Evaluation of selected horticultural crops for Kaipara District Council: Progress Report 2

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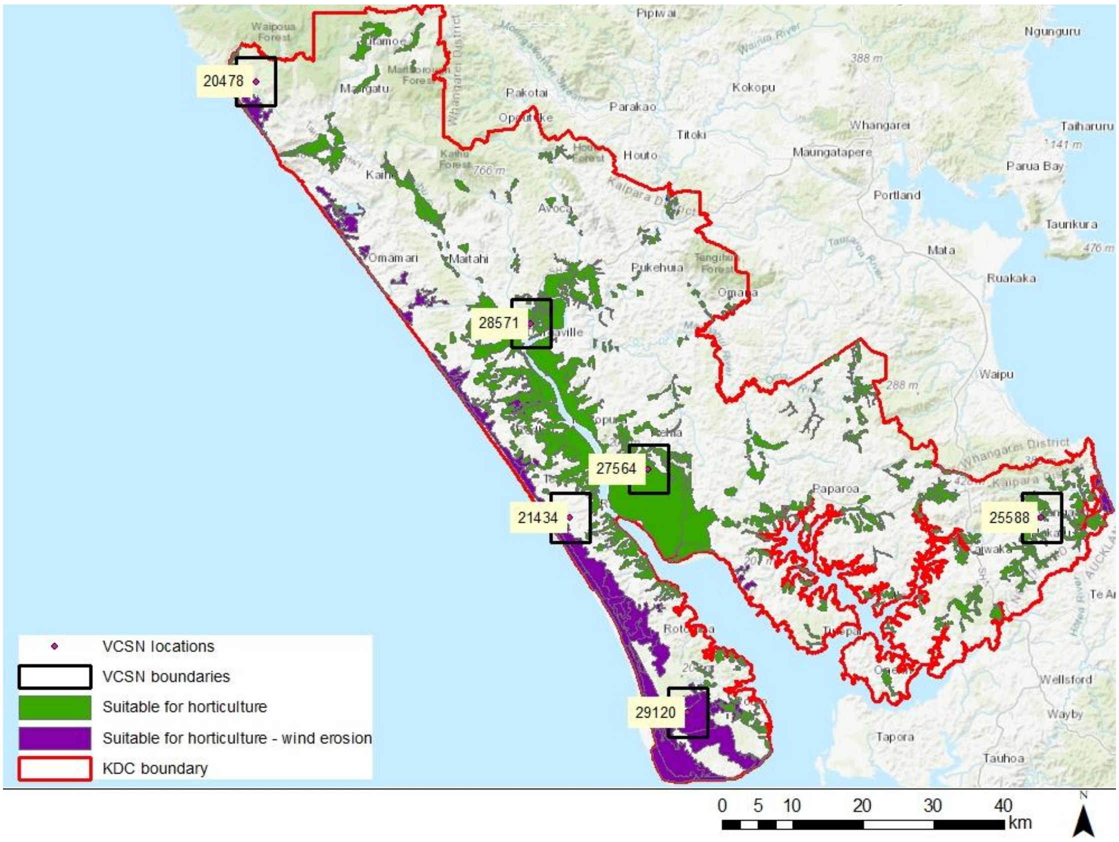

EXECUTIVE SUMMARY

In the first Progress Report for the Kaipara District Council (KDC), we identified areas within the rohe of council boundaries that were considered suitable for horticulture in a generic sense. Now in this second Progress Report we have selected six NIWA Virtual Climate Station Network (VCSN) stations for further analysis of three specific crops or crop groups, together with additional data on soils.

Olives:

Since olives are already grown around Northland including the Kaipara District near Mangawhai, it seems that this crop could be considered for cultivation in other areas of the Kaipara District. Based on the need for deep, free-draining soils, the west coast around Dargaville and the Pouto Peninsula would potentially be suitable sites. Mounding of the soil might be needed where the soils have imperfect drainage.

Hops, hemp and CBD cannabis

In terms of day length and summer warmth, the Kaipara District is considered suitable for hops, hemp and CBD cannabis. Due to the warm, humid climate of Northland, pest and disease control will likely be required. There may also be mitigation requirements for poor draining soils such as those near Dargaville, and mounding of soils would be a possibility.

In the case of hops, excessive wind is likely to be a limitation, because hops are grown on 5 m high trellises, wind mitigation is very likely to be needed. This could potentially be in the form of shelterbelts, or alternative methods of growing hops, such as the short, three-metre trellises common in China. However, in the windiest parts of the Kaipara District, such as the Pouto Peninsula, it could be possible that the wind is so strong to make the growing of hops not possible, even with mitigation measures.

Avocados

Avocados require fairly similar climatic conditions to olives. Since both olives and avocados are already grown in Northland, there are likely to be many areas in the Kaipara District where the growing avocados could be considered. The need for deep and free-draining soils could exclude Dargaville and Ruawai without soil mitigation. However Mangawhai and the west coast are potentially suitable areas.

Contents

1 INTRODUCTION

In the first Progress Report for the Kaipara District Council (KDC), we identified areas within the rohe of council boundaries that were considered suitable for horticulture in a generic sense. These fulfil general criteria on Land Use Capability (LUC) class (1, 2, 3, 4s and 6s), slope (< 15 °), plus climatic criteria on Growing Degree Days (GDD_{10} > 800 degree days), and Frost Free Period (FFP > 200 days). The areas of the KDC that fulfil these criteria are shown in Figure 1 in green.

We further identified areas susceptible to wind erosion that we would not normally consider as suitable for horticulture. This is because these areas could potentially be used for horticultural crops if the cropping practices under consideration could mitigate the risk of soil erosion. These areas are shown in Figure 1 in purple. Where there is this limitation due to potential wind erosion, mitigation measures could be considered.

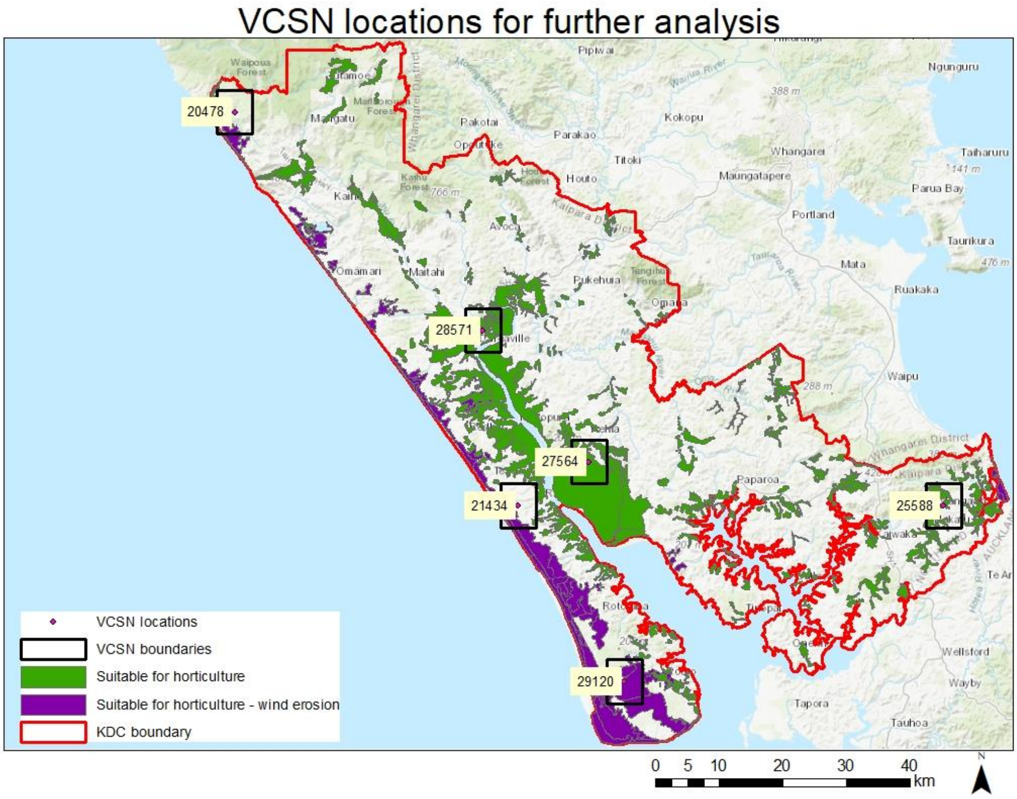

Figure 1: Areas of the Kaipara District which are considered suitable for horticulture based on our broad GIS sweep (green) and further areas susceptible to wind erosion that may be suitable (purple). Six NIWA VCSN stations are chosen for further analysis.

We have now selected six NIWA Virtual Climate Station Network (VCSN) stations for further analysis of their suitability for cultivation of three specific crops, or groups of crop. The six VCSN sites chosen span the geographical extent of the district, and are considered to be representative of the areas suitable for horticulture. The six stations are shown in Figure 1, and listed below as:

- 20478, Waipoua
- 21434, Te Kopuru
- 25588, Mangawhai
- 27564, Ruawai

- 28571, Dargaville
- 29120, Pouto

In this second Progress Report we now consider the suitability of three selected horticultural crops for the rohe of the Kaipara District Council using climate data from the VCSN network, and the report on soils by Manaaki Whenua Landcare Research (MWLR) (McLeod, 2019). Whereas the previous assessment for generic horticultural crops was broad-based using qualitative criteria for land and climate requirements, we now provide more detailed assessments.

The crops, or crop groups, we have been asked to consider here are:

- Olives
- Hops, hemp and CBD cannabis
- Avocados.

2 SOIL CHARACTERISTICS

In addition to our previous assessment of land using just LUC class, we now provide more details on the soil conditions across the extent of the KDC's lands.

The first characteristic is the potential rooting depth (PRD) (Figure 2) that is possible for a given soil (McLeod, 2019). Values of PRD greater than 0.5 m means the soil is favourable for deep rooting horticultural crops. These are shown in Figure 2 as being orange (moderately deep 0.6-0.9 m), red (0.9-1.2 m) and claret (very deep 1.2 1.5 m).

Next, we present a map from McLeod (2019) of the drainage classes of the soils across the lands of the KDC (Figure 3). While much of the district is very poorly (dark blue), poorly (light blue) or imperfectly (teal) drained, targeted soil management strategies could mitigate these limitations, especially for soils with imperfect drainage. For example, a possible mitigation is mounding of soil in which crops are planted, as we show later on.

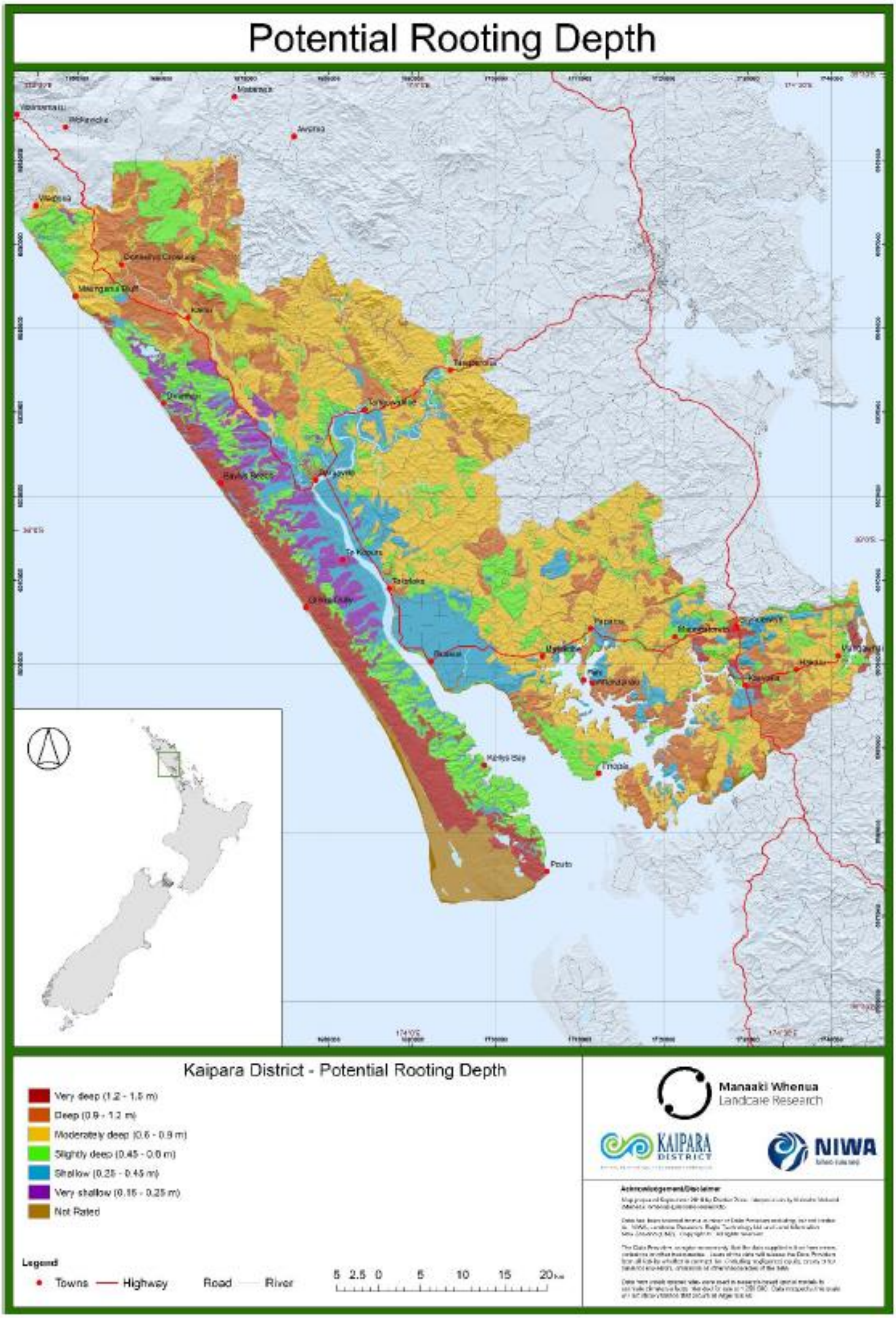

Figure 2: The potential rooting depth (PRD) across the extent of the Kaipara District Council.

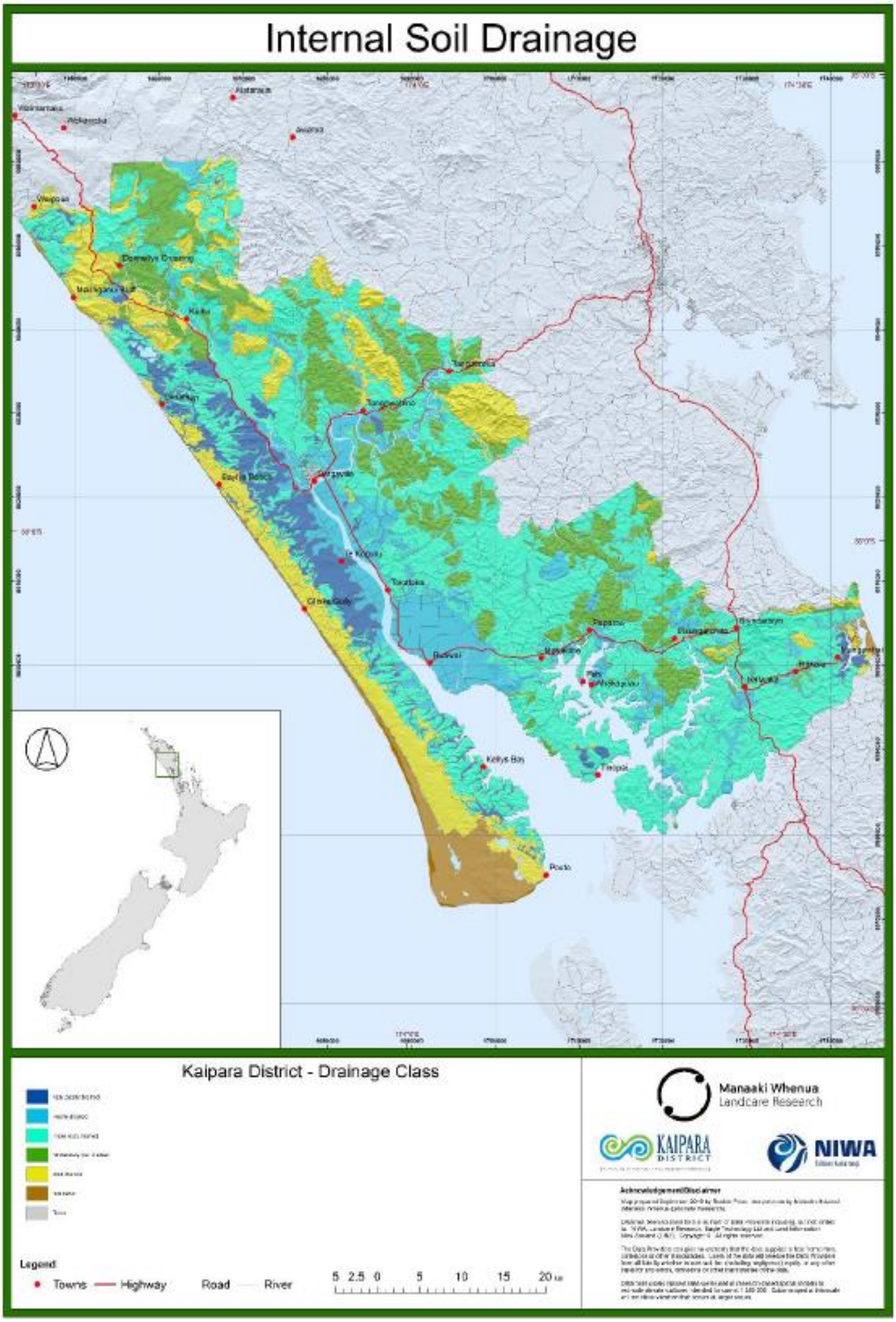

Figure 3: The drainage class of soils across the extent of the Kaipara District Council.

3 CROP ASSESSMENTS

3.1 Olives

Olives New Zealand (https://www.olivesnz.org.nz/) reports some 200 members, and of these 56% are full members with more than 250 trees. Only 20% of members are full-time professional growers. There are about 400,000 olive trees in New Zealand, and Olives New Zealand reports that over 25% of its members are in the Wairarapa, with 12% in both Northland and Kāpiti. There are over 50,000 olive trees in Northland. The most common cultivar across New Zealand is Frantoio. FreshFacts (www.freshfacts.co.nz) reports that there are 2,172 ha of olives in New Zealand with 118 ha in Northland. In New Zealand there is $190 million of on-farm investment into olives, plus $130 million of off-farm investment. Olive oil generates $12 million from domestic sales, and $0.5 million of export revenue. There are about 4 tonnes of table olive production as well.

Olives New Zealand lists six olive groves from Northland (https://www.olivesnz.org.nz/our-growers/northland/). These cover groves from near Mangonui, Kaikohe, and around Mangawhai, which is in the eastern part of the Kaipara District.

The 2019 Overview Paper by Olives New contains a SWOT analysis (Strengths-Weaknesses, Opportunities and Threats) for the future of Extra Virgin Olive Oil (EVOO) from New Zealand (https://www.olivesnz.org.nz/wp-content/uploads/2019/05/Olives-New-Zealand-Overview-Paper-1.pdf). The Haifa Group in Israel has produced a crop guide for growing olives (https://www.haifa-group.com/olives-fertilizer/crop-guide-growing-olives).

3.1.1 Rules for Olives

Torres et al. (2017) provided an assessment of olive growing in the Southern Hemisphere wherein they focussed on the chilling requirements for flowering, water requirements for irrigation, and the environmental effects on fruit oil concentration and quality.

3.1.2 Soils

Olives prefer well-drained soils that are slightly alkaline and with low to medium fertility. This would favour sandy soils, and land of Land Use Capability (LUC) classes LUC 1-3. Many of the soils in the Kaipara District have low subsoil acidities, as indicated in Figure 4 (McLeod et al. 2019). Olives favour near neutral (teal coloured areas of Figure 4), or better, still slightly alkaline conditions. Acid subsoils should be avoided, or managed by strategies such as liming.

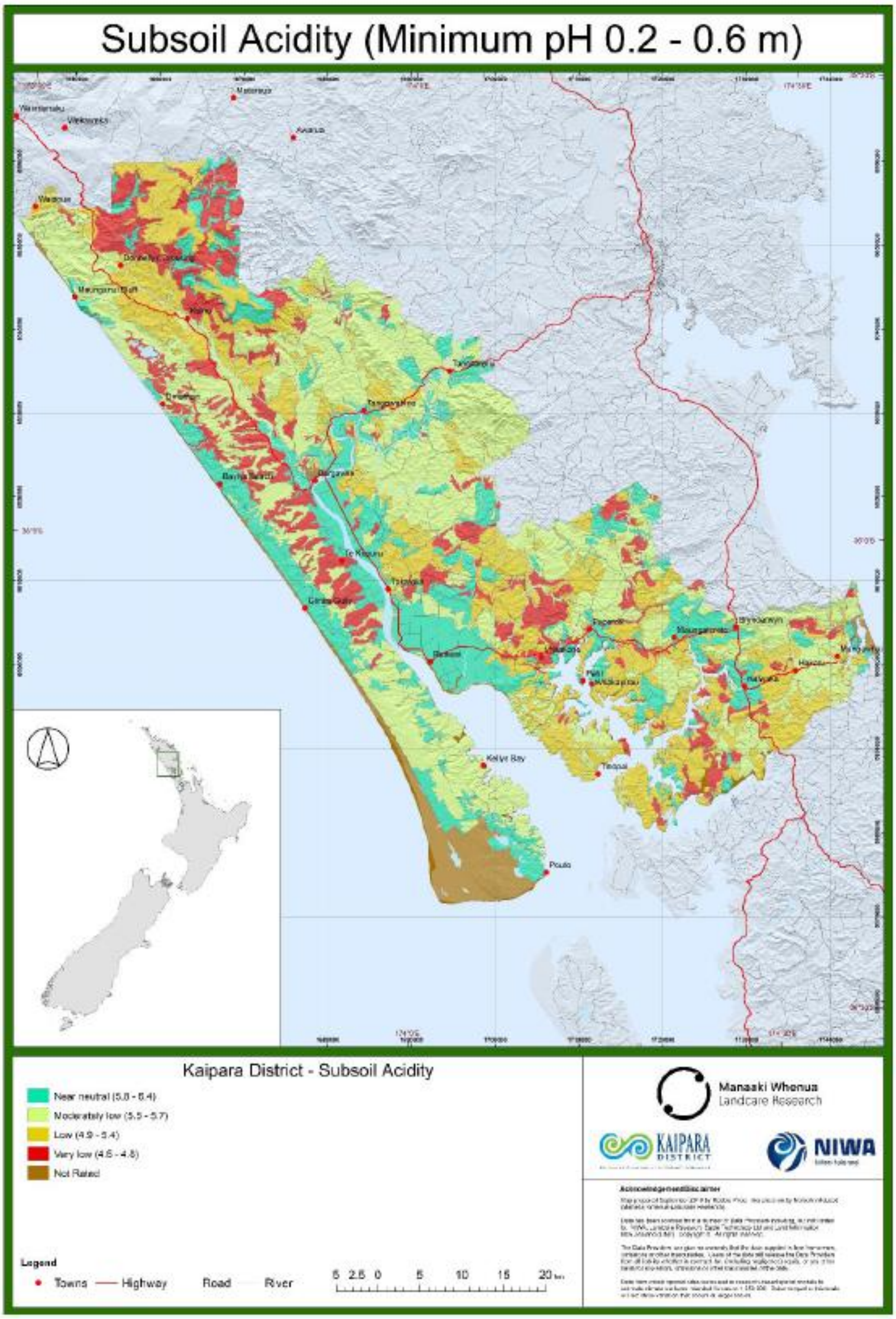

Figure 4: Subsoil acidity in the soils of the Kaipara District as presented by McLeod et al. (2019).

Furthermore, olives prefer free-draining soils, so if there were a wetness ('w') limitation in the LUC classification, or a shallow potential rooting depth, then mitigation would needed. Sandy loam, silty loams, sandy clays and silty clays are preferred, rather than heavier textured soils (IOO, 2007). The drainage class information presented by McLeod et al. (2019) provides insight into which soils could be considered for olives (Figure 3, brown, yellow and green coloured areas), and those with poor internal drainage classifications that should be avoided (Figure 3, turquoise, teal, and blue).

The root system of olives is concentrated in the top 50-70 cm (IOO, 2007). Where there are limitations to rootzone depth, either by pans or imperfect drainage, mounding of the interrow soil along the row can create a rootzone of sufficient depth. Mounding of soil along the row is a common practice in Northland orchards, as imperfect drainage can result from sub-surface pans at around 40-50 cm (Figure 5).

Figure 5: Avocados growing successfully near Kerikeri on a soil with a shallow impermeable pan. The soil of the interrow has been mounded along the row to provide a rootzone with good drainage characteristics.

Taylor and Burt (2007) noted that deep-ripping of soils in Western Australia could be used to facilitate better root growth if there were limitations to rooting depth or drainage status. It would seem that deep-ripping would not be needed in the suitable areas of the Kaipara District, although mounding may be worthwhile to overcome limitations resulting from imperfect drainage.

3.1.3 Climate

Olives are of Mediterranean origin, and so they favour cool winters and warm summers. Yet they are adaptable to a wide range of condition. Waimea Nurseries in Nelson have provided a guide to olive varieties for professional growers: https://commercial.waimeanurseries.co.nz/assets/Uploads/Comm-Olives/Olive-Brochure-2014.pdf).

Olives require winter chilling to trigger floral initiation, rather than maintain vegetative growth. The cultivars vary in their chilling requirements, depending on their provenance. Italian winters are quite long, so Italian cultivars such as ‘Frantoio’ and ‘Leccino’ have winter chilling requirement of about 600 hours under 7°C. Tunisian, Greek (Crete), and Spanish cultivars like ‘Chemlali’, ‘Koroneiki’ and ‘Arbequina’, where winters are shorter, have lower chilling requirements of between 150 and 300 hours (https://www.nature-and-garden.com/gardening/olive-tree-cold.html.

Despite the greater chilling requirements for 'Frantoio', many are grown in groves in the Mangawhai region, where winter chilling hours are typically less than 600. Future climates might pose a problem with the future loss of winter chilling hours. Torres et al. (2017) report that in north-western Argentina normal flowering of the variety 'Arbequina' was observed at almost all sites and in all years, while normal flowering events in 'Frantoio' and 'Leccino' were uncommon. These results confirmed that these two latter cultivars require a very high number of chilling units in accordance with values from the World Olive Germplasm Bank of Córdoba (Spain), and that the winter temperatures in north-western Argentina do not meet their chilling requirements for normal flowering in most years. In kiwifruit and other crops, hydrogen cyanamide (Hicane®), or the cytokinin called benzyladenine can be used to break dormancy and induce flowering, but Torres et al. (2019) report that is was not successful with 'Frantoio' olives in north-western Argentina.

One of the major problems threatening the young New Zealand olive industry is olive leaf spot, also called 'peacock spot', which is caused by the fungus *Spilocaea oleagina*. Obanor (2005) showed that lower temperatures (10-20°C), free moisture, and high humidity (100%) favoured the development of 'peacock spot' (http://www.olivesnz.org.nz/wp-content/uploads/2012/03/Olive-Leaf-Spot-Disease.pdf). Autumnal rains would increase the risk of 'peacock spot', and the VCSN stations record that there is on average between 160 mm and 200 mm of rain in March and April across the district. A good fungal-control programme will be needed.

3.1.4 Recommendation

Since olives are already grown around Northland including the Kaipara District near Mangawhai, it is likely that there are other areas of the Kaipara District where olives would be able to be grown. Based on the need for deep, free-draining soils, the west coast around Dargaville and the Pouto Peninsula could potentially be sites worthy of further investigation. Mounding of the soil might be needed where the soils have imperfect drainage.

3.2 Hops, hemp and CBD cannabis

3.2.1 Suitability Assessment - basis

Taxonomically, hops (*Humulus)* and both hemp and cannabis (*Cannabis*) are closely related, and both genera belong to the Cannabaceae family (Figure 6).

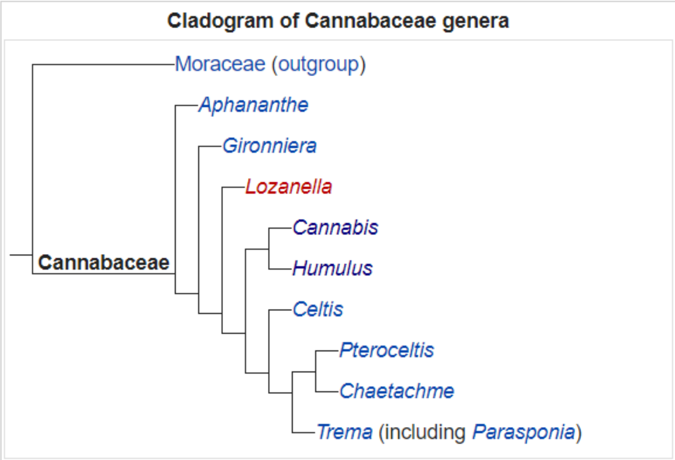

Figure 6: The taxonomic classification of the Cannabaceae family showing the genera, and that hops (*Humulus*) and cannabis (*Cannabis*) are closely related.

Given the nature of this crop suitability assessment, within this report we will treat hops, hemp, and CBD cannabis as one crop, recognising of course that their cultivation will involve different management and cultural practices.

Furthermore, because there is much more information publicly available on hops, after presenting a brief overview of the situation analysis for these three crops, subsequent sections will primarily refer to hops only. However the interpretations will, in general, apply to hemp and CBD cannabis. The exception is in relation to risks due to wind, as the cultivation system used for hops is quite different from that for hemp and CBD cannabis, as clearly shown in Figure 7.

3.2.2 Hops – situation analysis

Hops (*Humulus lupulus*) are an essential ingredient in beer. Plant & Food Research has an active hop-breeding programme based at our Motueka site. Hops contain alpha acids, or humulones, which provide the bitter taste to beer, as well as beta acids, or lupulones, and other essential oils which provide aromas and other flavours.

New Zealand Hops (https://www.nzhops.co.nz/about) is a Nelson-based contemporary grower co-operative with core business values founded on collective sustainability, innovative research, creative technologies and modern operational capability. Hops have been grown in the Motueka region for more than 150 years.

In 2018, New Zealand Hops reported that 23 growers grew hops across 539 ha, and the harvest yield was 721,958 kg. In 2019, there were 27 growers covering 763 ha, and the harvest yield was 1,045,598 kg.

3.2.3 CBD Cannabis – situation analysis

Cannabidiol (CBD) is a phytocannabinoid discovered in 1940. It is one of 113 identified cannabinoids in cannabis plants. Clinical research on cannabidiol includes preliminary studies of anxiety, cognition, movement disorders, and pain. In 2017 the New

Zealand government made changes to the regulations so that restrictions would be removed, which meant a doctor was able to prescribe cannabidiol to patients. Next, the passing of the Misuse of Drugs (Medicinal Cannabis) Amendment Act in December 2018 meant that cannabidiol is no longer a controlled drug in New Zealand, but is a prescription medicine under the Medicines Act, with the restriction that the amount of tetrahydrocannabinols (THC) and psychoactive related substances must not exceed 2 percent of the total CBD tetrahydrocannabinol and psychoactive substances content.

In anticipation of further changes in the social and political environment, a number of NZ-based companies are currently gaining research licenses, with a view to growing CBD cannabis crops in the future.

3.2.4 Hemp – situation analysis

Hemp, or industrial hemp, is a strain of the *Cannabis sativa* species that can be grown for industrial uses of its derived products. It is a fast growing plant and was first spun into usable fibre over 10,000 years ago. Hemp has lower concentrations of THC and higher concentrations of CBD, which decreases or eliminates its psychoactive effects. The New Zealand Hemp Industries Association (https://nzhia.com/about-nzhia/) is a resource for information and advice on the growing of hemp. To grow hemp a licence is required from the Ministry of Health, and there must be a secure site, more than 5 km from a school, and the growing area should not be visible from the street.

One company, The Hemp Farm, (https://www.hempfarm.co.nz/hemp-dual-crop-harvester/) harvested over 500 ha of hemp in both the North and South Islands. Hemp seed is used for hemp seed oil, protein powders and hemp milk. The stalks provides a source of versatile fibre.

3.2.5 Hops - overview

Hops (*Humulus lupulus*) is a niche, though important, crop grown around the world. In 2017, the total global production was around 110,000 tonnes grown on 61,000 hectares of land (http://www.fao.org/faostat/en/#home)[1], comprising around 150 cultivars. The largest producers of hops are the USA, in particular Washington, Oregon and Idaho, plus Germany, in particular the Bavaria region, and the Czech Republic, in particular the Žatec region. The USA and Germany together produce around two thirds of the global harvest, with smaller contributing nations to the global total including New Zealand and Australia, particularly in Tasmania.

New Zealand produces less than 1% of the global total, but almost all of it is sold before harvest for export, as New Zealand cultivars are highly regarded around the world by the craft beer industry. Many of these cultivars were developed by Plant & Food Research in Motueka. In 2019, twenty-one cultivars were produced commercially along with various trial varieties. Six of those cultivars were also grown organically.

Over 95% of the global hops harvest is used in the production of beer, although they also see some use in soft drinks, herbal teas, food and herbal medicines due to their natural bittering and sedative effects. As part of this increase in hop-derived, health-related products in NZ, products such as Calocurb® was recently launched, and targeted at the weight-loss market. When used in beer, anywhere from 0.1 to 10 grams of hops per litre are used depending on the style of beer, the desired flavours in the beer, and hops cultivar used. Hops are typically dried,

[1] The UN FAO lists Ethiopia as the second largest producer of hops, but this is in fact a difference crop called gesha that is also called hops in Ethiopia. Gesha is used for similar purposes, but is not related to *Humulus lupulus* in any way.

powdered and pelleted for brewing, however fresh hops, sometimes referred to as 'green hops' or 'wet hops', are occasionally used.

Hops are generally divided into bittering "alpha" hops and flavouring "aroma" hops, and dual-purpose cultivars exist as well. Alpha hops are high in alpha acid content and are used primarily for bittering beer. Aroma hops generally have low alpha acid content, but are rich in various flavour compounds and are used for flavouring beer, particularly by craft brewers. Overall, global hops yields average around 2 tonnes per hectare, but this is very dependent on cultivar and different regions will produce different yields depending on the mix of cultivars grown, plus the hopyard management practices employed and the local natural photoperiod. Alpha hops can produce yields up to 3.3 t/ha, while aroma hops will generally produce between 0.9 and 1.8 t/ha. However, aroma hops generally fetch higher prices at market. New Zealand's current hop harvest is about 85% aroma hops, due to the current rising trend for craft beer.

New Zealand's hops industry is centred on Motueka, and almost all hops grown on a commercial scale are produced here. This dominance is largely because Motueka is where hops have historically been grown in New Zealand, not because there's anything special about the region with regards to hops. Apart from Motueka, Plant & Food Research currently runs hops trials in Clyde and at Kerikeri. We are also aware of one commercial grower in Garston, near Queenstown (https://www.noted.co.nz/money/money-small-business/hops-garston-a-southern-man-goes-for-gold), and one grower near Cheltenham in the Manawatu (https://www.rnz.co.nz/national/programmes/countrylife/audio/2018710042/trees-bees-and-a-nice-cold-cider-please). Hobby growers are also found all over the country.

Figure 7: Bluebell Hopyard in Farmington, New York (www.bluebellhopyard.com). This arrangement of growing hops on tall trellises is typical worldwide.

The Hop Growers of America have provided indicative gross margins for cultivation, and this is available online at https://www.usahops.org/growers/cost-of-production.html. An overview of cultivation can be found at https://www.canr.msu.edu/uploads/234/78941/Hops_Production_-_Heather_Darby.pdf.

3.2.6 Hops – cultivation

Hops are a type of plant called a 'bine', which is like a vine, but instead of using tendrils and suckers to climb, the main stem itself entwines the support strings. They are typically grown on trellised systems not unlike wine grapes, albeit significantly taller (Figure 7). In New Zealand, the trellis is usually five metres high. In some other countries, the hops trellises may be six or eight metres high, while in China relatively short trellises of just three metres are used. The reason for such high trellises is that the main driver of growth in hops is sunlight, and these trellises are the optimal configuration for maximising sunlight exposure for the natural photoperiod, given that photoperiod dictates the timing of when plants change from vegetative to floral each season. Because of the need for trellises, hops are a crop that requires significant infrastructure, and they are relatively expensive and labour-intensive to establish.

Alternative arrangements, including horizontal trellises, are popular with hobby growers and in some beer gardens for aesthetic reasons. However we are unaware of any commercial hops operations using anything other than vertical trellises like that illustrated within Figure 7.

Hops are usually grown from rhizomes, or root cuttings, which are planted in spring. They will grow vegetatively until midsummer. The flowers, also called cones, will start to form once the days start getting shorter after the summer solstice, with the timing varying with cultivar. The New Zealand harvest occurs from late February through to the end of March, and staggered by cultivar as different cultivars mature at slightly different times.

Harvesting involves cutting the entire bine down, and feeding it through a mechanical device that strips and separates the flowers from the bines and leaves. Typically the hop flowers are then dried, powdered and pelleted for distribution to breweries. Fresh, ‘green’ hops are sometimes used in brewing, however fresh hops must be used within a day or two of harvest so this method of brewing is relatively niche.

Cover crops can be used over the winter for various reasons such as aiding in nitrogen fixing, however this is not typical in New Zealand. The usual practice here is to graze sheep in hopyards over the winter.

Pests and disease

Mites are frequently noted as being problematic but downy mildew is considered most limiting in crops internationally. The problems of fungal infections coinciding with the harvest period in regions where autumn rains occur are also noted, so a vigilant pest and disease programme is likely to be required.

3.2.7 Soils

There are reports that hops can grow well in soils that are also used to grow potatoes, with good drainage and soil pH between 6.2 and 6.5 being recommended. A large proportion of the Kaipara District has near neutral soils with pH levels between 5.8 and 6.4, denoted by the teal areas of Figure 4, and these would be suitable soils for hops. There is also a large proportion of the district with moderately low pH soils of between 5.5 and 5.7, shown by the light green areas of Figure 4, which would likely be acceptable for hops as well. Where there are areas with imperfect soil drainage, mounding of soil along the row would be recommended.

3.2.8 Climate

Relatively little research has been done on the growth and developmental response of hops to various weather and climate factors. One of the main reasons for this is that hops have been grown in the same areas for decades, if not centuries, and there has been little demand to significantly expand where hops are grown. The other main reason is that hops behave like ‘weeds’ in some ways, and they will grow in many different climates and conditions. This, however, does not necessarily mean that hops are commercially viable in all places where it is possible to grow them.

Day Length

The most important climatic factor for successful cultivation of hops is day length, also referred to as photoperiod. Hops will grow vegetatively with increasing day length, then flowering will begin when the days become shorter. However, a critical day length must be met before flowering is triggered, and this varies between cultivars. In general the critical day length is considered to be 15 hours, including an allowance for twilight.

Within the natural growing environment the sole predictor of day length is latitude, and for the majority of cultivars grown generally anywhere between 35° and 55° of latitude is considered ideal, in either the northern or southern hemisphere. Latitudes closer to the equator are generally considered to have insufficient day length, while latitudes closer to the poles are generally too cold to grow hops successfully, regardless of day length.

The major regions of US hop production are located within Washington, Oregon and Idaho in the northwest (Figure 8). There are also smaller commercial hopyards throughout the US, predominately in the north-eastern US and stretching south to North Carolina. Since North Carolina has some of the most southern commercial hops plantations in the US, these are highlighted in Figure 8 to indicate the range of latitudes across which hops are grown. Virtually all of New Zealand is within this latitude range, except for the very top of the North Island, corroborating the interpretation that hops can potentially be grown within New Zealand outside of Motueka.

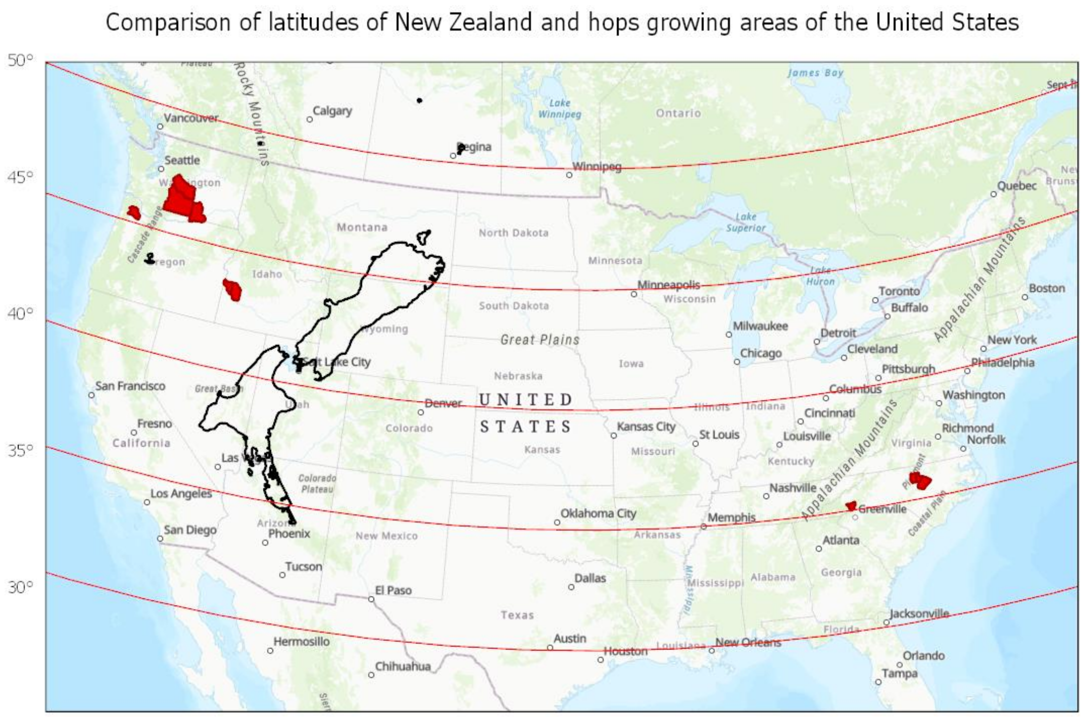

Figure 8: Equivalent latitude of New Zealand and the United States. Significant hops growing areas are highlighted in red: Yakima, WA; Willamette, OR; Parma, ID; Raleigh and Hendersonville, NC.

Growing Degree Days

Within the commercial areas of production across Michigan, Vermont and Washington State, by the time of harvest, hops needed between 945 and 1250 Growing Degree Days (GDD_{10}). The Kaipara District VCSN sites receive GDD_{10} values of about 1540 degree days on average, and GDD10 values of 1420 degree days every four years out of five, readily exceeding these requirements.

Wind - General

Since hops are typically grown on tall trellises, they are susceptible to wind damage. Hence wind is an important consideration for establishing a commercial hops operation. Corroborating this, Plant & Food Research has trialled hops in the Marlborough region, but the crops there failed, in part, due to excessive wind.

Hemp and CBD cannabis are cultivated differently to hops and so wind is likely to be less of a concern for these crops.

Windrun is a measure of how much wind passes over a certain point in a given time, and can be used to determine how windy a place is. Figure 9 shows the mean daily windrun over the year in Motueka. Given the experience of poor performance of hops in Marlborough, Figure 10 shows the mean daily windrun in Blenheim for comparison. There is about twice as much wind in Blenheim than there is in Motueka, and year-to-year variation is also much greater in Blenheim. Since it is known that the wind is acceptable in Motueka, yet excessive in Blenheim, it stands to reason that there is some level of wind between the two for which additional wind mitigation will become necessary.

Potential additional mitigation strategies for excessive wind could include shelterbelts, or using alternative methods of growing hops such as the short, three-metre trellises, common in China. We are however not aware of any NZ-based experience with using these short trellises.

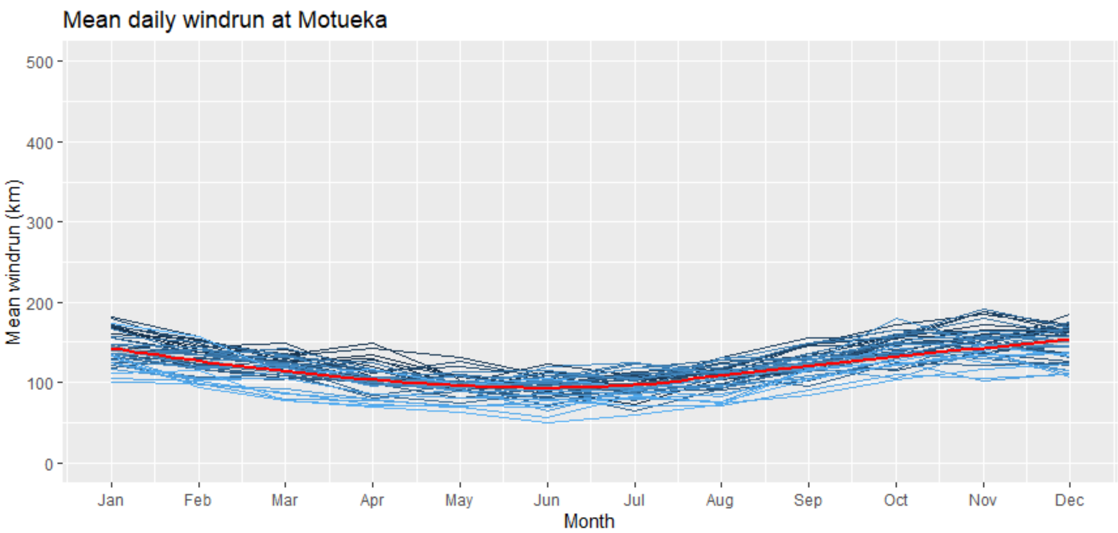

Figure 9: Mean daily windrun in Motueka across multiple years. It is windier in the summer than in the winter, and the mean maximum daily windrun over the year is about 150km.

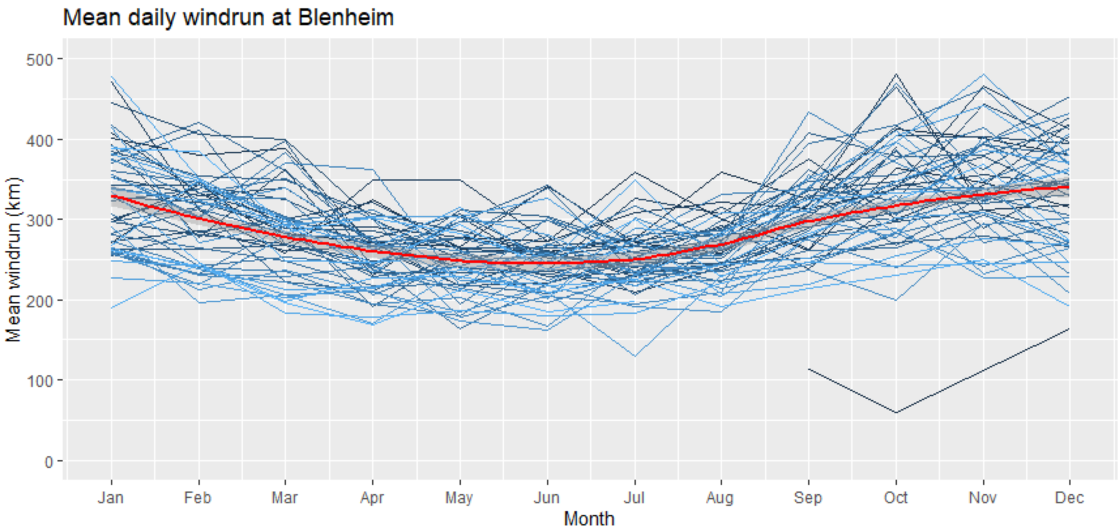

Figure 10: Mean daily windrun in Blenheim across multiple years. It is about twice as windy here than in Motueka, with the mean maximum daily windrun over the year of about 350km.

Wind – Kaipara District

Figure 11 shows the windruns for the six VCSN stations shown in Figure 1. All six stations experience significantly more wind than Motueka. Two VCSN stations, 20478 near Waipoua (Figure 11a) and 28571 around Dargaville (Figure 11e) experience less wind than Blenheim on average. The other four stations experience similar or greater winds than Blenheim, with the two stations on the Pouto Peninsula (21434 and 29120, Figure 11b and Figure 11f respectively) being the windiest.

Since it appears that the entire Kaipara District is relatively windy, it is likely that additional wind mitigation will be needed for hops, regardless of where they are grown. It is also possible that some areas of the Kaipara District would be unsuitable for hops due to excessive wind, even with additional mitigation.

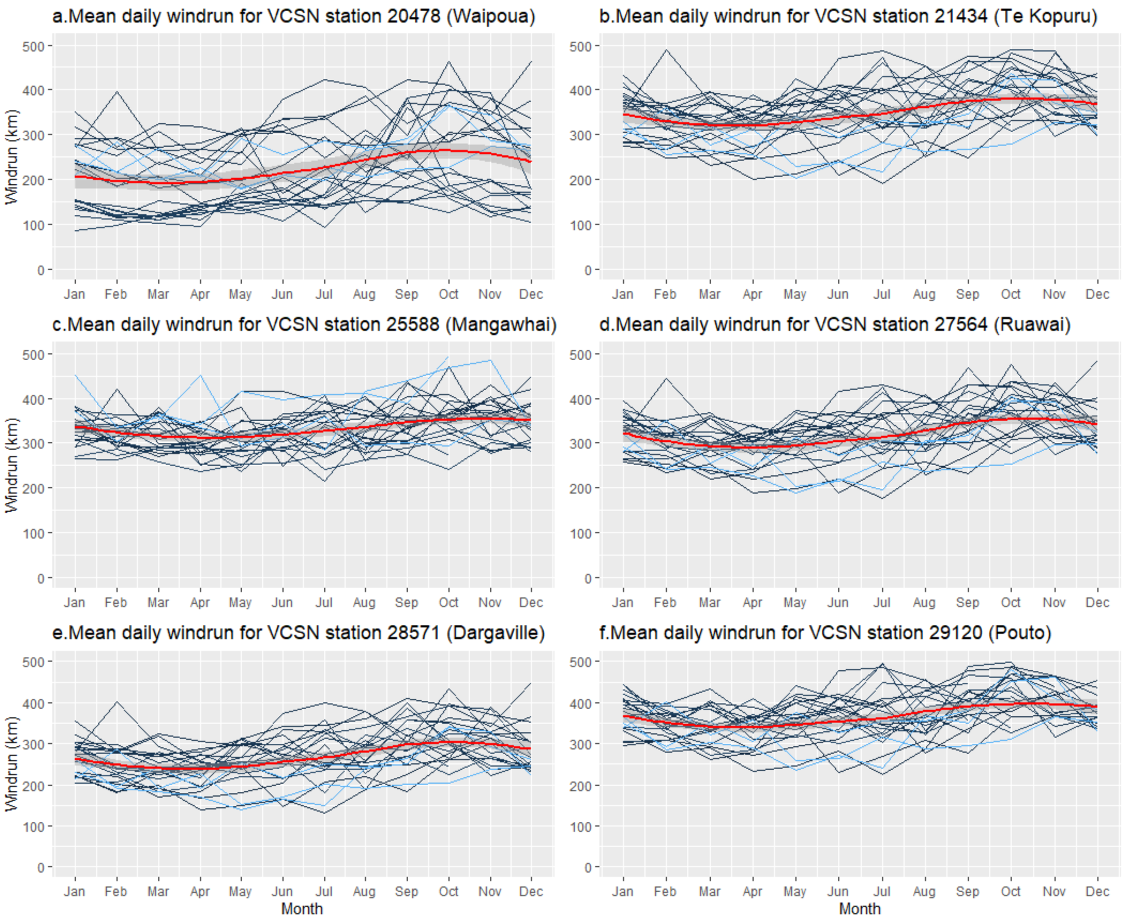

Figure 11: Windruns for the six Virtual Climate Station Network (VCSN) sites shown in Figure 1.

3.2.9 Recommendations

In terms of day length, and GDD_{10}, the Kaipara District is considered suitable for hops, hemp and CBD cannabis. Due to the warm, humid climate of Northland, pest and disease control will likely be required. There may also be mitigation requirements for poor draining soils such as those near Dargaville, and mounding of soils would be a possibility.

In the case of hops, excessive wind is likely to be a limitation. Since the wind in Kaipara is generally comparable to, or greater than, the windrun in Blenheim, wind mitigation is very likely to be needed. This could potentially be in the form of shelterbelts, or alternative methods of growing hops, such as the short, three-metre trellises common in China. However, in the windiest parts of the Kaipara District, such as the Pouto Peninsula, it could be possible that the wind is so strong to make the growing of hops not possible, even with mitigation measures.

3.3 Avocados

3.3.1 Overview

New Zealand Avocado (www.nzavocado.co.nz) is an industry body representing 1,800 growers who collectively manage 4,000 hectares of avocado orchards. The dominant cultivar of avocado grown in New Zealand is Hass, which was released in California in 1926. It is now the most popular cultivar of avocado worldwide. Around 95% of New Zealand's harvest, and 80% of the global harvest are Hass avocados.

In 2018-19, the total value of the New Zealand avocado industry was $144 million, and over 31,000 tonnes of avocados were harvested. Over half of New Zealand's avocado harvest is exported, with the majority sent to Australia and most of the rest sent to various countries across Asia. While New Zealand only accounts for around 2% of the global harvest, we are the ninth-largest exporter of avocados.

The majority of New Zealand's avocado orchards are located in the Bay of Plenty or Northland. The focus is around Whangarei, due to the favourable climate there. Avocados require fairly warm climates, and are relatively intolerant of cold temperatures. They also require adequate soil moisture, wind shelter and, as seedlings, protection from sunburn.

Due to a range of factors, avocados are prone to biennial bearing with alternating seasons of high and low yield. A cool season can produce a low yield, which is often followed by a high yield the year after. As well, a heavy crop can deplete nutrients in the tree leading to a low yield the following year, regardless of weather. It is common for avocado trees to synchronise into this kind of biennial pattern permanently. This is reflected in Figure 12 showing average avocado yields of between 3.4 and 11.5 tonnes per hectare over the past ten years. These yields generally alternate between years of high- and low-production.

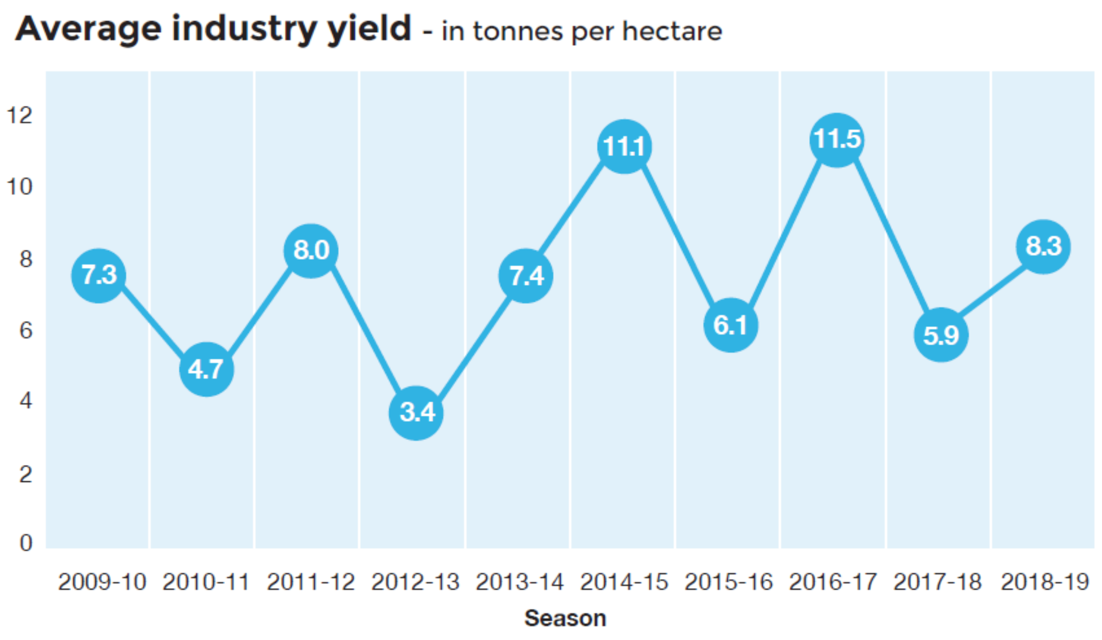

Figure 12: New Zealand avocado yields since 2009 (www.nzavocado.co.nz/about-us/annual-reports).

Pest, disease and weed control are generally required for avocados. Weeds will compete with the trees nutrients, while pests and diseases can cause low-quality fruit and are a biosecurity risk for export. These may be managed through a range of management practices.

3.3.2 Climate

Temperature

The main requirement for avocados is that there are generally warm temperatures all year-round. In particular, there needs to be sufficiently high temperatures in the spring for flowering. Avocados are relatively intolerant of frosts, so winter temperatures that never get too cold are a requirement. Unlike many other crops which, with appropriate mitigation, can be grown in areas that may not have ideal conditions, avocados are fairly sensitive to cold weather so these conditions are more limiting.

The average minimum temperatures in the spring should be at least 8°C, 9°C and 10°C for September, October and November respectively. Average minimum temperatures of 7°C, 8°C and 10°C for September, October and November, respectively, are acceptable but less than ideal.

The average maximum temperatures in the spring should be at least 15°C, 16°C and 17°C for September, October and November respectively. Acceptable, although marginal, maximum temperatures for those months could be 14°C, 15°C and 17°C respectively.

The final temperature requirement is that, on average, the temperature should never drop below 0°C at any point during the year. It is also acceptable, but less than ideal, for this annual extreme temperature to drop below 0°C, as long as it never drops below -2°C.

Table 1: Mean minimum and maximum temperatures for September, October and November plus the annual extreme minimum temperature for the six VCSN stations analysed.

VCSN Station	20478 Waipoua	21434 Te Kopuru	25588 Mangawhai	27564 Ruawai	28571 Dargaville	29120 Pouto
September maximum	19.7°C	19.9°C	19.5°C	20.4°C	20.4°C	19.8°C
October maximum	21.1°C	21.6°C	21.0°C	22.1°C	22.0°C	21.6°C
November maximum	23.0°C	23.4°C	22.9°C	23.9°C	23.9°C	23.4°C
September minimum	8.9°C	8.8°C	9.4°C	9.2°C	9.1°C	9.0°C
October minimum	10.1°C	10.1°C	10.6°C	10.5°C	10.4°C	10.3°C
November minimum	11.4°C	11.5°C	12.1°C	11.9°C	11.8°C	11.7°C
Annual extreme minimum	0.9°C	-0.1°C	2.5°C	0.4°C	0.3°C	0.2°C

Table 1 shows the mean minimum and maximum temperatures for September, October and November for the six VCSN stations selected across the Kaipara District (Figure 1). Also listed is the annual extreme minimum temperature. With regard to these six VCSN stations all temperature conditions for avocados are met, apart from the annual extreme minimum temperature for VCSN station 21434. Even then, this temperature of -0.1°C is possibly acceptable with mitigation. This meeting of temperature criteria is perhaps not surprising considering that avocados are already grown throughout Northland.

Precipitation

New Zealand generally gets enough total rainfall for avocados, however the dry summers in Northland present a challenge. Irrigation is generally considered necessary in the summer for avocados grown here, so would likely be necessary in the Kaipara District as well.

3.3.3 Soil

Avocados are relatively deep-rooting trees and they require a potential rooting depth of at least 60 cm, and ideally above 90 cm. They also require free-draining soils to avoid waterlogging and anaerobic conditions developing in the rootzone. As shown in Figure 2 and Figure 3, the PRD and drainage classes in most of the areas considered suitable for horticulture is relatively poor, particularly the imperfect drainage class of soils on the plains around Dargaville and Ruawai. Avocados planted here would likely require soil mitigations such as mounding, which is common in other areas where avocados are grown, for example Kerikeri (Figure 5). However, Mangawhai and long stretches of the west coast of the Kaipara District appear to have suitable soils.

3.3.4 Recommendations

Avocados require fairly similar conditions to olives. Since both olives and avocados are already grown in Northland, there are likely to be many areas in the Kaipara District where the growing of avocados could be worth further investigation. The need for deep and free-draining soils could exclude Dargaville and Ruawai without soil mitigation. In terms of soil suitability however, Mangawhai and the west coast are potentially suitable areas.

4 CONCLUSIONS

Soils and broad climate data presented in this report are just part of the factors that contribute to the establishment of a horticultural enterprise that is economically viable. This data however does provide some guidance for the reader to prioritise areas for closer examination for development.

Using climate data from six NIWA Virtual Climate Station Network (VCSN) stations and additional soils data for the region we can conclude that:

4.1.1 Olives:

Since olives are already grown around Northland including the Kaipara District near Mangawhai, it is likely that there are other areas of the Kaipara District where olives would be a crop worthy of further investigation for establishment. Due to the warm, humid climate of Northland, pest and disease control will likely be required. Based on the need for deep, free-draining soils, the west coast around Dargaville and the Pouto Peninsula would potentially be suitable sites. Mounding of the soil might be needed where the soils have imperfect drainage.

4.1.2 Hops, hemp and CBD cannabis

In terms of day length and summer warmth, the Kaipara District is considered suitable for hops, hemp and CBD cannabis. Due to the warm, humid climate of Northland, pest and disease control will likely be required. There may also be mitigation requirements for poor draining soils such as those near Dargaville, and mounding of soils would be a possibility.

In the case of hops, excessive wind is likely to be a limitation, because hops are grown on 5 m high trellises, wind mitigation is very likely to be needed. This could potentially be in the form of shelterbelts, or alternative methods of growing hops, such as the short, three-metre trellises common in China. However, in the windiest parts of the Kaipara District, such as the Pouto Peninsula, it could be possible that the wind is so strong to make the growing of hops not possible, even with mitigation measures.

4.1.3 Avocados

Avocados require fairly similar conditions to olives. Since both olives and avocados are already grown in Northland, it is considered worthy of further investigation for cultivation in the Kaipara District. The need for deep and free-draining soils could exclude Dargaville and Ruawai without soil mitigation. However Mangawhai and the west coast are potentially suitable areas.

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