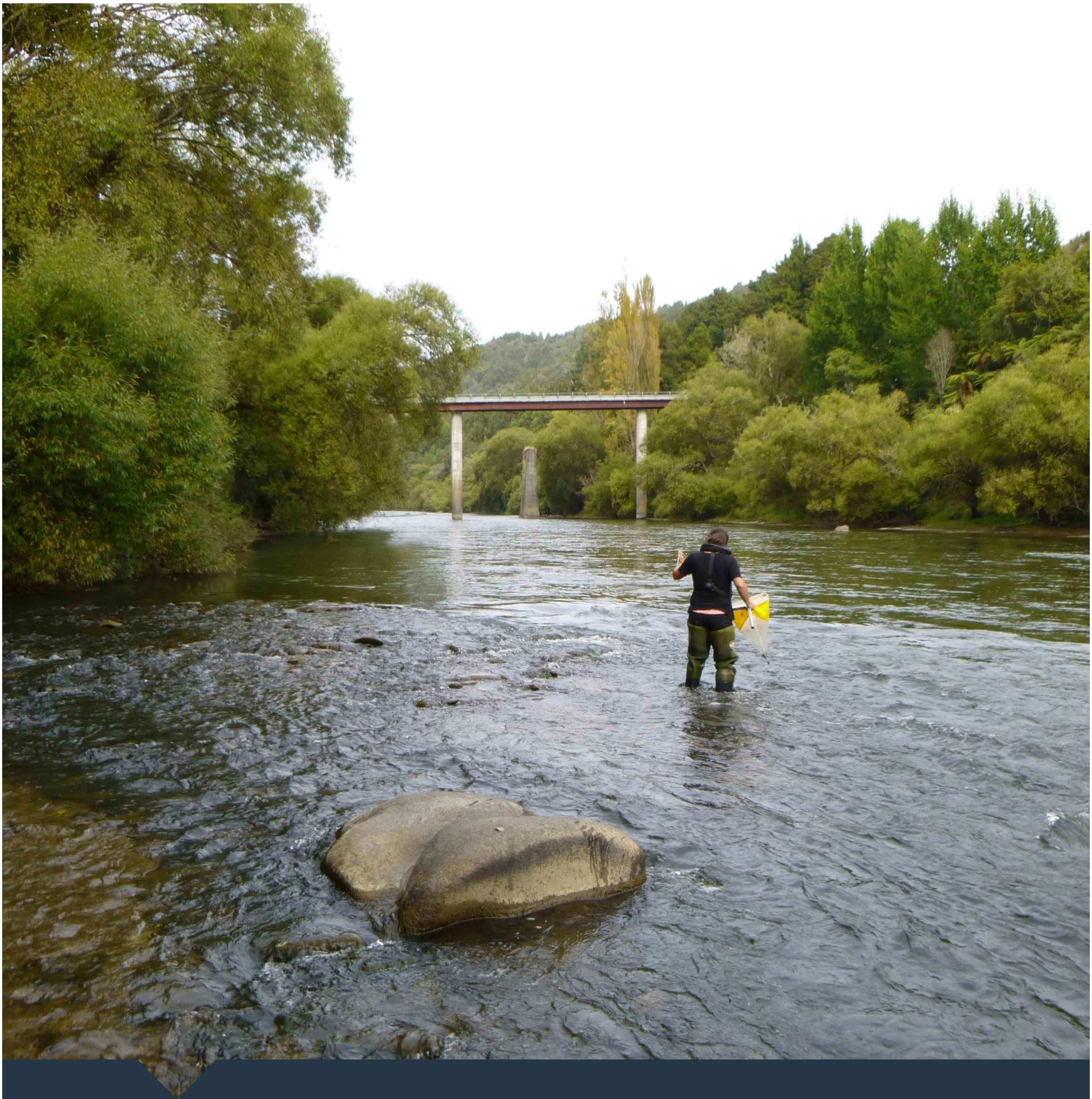

Remote sensing methods for tracking paddocks used for horticulture crops

May 2026

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REGIONAL COUNCIL

Prepared for:

Mike Patterson
Science Manager

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Prepared by:

Alexander C Aimes, Stella E Belliss, Benjamin H Jolly
Bioeconomy Science Institute Maiangi Taiao

CONTACT **24 hr Freephone 0508 800 800** **help@horizons.govt.nz** **www.horizons.govt.nz**

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POSTAL ADDRESS Horizons Regional Council, Private Bag 11025, Manawatū Mail Centre, Palmerston North 4442 | F 06 9522 929

Remote sensing methods for tracking paddocks used for horticulture crops

May 2026

Alexander C Amies, Stella E Belliss, Benjamin H Jolly

Bioeconomy Science Institute Maiangi Taiao

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Prepared for: Horizons Regional Council

Reviewed by:
James Shepherd
Senior Researcher - Remote Sensing and Research Priority Area Leader
Bioeconomy Science Institute

Approved for release by:
Melissa Robson-Williams
Group Portfolio Leader – Catalysing Change
Bioeconomy Science Institute

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Summary

Project and client

Horizons Regional Council (HRC) and the Bioeconomy Science Institute Maiangi Taiao (BSI) (Manaaki-Whenua – Landcare Research Group)[1] jointly funded a provisional study into robust methods for mapping and tracking paddocks used for horticultural cropping.

Objectives

- Conduct a pilot investigation of the Waimarino District to map and monitor horticultural cropping areas over three growing seasons: 2021–22, 2022–23, and 2023–24.
- Report results and recommend future research directions for capturing the full horticultural cropping cycle.

Methods

- Assemble time sequence of satellite imagery from Sentinel-2 for each of the three growing seasons.
- Carry out field investigation or, in the absence of fieldwork, examine Sentinel-2 and other imagery sources for evidence of horticultural cropping to create a limited time series of land cover information.
- Run the winter forage spectral analysis and rules methodology to separate winter cropping from winter pastures and horticultural cropping.
- Modify rules to capture summer land covers, crops, and bare ground areas, using bare ground in expected time windows as a likely indicator of horticultural cropping.
- Produce maps of Waimarino District for summer 2022, 2023, and 2024.
- Improve mapping accuracy by supplementing spectral signature library with signatures derived from collected potato and carrot crop paddock information from Canterbury as a best approximation of Waimarino spectral information.
- Briefly report results and recommendations.

Results

- We have produced maps of the likely horticultural crop paddocks of the Waimarino District for the 2022, 2023, and 2024 years, derived from semi-automated time-series satellite image analysis.
- We have provided these map layers as three shapefiles, one for each assessed year, containing polygons indicative of horticultural cropping. We have also provided a brief report describing the work.
- We have attributed the polygons with a likelihood of being representative of horticultural cropping, based on a heuristic set of rules applied to the polygons and the sequence of images used to derive the layers.

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[1] On 01 July 2025 Landcare Research New Zealand Ltd became the New Zealand Institute for Bioeconomy Science Ltd; Manaaki Whenua – Landcare Research operates as an internal group within this Institute, which is less formally known as the Bioeconomy Science Institute Maiangi Taiao or Bioeconomy Science Institute (BSI).

- Between each pair of growing years, paddocks that were found to have the highest likelihood of containing horticultural crops and were reused for cropping averaged 2.9% of the total area. The remaining polygons were not reused for horticultural cropping and represent the remainder of horticultural cropping polygons.

Conclusions

- Horizons Regional Council can be confident that the map layers show areas that were used for horticultural cropping in the Waimarino District in 2022, 2023, and 2024, especially when focusing only on the highest likelihood categories provided in the map layers. However, due to limited defensible ground truthing, they can be less sure that every horticultural cropping paddock within the study area was identified.
- In particular, we note that the accuracy of identification of paddocks containing parsnips or Brussels sprouts is likely to be low due the lack of ground truth data for these crops.

Recommendations

- Collect Waimarino District ground truth data in March of a future mapping year, when the horticultural crops are likely to be at full canopy cover, to add potato, carrot, parsnip, and Brussels sprouts information to our spectral library.
  - We could then continue the time series to gradually build the full 10-14 year crop movement pattern.
  - We could also re-run the earlier map layers to provide results with an improved confidence level.
- This additional ground truth data could also help crop classification work in other years, enabling us to progress delivery of the desired understanding of these crop movements over 10–14 year time intervals.
- If this work in the Waimarino District appears unable to continue, we recommend moving the test site. For HRC, this would be to the Levin area.

1 Introduction

Horizons Regional Council (HRC) and the Bioeconomy Science Institute Maiangi Taiao (BSI) (Manaaki Whenua – Landcare Research Group)[2] jointly funded a provisional study into robust methods for mapping and tracking paddocks used for horticultural cropping. The HRC are interested in more information on crop locations and crop rotations used in commercial vegetable growing. This knowledge will aid water quality resource accounting and modelling and will also assist HRC with policy development and implementation.

The two main horticultural cropping areas within the Horizons region are Levin – predominantly market gardens – and Waimarino – predominantly root vegetables. For this pilot project, we selected the Waimarino. This was for the reasons shown below.

- There are typically only four horticultural crops grown here (carrots, potatoes, parsnips and Brussels sprouts), simplifying this initial investigation.
- These crops are grown in paddocks of several hectares in size. Our current methodologies are based around paddock-level analyses and thus it is sensible to begin work at this scale, then move to the more complex and finer scale commercial vegetable-dominated scenarios.
- The Waimarino District is covered in full by a satellite orbit track and also in part by an adjacent orbit track on the western side. The Manawatū-Whanganui area is notably cloudy at most times of the year so this increases the opportunities for cloud-free imagery collection.

2 Background

The main horticultural crops grown in the Waimarino District are carrots and winter potatoes, with some parsnips and Brussels sprouts. Some of the potato crop may be for seed rather than for consumption. In this area horticultural cropping is typically secondary to the primary farming purpose of grazing sheep, cattle, dairy cows, or deer and is used as part of the regeneration of pastures. Typically, once a piece of land is worked up for the crop it is then planted in a forage crop – either cereal, kale, oats, or swede – and then resown back into pasture.

Potato and carrot crops are typically planted in October–December each calendar year and harvested February–September of the following one. The growing year is therefore defined as 1 October of one calendar year until 30 September of the following one. Carrots and potatoes cannot be grown in the same ground year after year because of the risk of disease, poor yields, and a huge drop in quality. At least a decade – and up to 14 years – will pass before a paddock is reused for the same horticultural crop.

[2] On 01 July 2025 Landcare Research New Zealand Ltd became the New Zealand Institute for Bioeconomy Science Ltd; Manaaki Whenua – Landcare Research operates as an internal group within this Institute, which is less formally known as the Bioeconomy Science Institute Maiangi Taiao or Bioeconomy Science Institute (BSI).

3 Objectives

- Conduct a pilot investigation of the Waimarino District to map and monitor horticultural cropping areas over three growing seasons: 2021–22, 2022–23, and 2023–2024.
- Report results and recommend future research directions for capturing the full horticultural cropping cycle.

4 Methods

4.1 Satellite imagery selection

We use imagery from the European Space Agency's (ESA) Sentinel-2 satellites for most of our regional and national mapping. These jointly collect imagery over the earth every five days. However, as part of the Waimarino District is in a satellite orbit track overlap area, the western side of the district can be covered twice every 5 days. Example coverages are shown in Figure 1.

The sensor on this satellite collects imagery at 10 spectral bands that we use for image analysis (as well as 3 others that we used for calibration). Four of these spectral bands have a spatial resolution of 10 m and six are at 20 m – this is an ideal pixel size for analysing New Zealand paddocks.

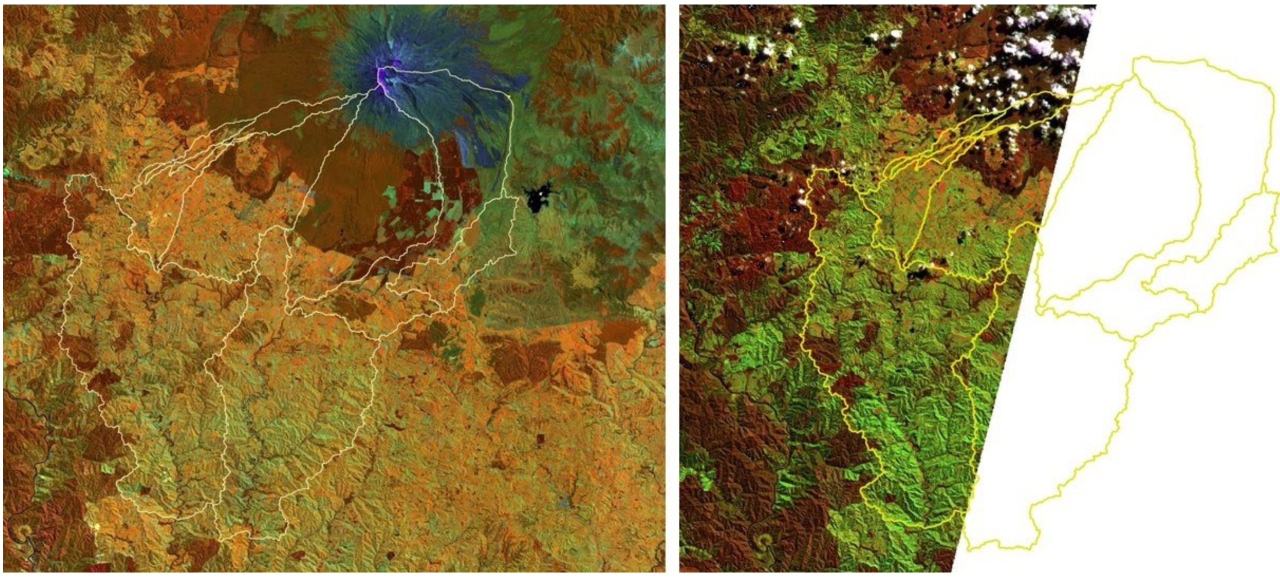

Figure 1. Examples of Waimarino District coverage from Sentinel-2 satellite orbit tracks. Left: orbit track 129 gives full coverage. This image was taken from a summer 23/24 national mosaic. Right: orbit track 29 provides coverage of the western side of the District, but not the eastern side. This image was taken on 28 March 2025 UT. These images are formed from a combination of near infrared, short-wave infrared, and red spectral bands. The yellow overlay in both images shows the boundaries of the Waimarino District.

Our first step was to inspect the available image sequence over the area of interest, culling all the very or completely cloudy scenes from the sequence. To provide an example of how much imagery is retained, Table 1 lists the imagery we used to perform the analysis the most recent time step of this project, 2023–24.

Table 1. Available Sentinel-2 images from which the 2023–24 horticultural crop map could be created. One of five classes was assigned to each image: excellent (dark green), very good (green), good (yellow), fair (orange), and too cloudy to be useful (grey)

Sentinel Satellite	2b		2a	
Pass ID	129	29	129	29
2023	2/09	5/09	7/09	10/09
	12/09	15/09	17/09	20/09
	22/09	25/09	27/09	30/09
	2/10	5/10	7/10	10/10
	12/10	15/10	17/10	20/10
	22/10	25/10	27/10	30/10
	1/11	4/11	6/11	9/11
	11/11	14/11	16/11	19/11
	21/11	24/11	26/11	29/11
	1/12	4/12	6/12	9/12
	11/12	14/12	16/12	19/12
	21/12	24/12	26/12	29/12
	31/12			
2024		3/01	5/01	8/01
	10/01	13/01	15/01	18/01
	20/01	23/01	25/01	28/01
	30/01	2/02	4/02	7/02
	9/02	12/02	14/02	17/02
	19/02	22/02	24/02	27/02
	29/02	3/03	5/03	8/03
	10/03	13/03	15/03	18/03
	20/03	23/03	25/03	28/03
	30/03	2/04	4/04	7/04
	9/04	12/04	14/04	17/04
	19/04	22/04	24/04	27/04
	29/04	2/05	4/05	7/05
	9/05	12/05	14/05	17/05
	19/05	22/05	24/05	27/05
	29/05	1/06	3/06	6/06
	8/06	11/06	13/06	16/06
	18/06	21/06	23/06	26/06
	28/06	1/07	3/07	6/07
	8/07	11/07	13/07	16/07
	18/07	21/07	23/07	26/07
	28/07	31/07	2/08	5/08
	7/08	10/08	12/08	15/08
	17/08	20/08	22/08	25/08
	27/08	30/08	1/09	4/09
	6/09	9/09	11/09	14/09
	16/09	19/09	21/09	24/09
	26/09	29/09		

4.2 Satellite imagery preprocessing

First, these satellite images were run through our automated processing pipeline on the REANNZ high-performance computing platform to take the ‘raw’ imagery and render it ready for analysis. This involved:

- re-projection to the NZ Transverse Mercator map grid
- re-sampling of the 20m bands to match the 10m bands using a sharpening technique
- radiometric and atmospheric calibrations
- cloud and cloud shadow detection
- processing through to a topographically ‘flattened’ product to minimise brightness variations in hill country.

We then limited the extent of the imagery to the area of interest and masked out all but the agricultural/horticultural land within the Waimarino District. The mask used for this work is derived from Land Cover Database (LCDB), version 5 and removes rivers, urban areas, forest, scrub and Department of Conservation land. This simplified the subsequent image processing and helped avoid false positive land parcels appearing in the final map layers.

4.3 Fieldwork and/or use of spectral signature library

We were unable to carry out a comprehensive field investigation for this project. Instead, we relied upon the processes outlined below.

- We used a library of spectral signatures that has been accreting gradually from our previous winter forage mapping work. The spectral signatures in this library align with a set of pre-determined land cover classes, of which certain combinations of expected landcovers are included within each regional/group of regional sets.
- For the Waimarino District, we used a set of such signatures that has previously been used for Manawatū-Whanganui winter forage mapping. This spectral signature set contains signatures for kale, rape, fodder beet, swedes, turnips, leafy turnips, cereals such as wheat, oats and barley, bare ground, stubble, and a variety of pastures. It does not include signatures for carrots, potatoes, parsnips, or Brussels sprouts.
- We used pseudo-ground truth data gleaned from examining the time series of Waimarino satellite images and creating map layers of paddocks that:
    - looked particularly lush at that date and might be a horticulture crop at full canopy cover
    - were partially bare at that date and the bare:non-bare portions were linear rather than random – and thus might be potatoes or carrots at harvest
    - were bare at that date and might thus have been harvested
    - were, based on our experience, likely to be winter forage crops rather than horticulture crops when considering the bare and vegetated dates through the complete time series.
- Google Street View imagery in the Waimarino District was also searched for evidence of horticultural crops. One paddock planted carrots was identified in 2024 imagery, which was used to validate the existing spectral signature library's classifications.
- Later, after the initial mapping, additional ground truth potato and carrot crop information was gathered in Canterbury in December 2025. Spectral signatures were created from this field data and were used to supplement the existing spectral library. These signatures were used

as a substitute for in-region spectral signatures and allowed for a comparison between layers derived with and without crop-specific spectral information. Lack of ground truth for parsnips and Brussels sprouts meant that attempts to classify these crops in the Waimarino District imagery were abandoned.

4.4 Paddock boundary mapping

We have in-house automated paddock boundary mapping routines that derive paddock boundaries from a subset of the full time-series of images and also ‘burns’ in the road networks. This enabled analysis to be performed at a per-paddock, rather than per-pixel level, boosting the classification accuracy of the algorithm.

4.5 Spectral classification of images and per-paddock identification of horticultural crops

We initially carried out an investigation into the feasibility of identifying horticultural crops without spectral signatures representing these crops. This approach used the identification of bare ground in the summer growing season, relying on the spectral signature library developed for identifying winter forage crops. To guide development of rules that used bare ground identification, it was assumed that relevant crops would be planted before 15 November and harvested between 15 December and 30 April. The slope of each polygon was also determined by taking a per-10 m pixel mean of a slope layer derived from the LINZ NZ 8 m Digital Elevation Model (DEM). Evidence of a moderate to high slope angle within a paddock decreases the probability that the paddock would be used for horticultural cropping. A heuristic for assessing the likelihood that each instance of classified bare ground was a signifier of horticultural cropping was developed:

- VegChance = 3 IF Bare before 15 November AND Bare after 15 December AND Bare observed for at least 7 days or 2 consecutive images AND not winter forage AND average slope < 7 deg AND area < 50 ha
- VegChance = 2 IF Bare after 15 December AND Bare observed for at least 7 days or 2 consecutive images AND average slope < 7 deg AND area < 50 ha
- VegChance = 1 IF Bare after 15 December AND average slope < 14 deg AND area < 50 ha.

We reviewed the polygon layers generated using these rules and, through desktop analysis, found the results to contain too many false positives to be satisfied with this approach. It was determined that the inclusion of supplemental spectral signatures of relevant crops was required for more accurate classification. After collecting limited field data for two horticultural crops (potatoes and carrots) from a different region (Canterbury), we developed spectral signatures by examining imagery close in time to the field collection date. The developed spectral signatures were used to reclassify each per-date image, and the polygon aggregations of these classifications were also redeveloped.

Preliminary analysis of per-image spectral classifications showed the value of obtaining ground truth in accurately classifying horticultural crops. The layers generated using the previous set of rules were discarded, and a new set of rules was applied which leveraged this new information:

- VegChance = 4 IF Bare between 15 December and 30 April AND Bare before 15 November AND Dominant land cover is potatoes or carrots between both bare dates AND average slope < 7 deg

- VegChance = 3 IF Bare between 15 December and 30 April AND Dominant land cover is potatoes or carrots between 15 December and bare date AND average slope < 7 deg
- VegChance = 2 IF Bare between 15 December and 30 April AND average slope < 7 deg
- VegChance = 1 IF Bare between 15 December and 30 April AND average slope < 10 deg.

For all VegChances categories, at least one date in the period between 1 November and 30 April must have an average NDVI of 0.84 or greater, which indicates full crop canopy cover. The developed maps were cleaned by dissolving paddock polygons by VegChance. Due to the tendency of the paddock boundary delineation algorithm to over-segment agricultural land, remnant isolated polygons smaller than 1 ha were removed as they were unlikely to represent actual horticultural cropping paddocks due to their small size.

4.6 Spectral classification of images and per-paddock identification of winter forages

Spectral classification of land cover provides insufficient evidence in distinguishing crops grown for horticulture from crops grown for other reasons. For instance, some paddocks used to grow winter forage crops may be bare at similar times of the year to those used to grow horticultural crops. Identifying paddock land use is therefore useful in removing false positives from the final horticultural crop layer.

To separate out the winter forage crops from other crops in the layers created using the methods described in Section 4.5, we used imagery from March to September of each relevant growing year to capture them at maximum leaf cover (March-May) and then grazed down in winter (June-August). The method used for this aspect of the work has been demonstrated and further documented in Belliss et al. (2022), Belliss et al. (2023), and Amies et al. (2024).

All images in this time series were classified to the key land covers at a per-pixel level using standard Maximum Likelihood spectral classification in the Manawatū-Whanganui spectral signature set. Then, our classification rules were applied to the time series of land-cover classifications to identify winter forage as a land use at the paddock polygon level.

Ideally, we expected this method to give a positive identification of a specific winter forage land cover in the autumn images, followed by observation of the polygon becoming bare soil in the winter images. However, the evidence for other polygons could be weaker (e.g. where the forage crop is difficult to identify, where there is a lack of image coverage in later winter/early spring, or where the green vegetation cover reduces significantly in winter, but bare soil is not found).

Depending on the certainty of the land cover classification, each polygon was assigned a confidence rating:

- CertRating3 = high = all evidence available
- CertRating2 = medium = the paddock goes bare by the end of the time series but the classification is unsure
- CertRating1 = low = although it might be a forage paddock, there are too few image dates to display the expected vegetation-to-bare pattern.
- CertRating0 = non-forage = all evidence indicates that the paddock does not contain a forage crop.

Polygons that were assigned a non-zero CertRating were discarded from the final layers of horticultural crops. Using this methodology to separate out the winter forage paddocks from all cropping paddocks, the remaining polygons flagged using the methods described in Section 4.5 were thus considered as likely candidates to contain the horticultural crops we are seeking to map.

5 Results

We have produced a map of the winter forage and likely crop paddocks of the Waimarino District for 3 years (2022, 2023, 2024) using time-series satellite images. We provided this map to HRC as three annual shapefiles, with nominal mapping dates of 30 April 2022, 2023, and 2024.

The attributes present in the map layers are listed below.

- PolygonID: An identifier for the horticultural cropping polygon that is unique to the shapefile.
- VegChance: The likelihood that the polygon is associated with horticultural cropping based on the rules described in the Section 4.5.
- Crop: The most commonly associated crop with the polygon through the vegetated period (after and including VegD1 and before BareD2). The possible values are potato and carrot, with blank values indicating that there was no spectral majority of either crop type in the sequence.
- MeanSlope: The average slope of the paddock.
- BareD1: The first date in the sequence the paddock was observed to be bare.
- VegD1: The first date in the sequence after BareD1 that the paddock was observed to not be bare.
- BareD2: The first date in the sequence after VegD1 and after 15 December that the paddock was observed to be bare.

Figure 2 gives an example of the 2024 map. The map contains only the polygons found to contain horticultural cropping areas for that year, with each polygon having a VegChance based on how the imagery was classified in each image.

The number of polygons representing horticultural cropping in the Waimarino growing areas, along with the area in hectares that these polygons represent, are shown in Table 2. These counts and areas are broken down by the VegChance metric (score), where higher scores indicate a higher likelihood of the polygon actually representing an area of horticultural cropping. VegChance scores of 4 and 3 are only achieved if the majority land cover in the vegetated period spectrally matched a known horticultural crop, while lower scores merely indicated bare periods that were expected in horticultural cropping temporal patterns. Maps of the horticultural cropping polygons are shown in Figure 3.

Table 2. The number of polygons, and the sum of their areas, in each of the three annual crop layers. These polygons have been separated by their VegChance metric (score), with higher values representing higher chances of being true positives

	2021–22		2022–23		2023–24	
VegChance	**Count**	**Area (ha)**	**Count**	**Area (ha)**	**Count**	**Area (ha)**
4	39	140	49	269	27	117
3	23	109	20	113	10	50
2	170	780	51	252	64	377
1	62	210	15	69	4	10

Developing a map of horticultural cropping areas over three consecutive years allows for an analysis of repeated use of land for cropping. Table 3 shows the areas used for horticultural cropping in consecutive years. These results show polygons with the two highest VegChance scores separated from the total set of polygons, allowing us to estimate lower and upper bounds of 2.9% and 13.8%, respectively, of mean annual land reuse for horticultural cropping.

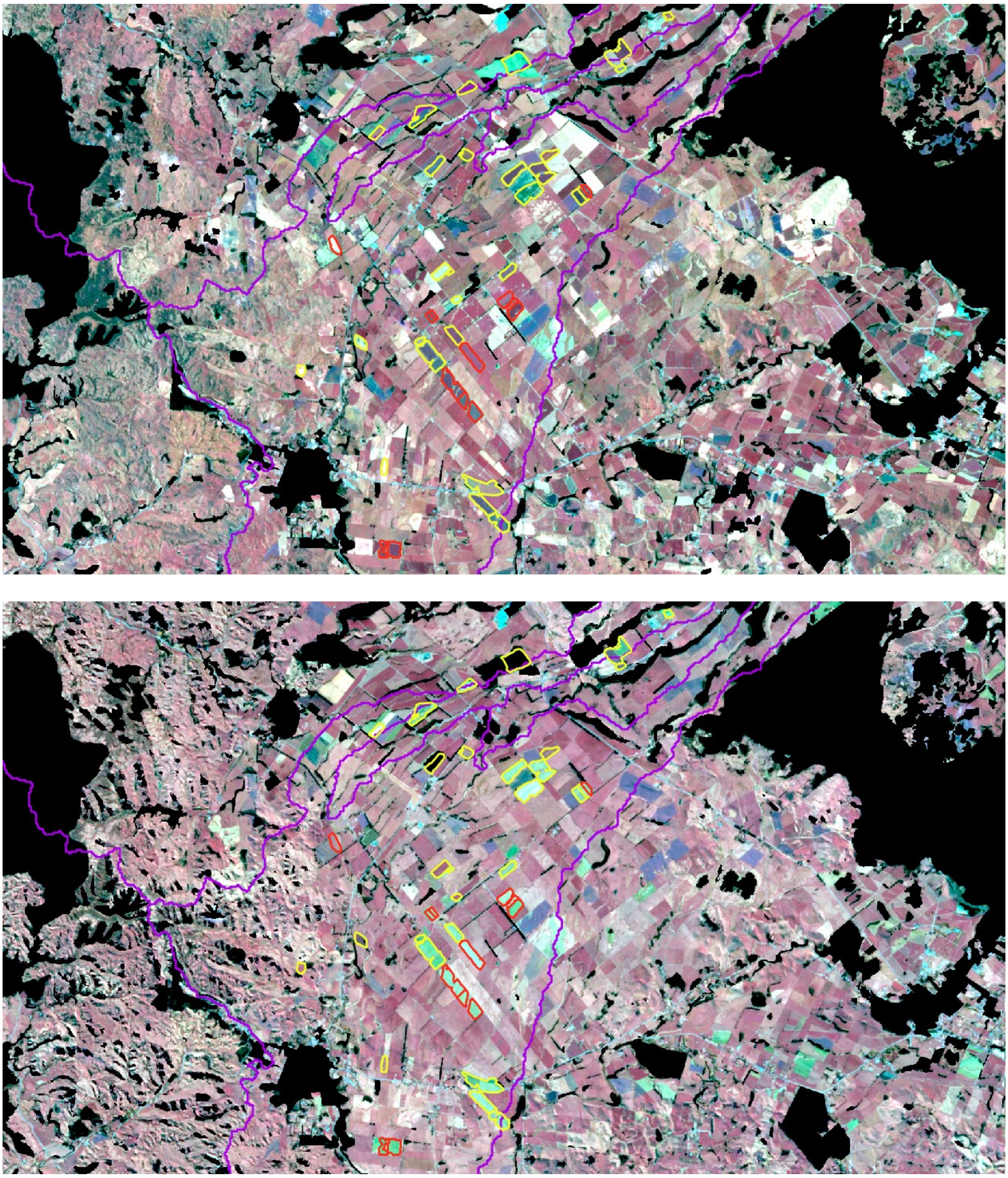

Figure 2. Images taken from 7 February 2024 (Top) and 29 April 2024 (Bottom) showing the output of the horticultural crop classification method for the 2023–24 season. Paddocks highlighted in red in these images have VegChance = 4, while paddocks in yellow have VegChance = 2. The Waimarino growing areas are highlighted in purple. These images are formed from a combination of short-wave infrared, red, and blue spectral bands to clearly show leafy crops in dark blue tones, and bare ground in pale green.

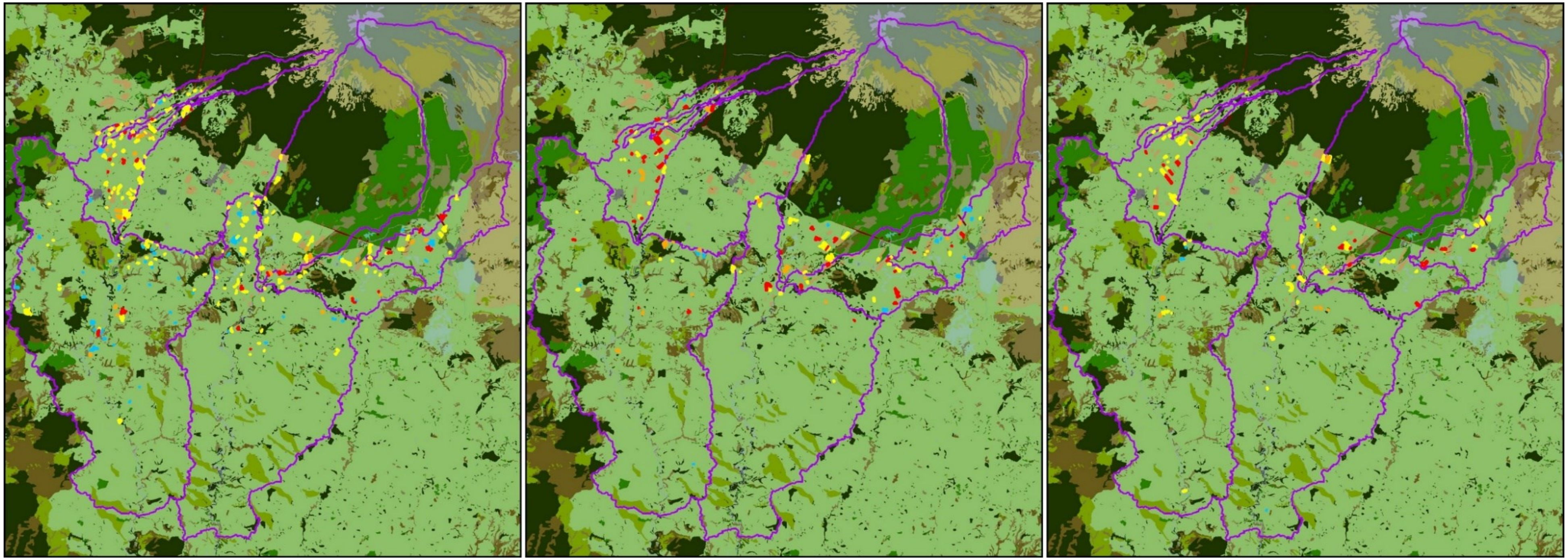

Figure 3. The map layers delivered to Horizons Regional Council (from left to right: 2022, 2023, and 2024), shown with the Land Cover Database version 6.0. Paddocks highlighted in red in these images have VegChance = 4, paddocks in orange have VegChance = 3, paddocks in yellow have VegChance = 2, and paddocks in blue have VegChance = 1. The Waimarino growing areas are highlighted in purple.

Table 3. Areas found to be planted with any horticultural crop in consecutive years, between 2022 and 2023, between 2023 and 2024, and an average of those periods. These areas are reported as areas having VegChance 3 and 4 scores in both years, and areas having any VegChance in both years. The percentage area denominator is the area of horticultural cropping in the first year of each pair. Polygons that are overlapped by less than 5% are omitted

	Overlap between 2022 and 2023			Overlap between 2023 and 2024			Two-year average		
	Count	Area (ha)	Area (%)	Count	Area (ha)	Area (%)	Count	Area (ha)	Area (%)
VegChance 3 and 4	5	9	3.7%	2	9	2.4%	4	9	2.9%
All VegChance	33	132	10.7%	22	135	19.3%	28	134	13.8%

The introduction of spectral signatures for potatoes and carrots into the spectral signature library made it possible to estimate the number of polygons which corresponded to each crop type. The results of this analysis are shown in Table 4. Note that this table only includes polygons which had VegChance 3 or 4: these were the categories that required evidence of horticultural crop in the time series of images, not just evidence of bare ground.

Table 4 The crops found in polygons from each map layer. Unknown crop type means that those areas lacked a majority of a particular crop type in their vegetated periods

	2021–22		2022–23		2023–24	
	Count	Area (ha)	Count	Area (ha)	Count	Area (ha)
Potatoes	36	153	49	263	28	120
Carrots	18	68	9	48	6	28
Unknown	8	29	11	71	3	19

6 Conclusions

Horizons Regional Council can be confident that the map layers show areas that were used for horticultural cropping in the Waimarino District in 2022, 2023, and 2024, especially when focusing only on the highest likelihood categories provided in the map layers. The inclusion of spectral signatures representing two of the expected crops found in the Waimarino region (potatoes and carrots), despite being taken from a different region, appeared to increase accuracy of horticultural crop detection as expected. For instance, in the 2022 map, the introduction of potato and carrot spectral signatures and associated heuristic change helped to detect an additional 419 ha of horticultural land, and to remove 2,549 ha of land from the layer that very likely was not horticultural land.

However, it is likely that the developed spectral signatures of these crops did not represent the full range of appearances of these crops in the Waimarino region. This will cause reduced model accuracy and, in particular, will limit the layers' usefulness in distinguishing between potatoes and carrots. The lack of spectral signatures for other crops, especially for parsnips and Brussels sprouts, meant that these crops could not be identified. It is notable that the planting and harvesting of these crops is most similar in a spectral sense to that of winter grazing, so it is particularly difficult to detect these crops from bare ground observation alone.

There was a small but observable reuse of land between years for horticultural cropping. Only 2.9% of the land that was found to be horticultural cropping land (VegChance 3 and 4) in a particular year was also used for horticultural cropping the following year. The proportion of reused land between years was larger (13.8%) when all VegChance values were considered. With the limited ground truth data available, we cannot confirm what proportion of reused land was planted with identical crops.

7 Recommendations

Collecting Waimarino District ground truth data in March, when the horticultural crops are at likely to be at full canopy cover, to add potato, carrot, parsnip, and Brussels sprouts information to our spectral library would improve crop detection accuracy. With this data, we could:

- continue this time series to gradually build the full 10–14 year crop movement pattern. We could also re-run the earlier map layers to provide results with an improved confidence level.
- use this ground truth data to also help crop classification work in other years, enabling us to progress delivery of the desired understanding of these crop movements over 10–14 year time intervals.

If continuation of this work in the Waimarino District is not feasible, we recommend moving the study location. Within the boundaries of the Horizons Regional Council area, the Levin area may be suitable.

8 References

Amies A, Belliss S, Pairman D. 2024. National intensive winter grazing mapping for winter 2023. Manaaki Whenua – Landcare Research Contract Report LC4419, prepared for Regional Software Holdings Limited.

Belliss S, Amies A, Pairman D, North H. 2023. National intensive winter grazing mapping for winter 2022. Manaaki Whenua – Landcare Research Contract Report LC4246, prepared for Regional Software Holdings Limited.

Belliss S, Amies A, Pairman D, North H. 2022. National winter forage – intensive winter grazing map for winter 2021. Manaaki Whenua – Landcare Research Contract Report LC4149, prepared for Regional Software Holdings Limited.

Appendix 1 – Horticultural Cropping Maps

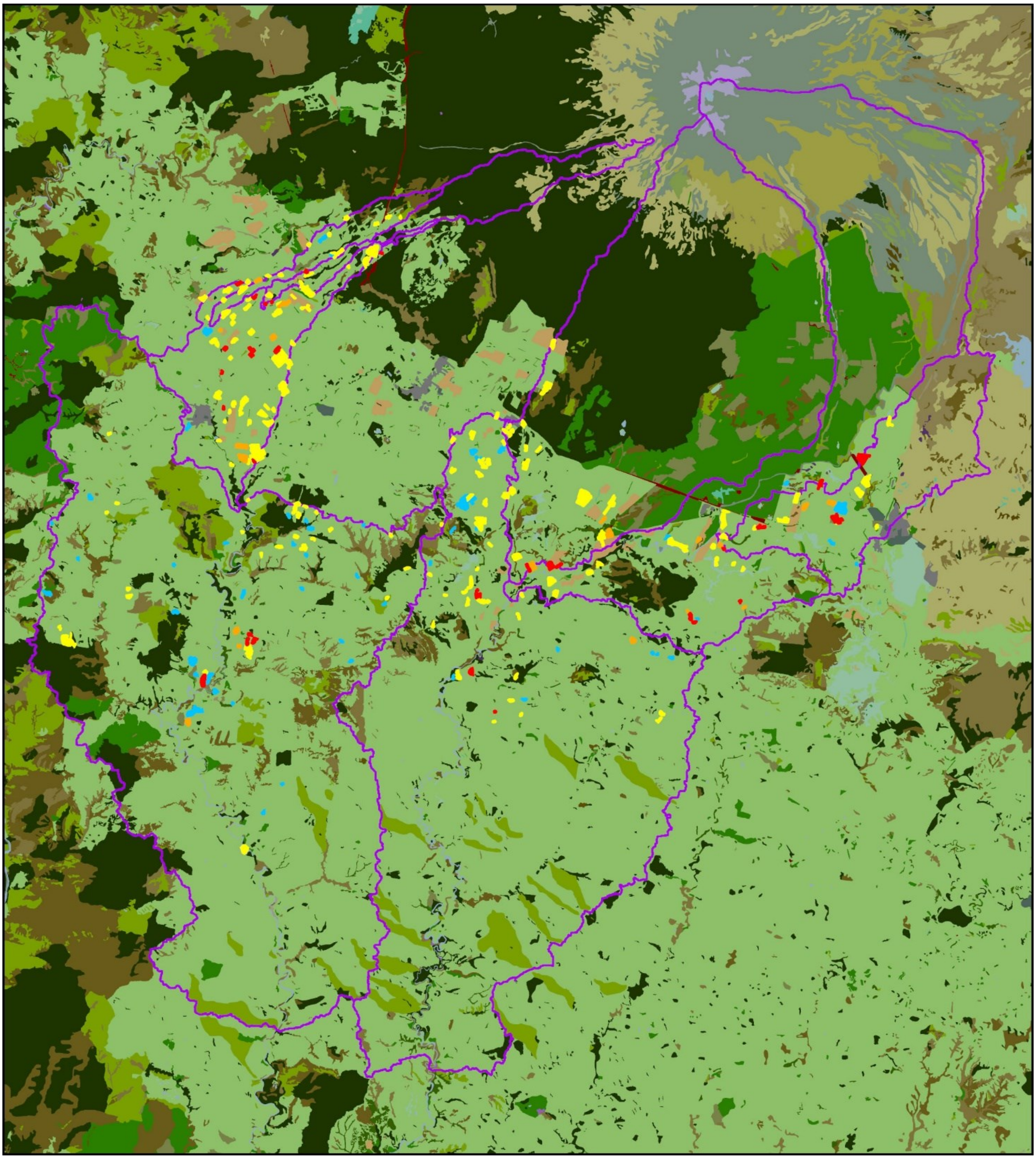

Figure A1. The 2022 map layer delivered to Horizons Regional Council, shown with the Land Cover Database version 6.0. Paddocks highlighted in red in these images have VegChance = 4, paddocks in orange have VegChance = 3, paddocks in yellow have VegChance = 2, and paddocks in blue have VegChance = 1. The Waimarino growing areas are highlighted in purple.

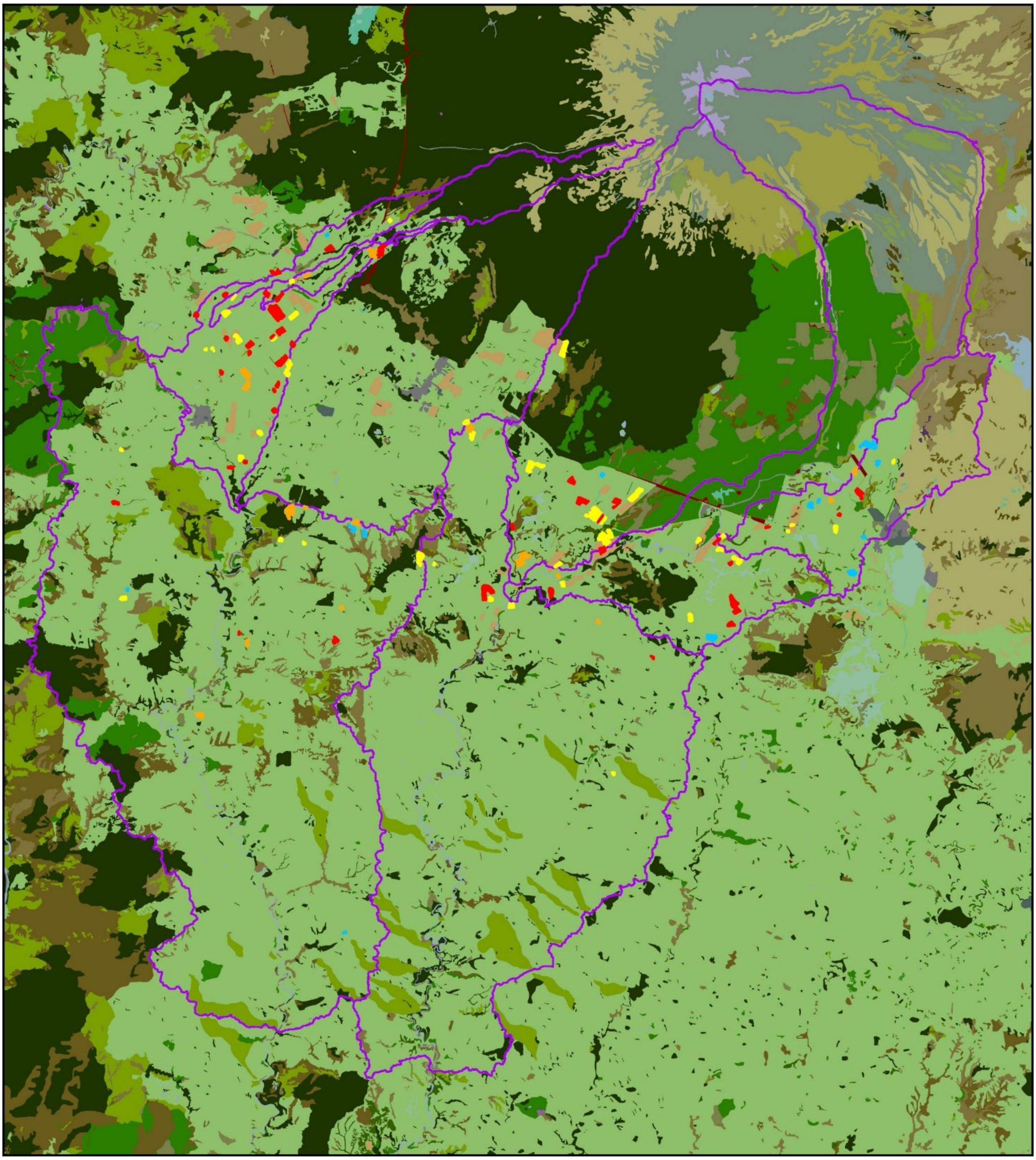

Figure A2. The 2023 map layer delivered to Horizons Regional Council, shown with the Land Cover Database version 6.0. Paddocks highlighted in red in these images have VegChance = 4, paddocks in orange have VegChance = 3, paddocks in yellow have VegChance = 2, and paddocks in blue have VegChance = 1. The Waimarino growing areas are highlighted in purple.

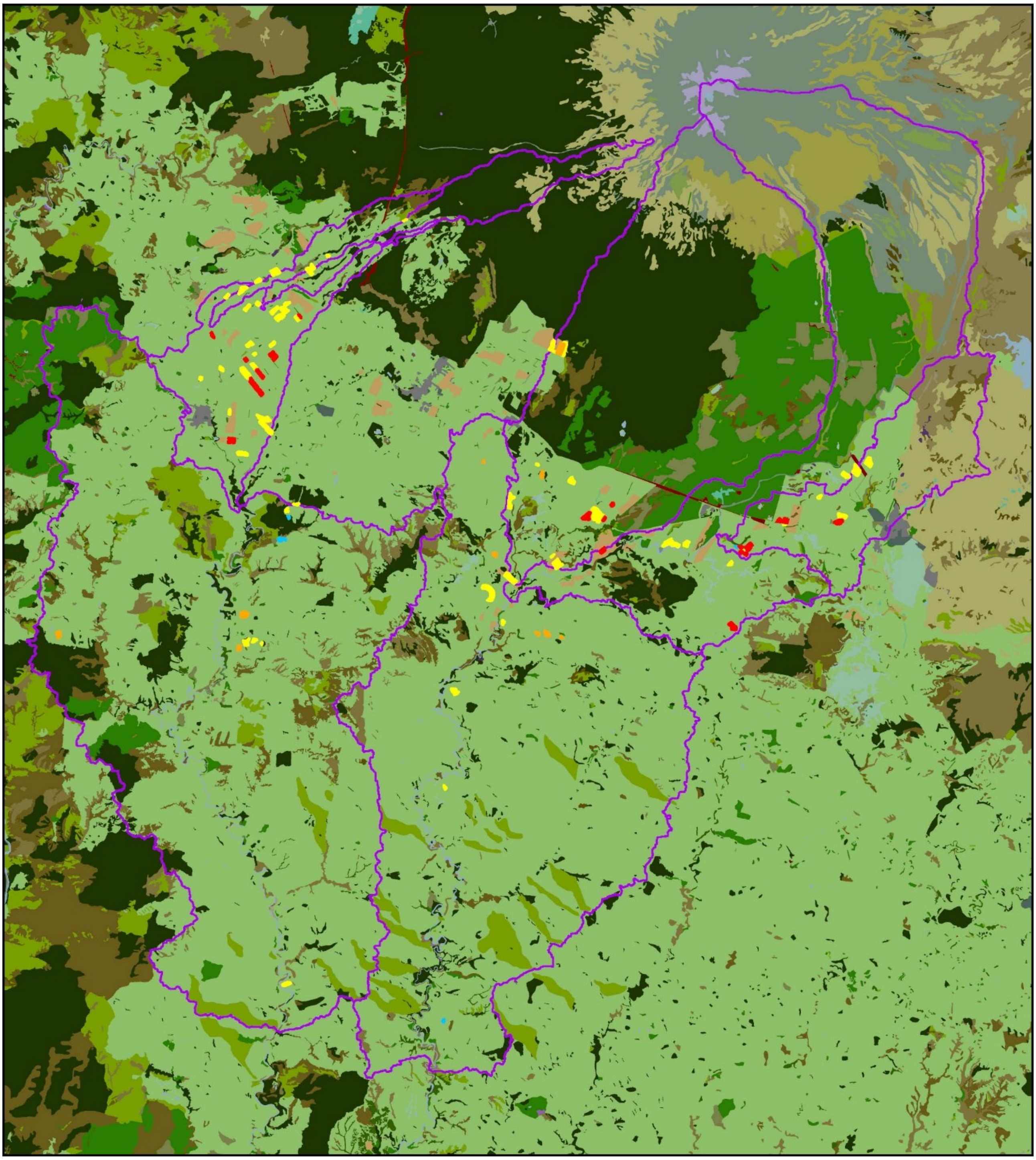

Figure A3. The 2024 map layer delivered to Horizons Regional Council, shown with the Land Cover Database version 6.0. Paddocks highlighted in red in these images have VegChance = 4, paddocks in orange have VegChance = 3, paddocks in yellow have VegChance = 2, and paddocks in blue have VegChance = 1. The Waimarino growing areas are highlighted in purple.

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REGIONAL COUNCIL

horizons.govt.nz

24 hour freephone 0508 800 800
fax 06 952 2929 | **email** help@horizons.govt.nz
Private Bag 11025, Manawatu Mail Centre, Palmerston North 4442