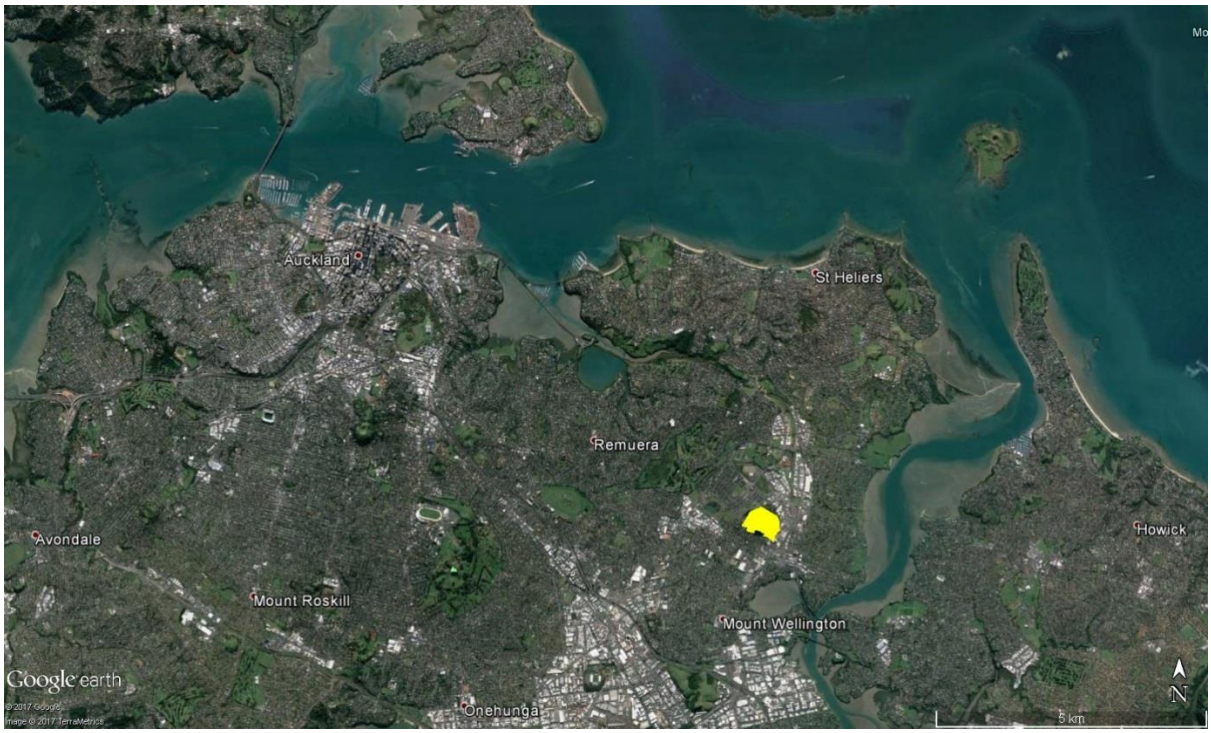


Figure 2: Maungarei – application site location (in yellow)

Maungarei / Mt Wellington has a Significant Ecological Area (site reference SEA_T_5244) over the entire site due to meeting criteria 2b (Threatened species) and 2e (Rare species).

Vegetation composition on Maungarei (Mt Wellington) over time

Pre-human vegetation cover

Work by Singer *et al*[1] indicates that much of the Auckland isthmus, including Maungarei (the application site), would originally have been covered in what is defined as the WF7 Puriri forest ecosystem type[2].

The entire "WF7 Puriri Forest" is one of the almost 40% of Auckland ecosystems that has a regional IUCN threat status of "critically endangered" [3], with some sub-habitats of this ecosystem type, specifically 'rock forest' being even rarer[4].

The WF7 Pūriri Forest is not entirely consistent with pollen cores from the period immediately prior to Māori settlement of these sites analysed by Horrocks *et al*[5] who, among other things, found a high proportion of *Metrosideros* pollen in samples from this period (see Appendix 1). WF7 is, however, sufficiently variable that the vegetation broadly fits this category.

Vegetation changes during Māori occupation

The volcanic cones of the Auckland isthmus were arguably some of the earliest areas settled by Polynesian arrivals and early Māori and have a long history of vegetation and landform modification.

Pollen core assessment on Te Kōpuke by Horrocks *et al* notes that a dramatic increase in the pollen of *Coriaria* (tutu), *Pteridium* (bracken fern) and *Taraxacum* (a native dandelion-like species) could be used to indicate approximately when Polynesians arrivals / early Maori settled the volcanic cones. Pollen from larger tree species remains during this period, although the fact that the three indicator species are sufficiently light-demanding that they are not able to exist under an intact canopy means that there must have been sufficient removal of canopy tree species to at least create light gaps.

Horrocks *et al* note that, on Te Kōpuke, the marked increase of these indicator species occurred around 800 years ago. Horrocks *et al* note that anomalies in the

---

[1] p.8 of Singers, N.; Osbourne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Webb, C. (2017) Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

[2] Electronic maps of potential / naturally occurring ecosystem types in the Auckland Region are publically available on GeoMaps under Environment theme: Biodiversity / Ecosystems Potential Extent.

[3] p.12 & 22 of Singers, N.; Osbourne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Webb, C. (2017) Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

[4] *Personal communication*, Miranda Bennett, Senior Biodiversity Advisor, Auckland Council, 4-Aug-17.

[5] M. Horrocks , S. L. Nichol , D. M. D'Costa , P. Shane & C. Prior (2005) Palaeoenvironment and human impact in modifying vegetation at Mt St John, Auckland Isthmus, New Zealand, New Zealand Journal of Botany, 43:1, 211-221, DOI: 10.1080/0028825X.2005.9512951

pollen cores may mean that these sites were actually settled later, and that pollen indicating early Polynesian settlement was mixed into lower layers due to agricultural practices in the crater. Due to the strategic importance of high points to early Maori, however, it seems likely that Te Kōpuke (and other volcanic cones) were settled early on and that land use practices, and therefore vegetation modification and clearance, was different in the earlier Maori societies on these sites compared to more recent times. Settlement of Te Kōpuke probably occurred around a similar time to settlement of Maungarei, and vegetation on volcanic cone sites, including Maungarei, has been subject to anthropogenic modification from that time.

Horrocks *et al* note that ash increases more during more recent periods of Māori occupation, indicating either less early clearance or that early vegetation clearance may have been more from felling trees of rather than burning larger areas of forest. This indicates there early Māori occupants may have had different land use practices, and therefore influences on vegetation cover, compared to later Māori occupants. Increased vegetation clearance via burning during later periods of Māori occupation of maunga would be consistent with an increased land area used for kumara production, as well as a greater need to use maunga for defensive purposes as the population of the Tāmaki Makaurau isthmus grew and pressure on available natural resources increased.

Vegetation changes during early European occupation

Modification of vegetation continued after European settlement as species that were dominant during Māori settlement were replaced by European pasture species.

Horrocks *et al* notes the introduction of large quantities of *Pinus* pollen as being a geological indicator of European settlement.

Pines and exotic grass species were also introduced to Maungarei, with existing pines being either planted or wilding from the large pine plantation that was established on the quarry slope, undoubtedly with the primary aim of trying to stabilise this artificially steep slope that resulted from industrial scale European quarrying activities.

European farming and land use practices also resulted in the introduction of invasive exotic woody species, such as hawthorn and Cape honeysuckle, for hedging, land stabilisation and ornamental purposes. A number of these species are now included in the operative Auckland Regional Pest Management Strategy 2007-2012 and managed as invasive species under the Biosecurity Act 1991.

Vegetation on Maungarei today

Current vegetation cover on Maungarei/Mt Wellington is dominated by exotic grassland with some patches of woodland areas dominated by exotic species (see Figure 3[6], below).

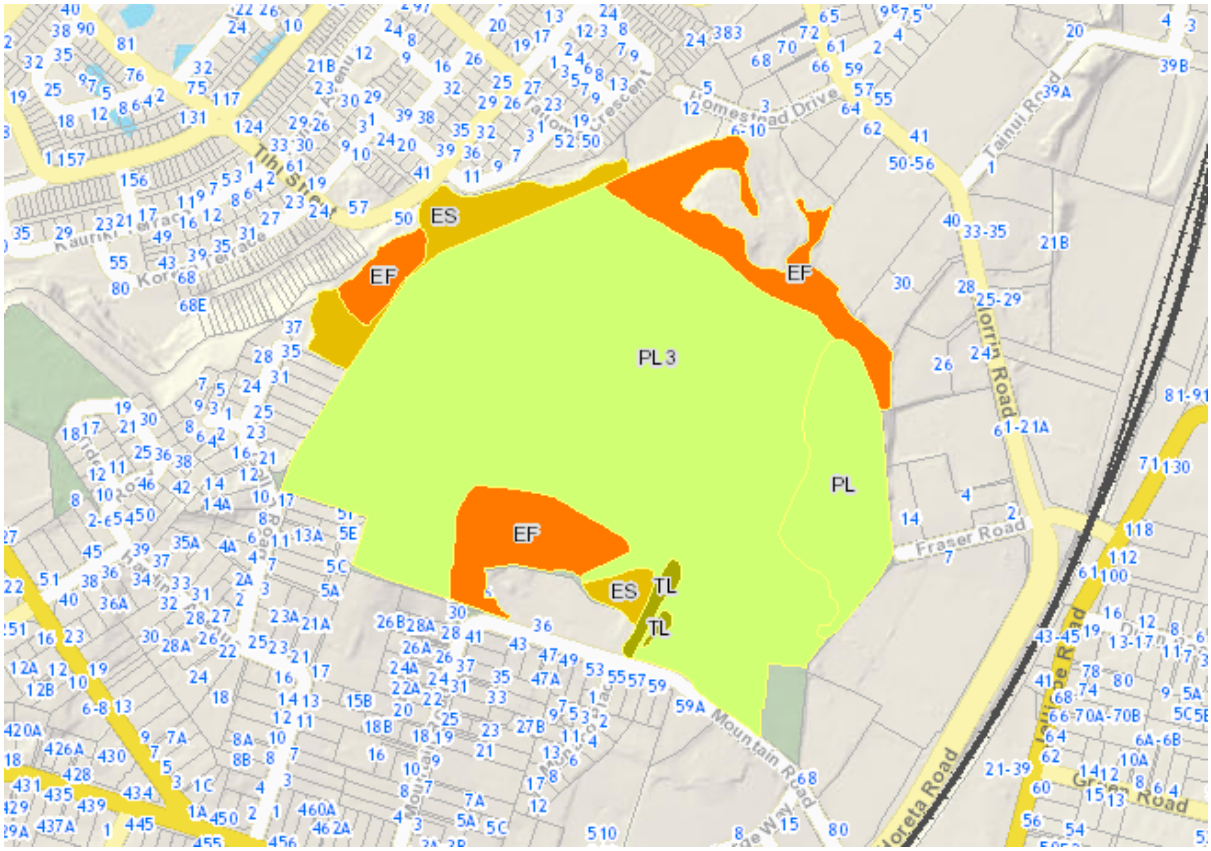


Figure 3: Current vegetation on Maungarei is highly modified and dominated by pasture (PL3), exotic forest (EF) and exotic scrub (ES) habitat types.

While there are is still some remaining native vegetation remnants on Maungarei / Mt Wellington and other volcanic cone sites, these are highly modified due to fragmentation and disruption in regeneration processes due to reduced seed sources and seed distribution, as well as predation of any remaining seed source that is available.

Vegetation cover over the majority of Maungarei / Mt Wellington is dominated by exotic kikuyu (*Pennisetum clandestinum)* grass.

Isolated pines and macrocarpa are present in kikuyu areas of Maungarei / Mt Wellington. The majority of trees on this site, however, are contained within the entranceway and exit areas, Winifred Huggins Memorial Grove, and the quarry slope on the southern face of Maungarei / Mt Wellington.

[6] Mapping of current vegetation cover in the Auckland Region can be found on the publically available Auckland Council GeoMaps under the biodiversity layer.

Winifred Huggins Woodland is *"…an area of 2ha established in exotic trees by the Auckland Tree Society in 1969…."* within which *"...volunteers planted several hundred exotic trees to create an 'English woodland', complete with bluebells."*[7]

Wilcox notes that a native tree plantation was established adjacent Winifred Huggins from 1972 by horticulturalist Arthur Farnell, with assistance from Rotary, local schools and Mr Bert Henham. Around 600 native trees were planted, of which "…totara has grown best."[8] This is consistent with Maungawhau, where totara has also been very successful[9].

While some individual trees will be removed from the Winifred Huggins Memorial Grove, primarily for reasons of safety and tree health, most the Winifred Huggins stand will be retained. No removal of native trees in the contiguous native planting area is proposed.

Three species of threatened plants have been located on Maungarei; *Anogramma leptinella*, *Pallaea falcata* (including *P. falcata x P. rotundifolia* hybrid), and *Geranium retrorsum*. The exact location of these species on Maungarei is not discussed in this publically available document to avoid potential risk of plant theft. If exact locations are required, please contact staff in the Tūpuna Maunga team at Auckland Council. The majority of sites are located within the main kikuyu-dominated area on Maungarei / Mt Wellington and are unlikely to be directly affected by the proposed tree removal works, although potential indirect effects are also discussed. Of most interest are three sites of *Anogramma leptinella* at the top of the quarry slope area. Potential effects on these populations, and potential mitigation for these, are discussed.

The long history of human settlement and modification of the volcanic cones on the Auckland isthmus, coupled with their natural rarity, means that there are no sites, including Maungarei, where original vegetation cover of the type that would naturally be present on volcanic cones exists. Whatever vegetation assemblages and ecosystem types that used to exist on the mainland isthmus volcanic cones within the Auckland volcanic field are now extinct; the ancestors who originally settled the Tūpuna Maunga of Tāmaki Makaurau would have experienced a vastly different environment in terms of both vegetation species and associated fauna to the one that existed even by the time of later Māori occupation, and certainly in comparison to the vegetation that exists today.

[7] Page 152 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[8] Page 153 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[9] *Personal communication*, Sel Arbuckle (Friends of Maungawhau volunteer), August 2017.

Assessment of environmental effects

Four main areas were identified and assessed:

1. Isolated exotic trees in kikuyu-dominated grass land
2. Winifred Huggins Memorial Grove
3. The native planted area contiguous with Winifred Huggins Memorial Grove
4. Entranceways
5. The quarry slope above the depot
6. Locations where populations of threatened species are extant or recently known to be present

Pasture dominated areas

Maungarei / Mt Wellington is dominated by grassland with isolated exotic trees.

All exotic trees in grassland areas will be removed to enhance traditional Maori cultural values associated with fortified pa sites, including the historic view lines that were maintained for strategic defensive purposes during latter periods of pre-European occupation of Maungarei / Mt Wellington by Maori, particularly around the tihi.

The isolated exotic trees are primarily pine, with some macrocarpa. Both species have been widely planted in New Zealand since European arrival; the sudden appearance of large quantities of pine pollen can be used as a geological marker for the arrival of European settlers in New Zealand[10]. Isolated specimens of pine and macrocarpa, such as exist in the kikuyu-dominated pasture on Maungarei / Mt Wellington, arguably have low ecological value.

Kikuyu has naturalised in New Zealand from East Africa. Originally introduced as a pasture plant, it was initially thought not to seed, but rather to spread only vegetatively. While vegetative spread of kikuyu is highly effective, spread by seed also occurs widely.

Kikuyu is described by Edgar and Connor[11] as:

> *"A troublesome weed in high rainfall areas in many warm countries….*
>
> *This strongly creeping grass can form swards over several hectares in area and is difficult to eradicate. Because shading does not stop its growth, it can grow up through hedges and bushes, eventually shading them to extinction. Where kikuyu grass grows in open scrubland or on forest margins the seedlings of native trees and shrubs have very little chance of establishment."*

[10] M. Horrocks , S. L. Nichol , D. M. D'Costa , P. Shane & C. Prior (2005) Palaeoenvironment and human impact in modifying vegetation at Mt St John, Auckland Isthmus, New Zealand, New Zealand Journal of Botany, 43:1, 211-221, DOI: 10.1080/0028825X.2005.9512951

[11] Pp.574-575 of Edgar, E. and Connor H.E. (2000) *Flora of New Zealand, Volume V, Gramineae.* Manaaki Whenua Press, Lincoln, New Zealand.

Both the isolated exotic trees and rank kikuyu grass have low ecological value and it is not anticipated that removal of isolated exotic trees will have a significant positive or negative effect on any residual ecological values that exist in these areas.

Winifred Huggins Memorial Grove

Winifred Huggins Woodland is *"…an area of 2ha established in exotic trees by the Auckland Tree Society in 1969…."* within which *"...volunteers planted several hundred exotic trees to create an 'English woodland', complete with bluebells."*[12]

Wilcox notes that:

> *"Auckland's surviving volcanic cones … have prominent grassy slopes, and usually numerous planted trees, both scattered and in groves. There is hardly any natural vegetation on the cones or associated lava flows and tuff beds, save for small rock forest remnants on the lower slopes of Mt Eden, in Gribblehirst Park, and on the North Shore at Lake Pupuke and Onepoto Basin…. Collectively, the volcanic parks are treasured for recreation, provide splendid viewpoints and are a very significant part of the planted urban forest."*[13]

Wilcox identifies the Winifred Huggins Woodland[14] as being a significant urban forest features on Maungarei / Mt Wellington.

It is proposed to remove only a small proportion of the memorial trees within Winifred Huggins Memorial Grove. There is not considered to be any significant negative ecological impacts from the removal of a proportion of exotic trees from this area.

Native planting area contiguous with Winifred Huggins Grove

Native vegetation remnants within Auckland's urban area *"…are a much-valued component of the urban forest, often having high plant biodiversity and birdlife, providing protection of stream courses, and containing a good representation of the native forest types and tree species of the region."*[15]

Despite the presence of some native species on Maungarei/Mt Wellington, however, Wilcox has not included this site as containing a significant native bush remnant[16]. Indeed, Wilcox notes only one native bush remnant in the whole of the Maungakiekie-Tamaki Local Board area[17], indicating an unrepresentatively depauperate native flora within the Maungakiekie-Tamaki Local Board area in general.

---

[12] Page 152 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[13] Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[14] Page 96 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[15] Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[16] Page 96 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[17] A 0.1ha area containing mainly karaka, pūriri and totara located in One Tree Hill Domain

No native trees are proposed for removal on Maungarei / Mt Wellington.

Entranceways
Wilcox notes that:

> *"To commemorate the opening of the Maungarei Memorial Drive, an area of 0.6 ha immediately through the entrance gates and on each side of the drive was set aside for the planting of memorial trees. Local people and organisations were invited to plant trees to commemorate their links with the district, and suitably inscribed plaques were placed beside each tree. The first of 30 trees were planted in August 1972 with subsequent plantings in 1975, 1978 and 1980. The trees are mostly pohutukawa and Kermadec pohutukawa, which in 40 years have grown to a height of just 7-12 m."*[18]

No removal of native trees, including the Kermadec pohutukawa which are not ecosourced to this part of New Zealand, is proposed on Maungarei / Mt Wellington.

Quarry slope above the depot
The majority of the pines proposed for removal are located on the old quarry slope, where a stand of Monterey pine was planted in the 1940s[19]. Wilcox identifies this stand as being a significant urban forest feature on Maungarei / Mt Wellington[20].

The current vegetation on the quarry slope consists primarily of a pine canopy with an understorey dominated by Chinese privet and *Cotoneaster* with scattered woolly nightshade and other weed species. Native species are present, but less common than exotic species, with the most commonly occurring native species being large leaved *Coprosma* species. In some areas ground cover includes areas of hounds tongue fern (*Microsorum pustulatum* ssp *pustulatum*), but is largely dominated by exotic species.

The primary ecological value of this vegetation is preventing mass erosion of the unstable quarry slope. It is therefore proposed to stage pine removal and revegetate this area with native vegetation that approximately restores a WF7 Pūriri broadleaf ecosystem (see Appendix 3 for further details).

The WF7 Pūriri broadleaf ecosystem is classified as "critically endangered habitat type under IUCN criteria[21]. In addition, WF7 Pūriri broadleaf ecosystems are highly variable and the species assemblages that used to be found on volcanic cones may be rarer still (see further discussion in Appendix 2).

---

[18] Pages 153-154 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[19] Page 154 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[20] Page 74 of Wilcox, M.D. (2012) *Auckland's Remarkable Urban Forest.* Auckland Botanical Society.
[21] Singers, N.; Osbourne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Webb, C. (2017) Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

Replacing the exotic-dominated Monterey pines, along with the privet / *Cotoneaster*-dominated understorey, on the quarry slope with native vegetation that broadly reinstates a critically endangered WF7 Pūriri broadleaf forest ecosystem would arguably result in a strongly significant positive net ecological benefit on this site. This is particularly the case in the context of the dis-representative lack of native forest remnants, particularly native forest remnants of high ecological quality, within the Maungakiekie-Tamaki Local Board area.

Threatened plants

Maungarei / Mt Wellington has a Significant Ecological Area (site reference SEA_T_5244) over the entire site due to meeting criteria 2b (Threatened species) and 2e (Rare species). Threatened species on site are listed as *Anogramma leptophylla*, *Pallaea falcata* and *Senecio scaberulus*. Rare species are listed as *Pallaea calidirupium*, *Poa imbecilla* and *Senecio quadridentatus*.

Unfortunately, some of the species originally listed are not currently known to have extant populations on Maungarei / Mt Wellington.

A threatened plants survey on Maungarei / Mt Wellington in 2014 found this maunga holds the largest population of the nationally critical Anogramma leptophylla in New Zealand. 5 populations of *Anogramma leptophylla*, 1 population of *Geranium retrorsum*, 1 population of *Pellaea falcata x P. rotundifolia* and 2 populations of *Pellaea falcata* were also located.

There are no recent records of *Senecio scaberulus*, *Pallaea calidirupium*, *Poa imbecilla* or *Senecio quadridentatus.*

Of these, the most relevant is the *Senecio scaberulus,* which was classified in Nationally Critical in 2012[22]. Although previous staff investigations into this record[23] and a previous survey[24] did not pick this up, it will be searched for in future surveys in case it is still present.

It is possible that the *Pallaea calidirupium* was actually a hybrid of *Pellaea falcata x P. rotundifolia*, as the *Pallaea* are similar and this hybrid was not picked up in the literature-based SEA review. *Poa imbecilla* and *Senecio quadridentatus* were assessed as Not Threatened in 2012[25]. Any risk of negative impacts on these species from the proposed tree removals is therefore considered negligible.

The majority of known extant threatened plant sites on Maungarei / Mt Wellington are not in the vicinity of proposed tree removals. A map is not provided in this

[22] www.nzpcn.org.nz
[23] Personal communication with Janeen Collins, Senior Regional Advisor Flora, Biodiversity Team, Auckland Council on 18 September 2017 –investigations not written up yet.
[24] By Wildlands in 2014
[25] www.nzpcn.org.nz

publically available document for security of the sites, but may be requested from the Maunga Authority.

The sites that may be directly affected by the proposed tree removal include three sites of *Anogramma leptophylla* along the top of the quarry face and one *Anogramma leptopylla* site that near a small group of pines proposed for removal.

Anogramma leptophylla is a small species of fern. The highly specialised habitat requirements of this species means it is restricted to south- and east-facing sides of rocky outcrops where a “crust” of organic matter has developed. Maungarei contains populations of *Anogramma leptophylla* on six known locations within the maunga.

There is potential for significant negative direct impacts on three *Anogramma leptopylla* sites at the top of the quarry slope due to disturbance by workers on site during tree removal.

The potential for impacts on *Anogramma* due to disturbance during pine removal are mitigated to a large extent by the proposal to remove pines in the main area where extant populations of *Anogramma* are known to exist by helicopter (see figure 4, below).

Figure 4: Proposed removal methodologies, but area

Measures to avoid or mitigate for residual effect on *Anogramma* are discussed more fully in Appendix 1 and 3 and include:

- Surveying known areas of extant *Anogramma* populations prior to pine removal. (*Senecio scaberulus* should be searched for at the same time.)
- Briefing contractors to avoid *Anogramma* habitat (rock areas with crust substrate on which *Anogramma* can establish)
- Undertaking pine removal during summer, when *Anogramma* is largely dormant
- Removal of the majority of slash from the site, particularly in extant *Anogramma* areas.

With implementation of the proposed mitigation measures, it should be possible to avoid any potential negative effects on *Anogramma*.

Myrtaceae and general biosecurity

Myrtle rust was discovered in New Zealand within the last 12 months and is expected to be detected within the Auckland Region during summer 2017 – 2018.

Native Myrtaceae include species such as manuka (*Leptospermum*), kanuka (*Kunzea*), pohutukawa / rata (*Metrosideros*) and ramarama (*Lophomyrtus*). Based on MPI records of host species, ramarama and pohutukawa / rata seem particularly susceptible to myrtle rust.

Exotic Myrtaceae include species such as gum (*Eucalyptus*), monkey apple (*Acmena* and *Syzygium*), bottle brush (*Callistemon*), and guava (*Psidium*). The impact on exotic Myrtaceae is variable. Some gum species have been assessed by MPI as being susceptible to myrtle rust infection. Removal of exotic Myrtaceae species, such as gum, on Maungarei / Mt Wellington would remove a potential myrtle rust host on this site, and therefore may assist to slow spread to this site.

Equipment used to fell trees should be cleaned prior to use on site to avoid spreading pathogens, including potentially myrtle rust, to Maungarei / Mt Wellington via felling equipment. Contractors should also observe standard biosecurity hygiene practices (e.g., vehicles and tyres free of mud, mulch and other debris) used to manage spread of other pathogens, such as kauri dieback.

Other

Bats

Bats were not surveyed for as it was considered unlikely that either of the extant species of native bats are present on this site.

Although the site could theoretically contain long tailed bats (*Chalinolobus tuberculatus*), it is considered unlikely they are present. The nearest known populations of long tailed bats in urban areas are approximately 20km west of this

site in vegetated areas in urban park and woodland areas near the edge of the Waitakere Ranges. In addition, there is a limited range of tree specimens, both on the site and in surrounding areas, that large enough and sufficiently mature to provide cavities suitable for the maternity roosts that would be required for a resident local population of long tailed bats.

The forest remnants on this site are too small and provide insufficient intact native forest to allow for a viable population of short tailed bats (*Mystacina tuberculata*) on this site. This species is highly specialised and requires large tracts of intact native forest and is seldom recorded within 200m of the edge of forest tracts[26]. The bush areas on Maungarei / Mt Wellington are of insufficient size and quality to support short tailed bats.

Skinks and geckos

Skinks and geckos were also not surveyed for. Invasive plague (or rainbow) skinks (*Lampropholis delicata*) were observed in the kikuyu dominated areas and are therefore likely to have outcompeted most native skink and gecko species in these areas.

There is a possibility that there are some native reptile species in the pine block, as native skinks and geckos can out-compete rainbow skinks in intact native forest habitats. However, due to the modified nature of this site, it is considered unlikely that any significant native species are present.

It is proposed that pine removal is staged in this area, so any native skinks or geckos present would have the opportunity to repopulate areas that are being replanted in native vegetation prior to the next stage of the pine removal. In addition, removal in some areas is by helicopter, so should have lower impacts on any surviving native skink or gecko species in this area.

Invertebrates

Native invertebrate species were also not surveyed for. Again, the highly modified nature of this site means that it is considered unlikely that any significant species of native invertebrates are present here. In the event they are present, staged removal of the pines would allow native invertebrates to repopulate areas being revegetated in native species prior to the next stage of pine removal.

[26] Colin F. J. O'Donnell , Jennifer E. Christie & Warren Simpson (2006) Habitat use and nocturnal activity of lesser short-tailed bats (*Mystacina tuberculata*) in comparison with long-tailed bats (*Chalinolobus tuberculatus*) in temperate rainforest, New Zealand Journal of Zoology, 33:2, 113-124, DOI: 10.1080/03014223.2006.9518435

Conclusion

The proposed activity would have a positive impact on vegetation values at this site in terms of reducing the local seed source of exotic species.

With the exception of the removal of a large number of pines from the quarry slope, the negative effects of this project on ecological values of vegetation are considered to be less than minor.

With the proposed mitigation, however, the net negative effect of removing pines from the quarry slope is also considered less than minor, as replacing the pines with native species will arguably result in a net positive ecological benefit, both on Maungarei and within the Maungakiekie-Tamaki Local Board area, over the long term.

Restoration of critically endangered volcanic rock forest and extinct volcanic crater ecosystem types within the quarry slope area, as well as site management that prevented regeneration of exotic weed species and facilitated natural regeneration of native species within the urupa area / Winifred Huggins grove over the long term, would result in a strongly net positive effect on the vegetation values at this site, as well as regionally.

Appendix 1: The possibility that an ecosystem variety endemic to the rims and upper slopes of older volcanic cones, and currently extinct within the Auckland Region, may have previously existed on Tūpuna Maunga sites

Singer *et al*[27] state that in pre-human times:

> *"Pūriri forest would have supported a diverse range of invertebrates, amphibians, reptiles, birds and bats…. In some places, forest productivity would have been enhanced by the nutrients brought ashore by burrowing and surface-nesting seabirds…. Abundant fruit and nectar would have favoured species such as kākāpō, kākā, kererū, huia, saddleback, kōkako and piopio..., while nectivorous reptiles and birds would have benefited from an almost year-round nectar supply…. Insectivores would have included tuatara, skinks, geckos, small rails, snipe, owls, owlet-nightjar, wrens, robin, tomtit, whitehead, fantail, grey warbler, saddleback, huia, piopio and bats…. Large cavities in pūriri would have provided shelter, roosting and nesting sites for geckos, kākā, kākāriki, hihi, huia, saddleback and bats."*

With the exception of coastal areas, where WF11 Kauri, podocarp, broadleaf forest ecosystems dominated, much of the isthmus, including all the Tūpuna Maunga sites originally had a WF7 Pūriri forest type[28].

Analysis of pollen cores taken from the crater area of another Tūpuna Maunga volcanic cone within the Auckland isthmus, Te Kopuke, by Horrocks *et al*[29], however, appear somewhat inconsistent with the species assemblage we would expect from the WF7 forest that Singer *et al* have defined.

The most obvious inconsistency between a Singer *et al* WF7 ecosystem and the Horrocks *et al* pollen cores is a dominance of *Metrosideros* (pohutukawa and rata) and presence of other species unusual for WF7 species assemblage, including *Prumnopitys taxifolia* (matai), *Dacrycarpus* (kahikatea), *Dacrydium* (rimu), *Eleocarpus* (hinau) and *Prumnopitys ferruginea* (miro). While the presence of kahikatea on the Te Kopuke / Mt St John pollen cores can be explained by the presence of a crater wetland, the reason for the relative dominance of matai, miro and some other species is less obvious.

---

[27] p.22-23 of Singers, N.; Osbourne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Webb, C. (2017) Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

[28] Data available on GeoMaps / Environment layer / Biodiversity / Ecosystems Potential Extent.

[29] M. Horrocks , S. L. Nichol , D. M. D'Costa , P. Shane & C. Prior (2005) Palaeoenvironment and human impact in modifying vegetation at Mt St John, Auckland Isthmus, New Zealand, New Zealand Journal of Botany, 43:1, 211-221, DOI: 10.1080/0028825X.2005.9512951

In addition, *Vitex* (puriri) pollen, which we would expect to find more than trace quantities of within a WF7-type habitat, is only present in small quantities in the older pollen samples, although interestingly pūriri pollen increases slightly in the more recent sections of the pollen cores.

The Horrocks *et al* study of pollen cores from Te Kopuke is the only study like this we currently have of Tūpuna Maunga sites. This is mostly because preservation of pollen cores requires wetland conditions of the type not found within the crater of Maungarei and most other volcanic cones around Auckland. In addition, the high archaeological value of these sites makes it very difficult to gain permission to take pollen core samples from them. The Tūpuna Maunga sites, however, while each unique, are also similar in that they exist within the same habitat type, and could therefore be expected to have many features in common. This means the Horrocks *et al* study provides a valuable insight into vegetation changes on not only Te Kopuke, but volcanic cones in general, including Maungarei.

Horrocks *et al* note that the dominance of *Metrosideros* pollen may be at least partially due to the high pollen production of this species swamping the samples, and thus giving a distorted view of how abundant *Metrosideros* actually was on the site. The authors also note that the only evidence of the scale of deforestation they hypothesise “terracing would presumably have required” is indicated by the decline of *Dacrycarpus* (kahikatea) pollen during the period of early Māori settlement of Te Kopuke. Horrocks *et al* suggest this both supports their hypothesis that *Metrosideros* pollen not only swamped other pollen in their samples, but also masked early forest clearance.

An alternative explanation, however, is that there actually WAS a high proportion of *Metrosideros* around the crater areas, lower vegetation clearance than Horrocks *et al* appear to have assumed they would find during early Māori settlement of Te Kopuke (and other maunga), and that *Dacrycarpus* (kahikatea) were one of the first tree species to be cleared as Maori cleared the flat crater area first due to its fertile, flat soil and relatively sheltered position making it most suitable for cultivation.

The soil depths Horrocks *et al* suggest were within the period of Maori occupation of Tupuna Maunga, but prior to European settlement, are 33-10cm. Horrocks *et al* also note, however, that increased ash and sheet erosion within the soil depths 20cm or less. This also indicates that wider scale vegetation clearance may have only become more widespread during later periods of Maori occupation. If this is the case, one explanation is that lower populations in the period after Maori occupation of the Auckland isthmus would have meant a lower need for resource defence during earlier periods of Maori occupation of maunga. This would may have resulted in only the sheltered crater area (where the bulk of any kahikatea would have been located) being cleared during earlier periods of Maori occupation, rather than widespread

clearance of the entire tihi area. If so, this would explain both the lack of indication of early large scale clearance in pollen samples within early periods of settlement, and also the decline in kahikatea pollen being one of the first indicators of forest clearance.

With regard to the high levels of *Metrosideros* pollen: *Metrosideros* are known for their ability to tolerate steeper and more exposed slopes typically found on the upper slopes of volcanic cones, and may also tolerate regeneration interference caused by the burrowing seabirds that are likely to have used maunga as nesting sites. It would therefore make sense that, rather than the *Metrosideros* pollen being an anomalie in the data, it actually indicated that *Metrosideros* were originally a feature of the crater rims and upper areas of Auckland's volcanic cones.

Changes in land use (and vegetation clearance) over different periods of Māori occupation also wouldn't be out of the question as it seems unlikely that societies would remain unchanged in terms of population size and land use practices for the approximately 800-900 years that Māori have occupied maunga. It also seems unlikely that the level of resource competition that seems likely to have driven the high investment required to build defensive structures such as the extensively terraced structures we are familiar with on maunga today would have been a feature of the earlier periods of human settlement of maunga.

Frustratingly, Horrocks *et al* note that pollen is actually absent in the pre-Polynesian sections of the pollen cores and suggests that the pollen may not have survived due to microbial degradation. This means the limited pollen samples we have, particularly given these pollen samples have only been collected from Te Kopuke and not from a range of maunga, are not able to provide a robust indication of pre-human vegetation composition on maunga sites. But even with vegetation clearance, any regeneration occurring during early Māori occupation of these sites would have been driven by locally available seed source. Pollen samples from early occupation periods could still be assumed to be relatively representative of original volcanic crater vegetation.

Either way, the pollen species found in the Te Kopuke crater does not match any of the extant ecosystem types defined by Singer *et al* particularly well. The work by Horrocks *et al* could therefore indicate that the original vegetation, specifically around the tihi area and upper slopes of volcanic cones on the isthmus[30], may have been a now-extinct ecosystem variation restricted to the exposed upper slopes and craters of volcanic cones on the Auckland isthmus.

Application of Horrocks *et al* research to partial restoration of an endemic volcanic cone ecosystem type

Removal of exotic trees from the quarry slope area is required both to support cultural aspirations of the governing Maunga Authority and because the pine trees

[30] Including Maungarei

are approaching the end of their healthy life span. High erosion potential of this unstable slope will require it remains vegetated in some manner. The Monterey pines do not appear to be regenerating under their existing canopy so, based on the current species composition of this area, the most likely unmanaged progression of this site would appear to be a tree privet canopy with a *Cotoneaster* and Chinese privet understorey and some scattered native species.

Tree privet, *Cotoneaster* and Chinese privet are all listed pest plants under the Auckland Regional Pest Management Strategy 2007-2012. Cultural inappropriateness of invasive exotic species in this location, coupled with the expense and logistical difficulties of planting and harvesting pine as a commercial venture on this site, makes revegetation of this slope in native forest cover a good option.

The primary function of native vegetation cover at this site would be erosion control. Beyond that, however, there is an opportunity to restore an example of rare volcanic cone habitat to this area.

The dominant natural vegetation cover over Maungarei, as well as all other Tūpuna Maunga sites and much of the Auckland isthmus, is WF7 Pūriri broadleaf forest. WF7 Pūriri broadleaf forest meets the IUCN criteria for a critically endangered ecosystem[31] and any area that is able to be restored has high ecological value.

Horrocks *et al* state that,

> *"Podocarp-hardwood forest, dominated by Metrosideros trees, grew on the rim and inner slopes of the crater in the early part of the pollen sequence. Some Elaeocarpus and Griselinia would also have been present. Cyathea tree ferns comprised a significant part of the under-storey."*

While pohutukawa is not a dominant feature of most naturally occurring WF7 ecosystems, it would be particularly suitable for the upper quarry slopes. This is due primarily to the rapid growth of pohutukawa making it a suitable species to use in early establishment plantings, as well as the suitability of pohutukawa to provide erosion control[32]. In addition, the partial shade it would provide may reduce the risk of vegetation established along the upper quarry slope shades out known extant sites of threatened *Anogramma* along the top of the quarry slope.

A risk of using pohutukawa is the recent arrival of myrtle rust disease to New Zealand, and this would need to be taken into consideration so large areas of pure pohutukawa were not used to avoid risk of large areas of potential dieback. Having said that, the upper quarry slope does provide a location where, if necessary,

[31] Singer ref
[32] Crowe, A. 1997. Growing native plants. Penguin Books, Albany.

pohutukawa could be treated with a systemic, protective and systemic fungicide that could be applied from above to even quite large trees. These sorts of sites are not common around Auckland as treating pohtukawa from above would usually involve a substance that is likely to trigger a HSNO[33] classification of 9.1A into the Coastal Marine environment, whereas on maunga discharge would be to land where a substance triggering a HSNO 9.1 classification would not have an impact.

Large leaved *Coprosma*, which were the dominant component of the early period "small trees & shrubs" Horrocks *et al* pollen samples, also grow rapidly and provide erosion control[34]. Their suitability of large leaved *Coprosma* species on the quarry slope area is further demonstrated by it being the dominant native species colonising the understorey of the current pine forest[35].

Other species indicated by Horrocks *et al*, such as totara, toatoa and tanekaha, may also be worth considering for this site, despite not being obvious candidates in a standard WF7 Pūriri broadleaf habitat restoration project. Advice from specialists in the Biodiversity team of Auckland Council prior to finalising planting plans would be valuable.

Conclusion

The long history of human settlement and modification of the volcanic cones on the Auckland isthmus, coupled with their natural rarity, means that there are currently no sites, including Maungarei, where original vegetation cover of the type that would naturally be present on volcanic cones exists. Whatever vegetation assemblages and ecosystem types that used to exist on the mainland isthmus volcanic cones within the Auckland volcanic field are now extinct. The ancestors who originally settled the Tūpuna Maunga of Tāmaki Makaurau would have experienced a vastly different environment in terms of both vegetation species and associated fauna to the one that existed even by the time of later periods of Māori occupation, and certainly in comparison to the vegetation that exists today.

A risk of using pohutukawa is the recent arrival of myrtle rust, a potentially landscape changing disease, to New Zealand. Planting of any Myrtaceae species would need to be managed to reduce risk of large-scale dieback in one area. This is, however, likely manageable, and the data provided in Horrocks *et al* could assist to inform other species selected to be planted on this site.

While the high archaeological values of Maungarei means there are limited opportunities for revegetation, the necessity to manage erosion of the quarry slope provides an opportunity to restore vegetation assemblages associated with the now critically endangered native ecosystems that used to exist on Maungarei.

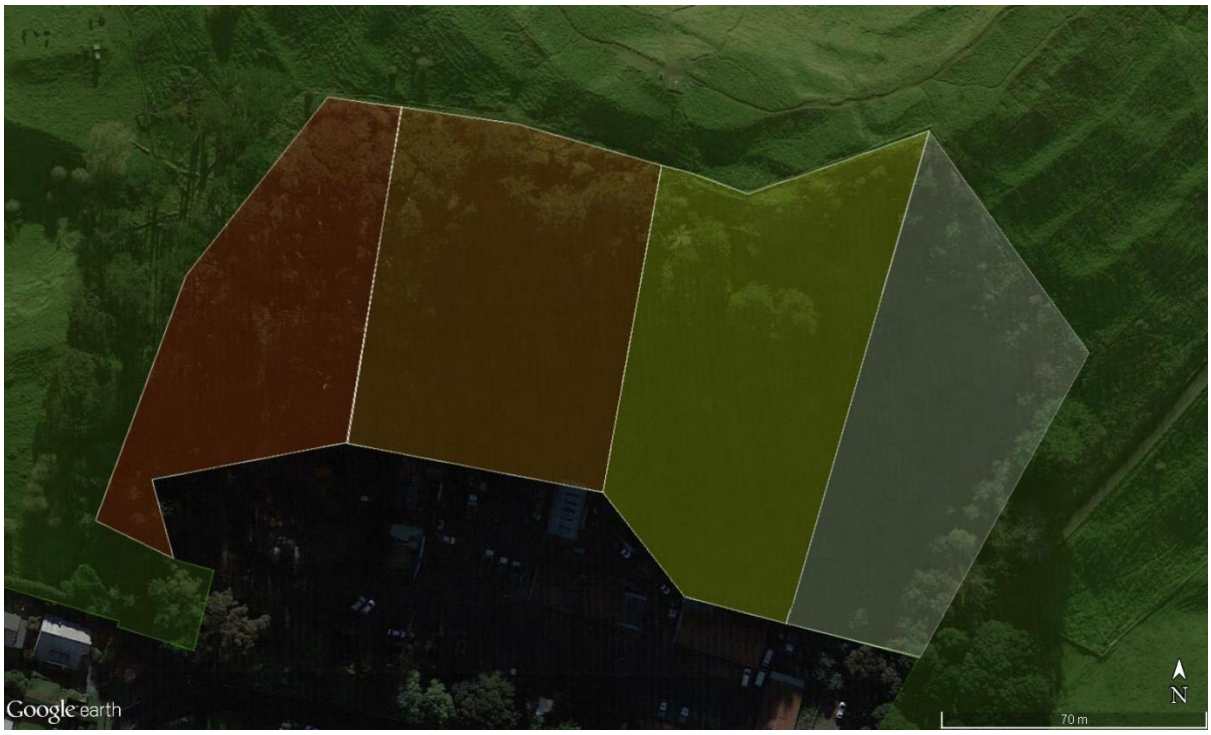
---

[33] Hazardous Substances & New Organisms
[34] Crowe, A. 1997. Growing native plants. Penguin Books, Albany.
[35] *Pers obs*

Appendix 2: Proposed wording for resource consent conditions

Removal of trees from the quarry slope area shall be staged in a manner that minimises erosion risk and enables effective rehabilitation of this slope in native species.

The top of the quarry slope shall be surveyed for *Anogramma leptophylla* and *Senecio scaberulus*. This survey must take place prior to pine removal in the eastern 75% of the quarry slope (Areas B, C & D, see map below) and between the months of July and November when *Anogramma* is most easily visible and the current extent of this species mapped. Pine removal in the western 25% of the quarry slope (Area A, map below), where there is a dense privet-dominated understorey and no known extant *Anogramma* sites, may take place prior to this survey.



Removal of pines from the upper quarry slope area shall be in a manner that minimises impacts on *Anogramma leptophylla* in this area. This specifically includes:

- minimising foot traffic through this area
- briefing staff involved in pine removal about *Anogramma* habitat and the importance of avoiding these areas prior to staff working in *Anogramma* areas
- minimising slash that could increase fire risk within the vicinity of *Anogramma* populations
- avoiding slash being dropped on or shading *Anogramma* areas.

The quarry slope is to be revegetated in native species suitable to achieve slope stability and enhance the ecological values of the maunga through restoration of ecosystem WF7, as defined by Singer *et al*. Final species composition of planting plans shall be approved by the Biodiversity team at Auckland Council. Pine removal and revegetation may be staged, but planting shall be undertaken as soon as practicable following any vegetation removal in order to minimise slope instability risk following pine control. Within any staged area, planting areas shall be maintained for a period of four years from planting or until native canopy closure is achieved, whichever is longer. Maintenance shall include control of invasive exotic species.

The post, batten and wire fence surrounding the quarry shall be retained until after canopy closure is achieved in order to provide a falls barrier for members of the public, and secure anchor points where ropes access is required for maintenance and survey activities.

Populations of *Anogramma leptophylla* currently present shall be surveyed annually to assess population health and, insofar as they remain consistent with other consent conditions, management plans adjusted as required to ensure the survival of *Anogramma leptophylla* in this area. Some means of accessing populations of *Anogramma leptophylla* present at the time of this consent being granted shall be maintained, including maintenance of anchor points for ropes access only sites.

Appendix 3: Overview of a potential restoration plan for the quarry slopes on the southern side of Maungarei

Purpose

To stabilise the quarry slope, following the removal of exotic species, by restoring a vegetation assemblage resembling a WF7.2 Pūriri rock forest ecosystem, potentially also with aspects of now extinct ecosystems that may have existed in tihi areas of volcanic cones on the Auckland isthmus.

The aim is to replace the current pine canopy and privet / *Cotoneaster*-dominated understorey with native vegetation cover that will provide erosion control and restore the critically endangered WF7 Pūriri broadleaf[36] ecosystem type that is thought to be the original vegetation cover in this area[37].

Notes:

- Pines should be removed in late summer to minimise soil / slope damage / erosion risk.
- Planting should occur autumn to maximise plant establishment time during winter rainy period prior to summer dry seasons.
- Final species assemblage will be confirmed by Biodiversity team to ensure it will result in restoration of a WF7 ecosystem type, as defined by Singer *et al*. Variation to WF7 that is consistent with Horrocks *et al* shall be permitted, particularly in upper slope areas.
- Species selection will need to prioritise slope stability and survival on a steep, modified slope.
- Where pohutukawa and other Myrtaceae are included in planting lists, consideration will need to be given to hygiene protocols to reduce the risk of spreading myrtle rust into the site during planting, as well as managing for myrtle rust in the long term, including the possibility that Myrtaceae may have a much reduced survival rate in the near future than would currently be expected.
- Plants should be eco-sourced to the site as closely as practicable.
- In general, sizes no greater than PB3 will be required to accommodate shallow soil depths. Prior weed removal, post-planting green mulching and weed control until canopy closure is achieved are the key methods that will allow for native species to successfully outcompete weed and other exotic species during establishment. It is anticipated functional canopy closure will

[36] Singers, N; Osbourne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Hill, S.; Webb, C. 2017. Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

[37] See GeoMaps, Environment layer/Biodiversity/Ecosystems Potential Extent.

take 3-5 years on this slope, although visually the trees should be established within 2-3 years.

- Due to the logistical difficulties working a slope this steep, works will be staged over 4 years (see figure 1, below) to allow methodologies to be site-tested and adjustments made as necessary in order to ensure objectives can be met.
- To reduce HSE risks of falls from people walking on the slope above the quarry once the existing privet and *Cotoneaster* shrubs are cleared, as well as to establish a strong “edge” that will help resist future weed incursion into this area, consideration should be given to planting an edge with dense, shallow rooted species such as flax and kawakawa to a distance up to 2m from the edge of the top of the quarry slope.

Figure 1: Proposed approximate time frames for project staging

	Area A (red)	Area B (orange)	Area C (yellow)	Area D (white)
Pre-pine removal weed control	Year 1-1	Year 2-1	Year 3-1	Year 4-1
Pine removal	Summer Year 1	Summer Year 2	Summer Year 3	Summer Year 4
Initial planting (approx. $1m^2$, as can be achieved given slope and soil depth), then green mulching (grass seeding) for slope protection	Autumn Year 1	Autumn Year 2	Autumn Year 3	Autumn Year 4
Plant maintenance weeding – season 1	Spring (then re-grass), early autumn Year 2	Spring (then re-grass), early autumn Year 3	Spring (then re-grass), early autumn Year 3	Spring (then re-grass), early autumn Year 3
Infill planting and green mulching (grass seeding) to maintain a 90% survival rate	Autumn Year 2	Autumn Year 3	Autumn Year 4	Autumn Year 5
Plant maintenance weeding – seasons 2-5	Spring & autumn, Year 3; Summer Years 4-5	Spring & autumn, Year 4; Summer Years 5-6	Spring & autumn, Year 5; Summer Years 6-7	Spring & autumn, Year 6; Summer Years 7-8
Infill planting as required to achieve canopy closure by Year 5	Autumn Year 4	Autumn Year 5	Autumn Year 6	Autumn Year 7

NB: due to less pines in Area D (white), understorey weed removal and replanting with native species may be able to begin in this area before scheduled.

Figure 2: Approximate staging areas