National Scan of Vineyards of Australia 2019

Milestone Report Y2.3

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Version 1.0

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Introduction **4**

1. Headline Results **4**

1.1 Scan Summary 4

1.2 Western Australia 6

1.3 Tasmania 6

1.4 South Australia 7

1.5 Victoria 8

1.6 New South Wales 9

1.7 Queensland 10

2. Completing National Vintage Scan 2019 **11**

2.1 Areas of Interest (AOIs) used for NVS2019 12

2.2 Imagery availability for NVS2019 24

2.3 Change of registration data source for NVS2019 25

3. National Scan Quality Assurance **27**

3.1 Quality Assurance Summary Statistics 28

3.2 Vineyard Area Error Analysis 29

4. Quality Assurance in Western Australia **30**

4.1 Margaret River 31

4.2 Swan Valley #1 33

4.3 Mount Barker 35

4.4 Geographe 37

4.5 Swan Valley #2 39

5. Quality Assurance in Tasmania **41**

5.1 Tasmania North 43

5.2 Tasmania South 44

6. Quality Assurance in South Australia **45**

6.1 Riverland 46

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6.2 Clare Valley 48
6.3 Wrattonbully 50
6.4 Barossa Valley 52
6.5 Adelaide Hills 54
6.6 Coonawarra 56
6.7 McLaren Vale 58

7. Quality Assurance in Victoria 60

7.1 Murray Darling VIC #1 61
7.2 King Valley 63
7.3 Goulburn Valley 65
7.4 Yarra Valley 67
7.5 Strathbogie Ranges 69
7.6 Grampians 71
7.7 Gippsland 73
7.8 Mornington Peninsula 75
7.9 Murray Darling VIC #2 77

8. Quality Assurance in New South Wales 79

8.1 Riverina 80
8.2 Canberra District 82
8.3 Hunter 84
8.4 Orange 86
8.5 Shoalhaven Coast 88
8.6 Swan Hill (NSW) 90

9. Quality Assurance in Queensland 92

9.1 South Burnett 93
9.2 Granite Belt 95

Acknowledgements 97

Appendix 1 - Document Revision History 98

Version 1.0 - X January 2020 98

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Introduction

In this document we first present the headline results for the National Vintage Scan 2019 (NVS2019) and provide high-level data relating to the total area of satellite imagery on which GAIA's machine learning algorithm was run. Following this we detail, for each state, the total area of vineyards and total length of vine rows within each Geographical Indication (Zones, Regions and Subregions).

The results we present to Wine Australia herein represent the 2nd time satellite imagery over Australia has been used to measure and report on production capacity of the Australian wine industry. With NVS2019 being undertaken some 6 months after the completion of NVS2018, many of the systems and processes used for NVS2018 remain the same for NVS2019. However, being the 2nd scan and starting from *something* and not *nothing*, there are also many things that have changed for NVS2019. A comprehensive examination of the how and why of completing NVS2019 is detailed in 2. Completing National Scan 2019.

The remainder of this report is devoted to the presentation of the Quality Assurance (QA) results. The QA results are presented by state as follows:

- Western Australia (Section 4)
- Tasmania (Section 5)
- South Australia (Section 6)
- Victoria (Section 7)
- New South Wales (Section 8)
- Queensland (Section 9)

1. Headline Results

1.1 Scan Summary

GAIA scanned Australia on a state-by-state basis for NVS2019. In total, **16,934** areas of interest (AOIs) within **836** different satellite captures were passed through GAIA's machine learning infrastructure. The total area of the AOIs covered **~3.7 million hectares** of imagery from the current vintage growing season.

After the outputs were manually reviewed, the total area of vineyard blocks was found to be **146,244** hectares. This represents a slight increase from the value of 146,128 hectares reported for NVS2018. The results, presented in Table 1, have an increase in the total area of vineyards for SA, NSW (including ACT) and QLD, whereas a decrease for WA, TAS and VIC. The decrease in reported vineyard area for these 3 states has been investigated and can predominantly be attributed to the removal of ***false positives***. False positives are where GAIA has indicated that vineyards exist, but where no vineyards actually exist; for example, an orchard may have been identified as a vineyard. Specifically, enhanced human review of GAIA's machine generated output for NVS2019 has led to the removal of many such false positives from the data set. Thus, it should be emphasised that the values reported for NVS2019 more accurately represent the on-ground reality than NVS2018. Identification of many of

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these false positives, and indeed general improvements to the scan results for NVS2019, are the result of feedback provided by users of the GAIA NVS2018 vineyard maps. Consilium Technology thanks everyone that has provided feedback on GAIA.

Table 1. *Summary statistics of wine vineyard block area for each state and Australia.*

State	Total area "scanned" (ha)	Total area of vineyards (ha)
WA	209,901	10,784
TAS	257,423	1,702
SA	948,558	76,292
VIC	764,693	22,151
NSW (incl ACT)	1,249,170	34,641
QLD	274,990	674
TOTAL	3,704,735	146,244 ± 8,347

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1.2 Western Australia

Table 2. *Vineyard area for all Geographical Indications in WA.*

GI name	GI type	Total area of vineyards (ha)
Central Western Australia	Zone	42
Eastern Plains Inland and North	Zone	0
Greater Perth	Zone	849
South West Australia	Zone	9893
Western Australia South East Coastal	Zone	0
Blackwood Valley	Region	309
Geographe	Region	790
Great Southern	Region	2480
Manjimup	Region	153
Margaret River	Region	5671
Peel	Region	52
Pemberton	Region	466
Perth Hills	Region	119
Swan District	Region	709
Albany	Subregion	80
Denmark	Subregion	89
Frankland River	Subregion	1323
Mount Barker	Subregion	868
Porongurup	Subregion	96
Swan Valley	Subregion	525

1.3 Tasmania

Table 3. *Vineyard area for all Geographical Indications in Tasmania.*

GI name	GI type	Total area of vineyards (ha)
Tasmania	Zone (state)	1702

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1.4 South Australia

Table 4. *Vineyard area for all Geographical Indications in SA.*

GI name	GI type	Total area of vineyards (ha)
Barossa	Zone	13519
Far North	Zone	176
Fleurieu	Zone	15318
Limestone Coast	Zone	15405
Lower Murray	Zone	22261
Mount Lofty Ranges	Zone	9541
The Peninsula	Zone	72
Adelaide Hills	Region	3832
Adelaide Plains	Region	498
Barossa Valley	Region	11156
Clare Valley	Region	4994
Coonawarra	Region	5293
Currency Creek	Region	1054
Eden Valley	Region	2102
Kangaroo Island	Region	145
Langhorne Creek	Region	6094
Mclaren Vale	Region	7173
Mount Benson	Region	535
Mount Gambier	Region	274
Padthaway	Region	4067
Riverland	Region	21816
Robe	Region	677
Southern Fleurieu	Region	488
Southern Flinders Ranges	Region	176
Wrattonbully	Region	2666
High Eden	Subregion	391
Lenswood	Subregion	245
Piccadilly Valley	Subregion	221

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1.5 Victoria

Table 5. *Vineyard area for all Geographical Indications in Victoria.*

GI name	GI type	Total area of vineyards (ha)
Central Victoria	Zone	4363
Gippsland	Zone	187
North East Victoria	Zone	2903
North West Victoria	Zone	8656
Port Phillip	Zone	4329
Western Victoria	Zone	1714
Alpine Valleys	Region	241
Beechworth	Region	127
Bendigo	Region	610
Geelong	Region	467
Glenrowan	Region	205
Goulburn Valley	Region	1214
Grampians	Region	640
Heathcote	Region	1696
Henty	Region	139
King Valley	Region	1483
Macedon Ranges	Region	215
Mornington Peninsula	Region	920
Murray Darling Vic	Region	6736
Pyrenees	Region	870
Rutherglen	Region	779
Strathbogie Ranges	Region	534
Sunbury	Region	101
Swan Hill Vic	Region	1915
Upper Goulburn	Region	289
Yarra Valley	Region	2536
Great Western	Subregion	468
Nagambie Lakes	Subregion	513

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1.6 New South Wales

Table 6. *Vineyard area for all Geographical Indications in NSW.*

GI name	GI type	Total area of vineyards (ha)
Big Rivers	Zone	25213
Central Ranges	Zone	4512
Hunter Valley	Zone	2609
Northern Rivers	Zone	136
Northern Slopes	Zone	115
South Coast	Zone	302
Southern New South Wales	Zone	1748
Western Plains	Zone	8
Canberra District	Region	330
Cowra	Region	932
Gundagai	Region	595
Hastings River	Region	13
Hilltops	Region	595
Hunter	Region	2609
Mudgee	Region	1922
Murray Darling Nsw	Region	6754
New England Australia	Region	77
Orange	Region	1060
Perricoota	Region	416
Riverina	Region	17248
Shoalhaven Coast	Region	41
Southern Highlands	Region	140
Swan Hill Nsw	Region	171
Tumbarumba	Region	215
Broke Fordwich	Subregion	510
Pokolbin	Subregion	1355
Upper Hunter Valley	Subregion	471

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1.7 Queensland

Table 7. *Vineyard area for all Geographical Indications in QLD.*

GI name	GI type	Total area of vineyards (ha)
Granite Belt	Region	317
South Burnett	Region	218

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2. Completing National Vintage Scan 2019

The production of NVS2019 saw many improvements to process, but also additional challenges to overcome. At a technical level, the mechanisms for running the scan at scale were improved to streamline the generation of data and reduce the possibility of human error. The generation of statistics and metrics was optimised and broadened, to provide more insight and allow for faster iteration on scan data.

The search areas that were scanned in the pursuit of vineyard geolocation were refined from those used in NVS2018 as described in 2.1 Areas of Interest (AOIs) used for NVS2019 and 2.2 Imagery availability for NVS2019. The proportion of satellite data available from the ***2019 vintage growing season*** (1st July 2018 - 30th June 2019) for NVS2019 was 84%, with the remaining 16% being satellite data from prior to 1st July 2018. This is a marked increase from NVS2018, where 64% of satellite data was from the ***2018 vintage growing season*** for NVS2018. This gives NVS2019 significantly more temporal currency than NVS2018. This increase was a result of the partnership between Maxar and GAIA to actively task satellites to capture imagery of vineyards during the Australian summer.

The spatial alignment of produced vineyard block boundaries to the basemap has also improved, as viewed in the GAIA web-app. This improvement was the result of a change in the basemap produced by Maxar and was supported by technical improvements within GAIA to enhance the ***spatial registration*** of map boundaries with the basemap imagery, as shown in Figure 1. Further details of spatial registration with the new basemap source is provided in 2.3 Change of registration data source for NVS2019.



Figure 1. Basemap registration of the NVS2018 (left) compared to the *improved* NVS2019 (right).

An additional improvement to NVS2019 came from a significant reduction in false positives. These are areas that GAIA's machine learning system has mistakenly identified as vineyards but are actually orchards or other vegetation. This is exemplified in the "Eastern Plains Inland and North" GI of Western Australia, which previously reported vineyards that have been found to be spurious. Reducing

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these false positives represents a refinement of results, and is an improvement complementary to detecting previously unknown vineyards. This is the dominant factor in GIs that have seen reduced area estimates, showing a refinement of the data rather than an indication of vineyards being grubbed up. An enhancement related to the reduction in false positives present in the NVS2019 results is the general improvement in vineyard block boundaries right across Australia, as demonstrated in Figure 2.

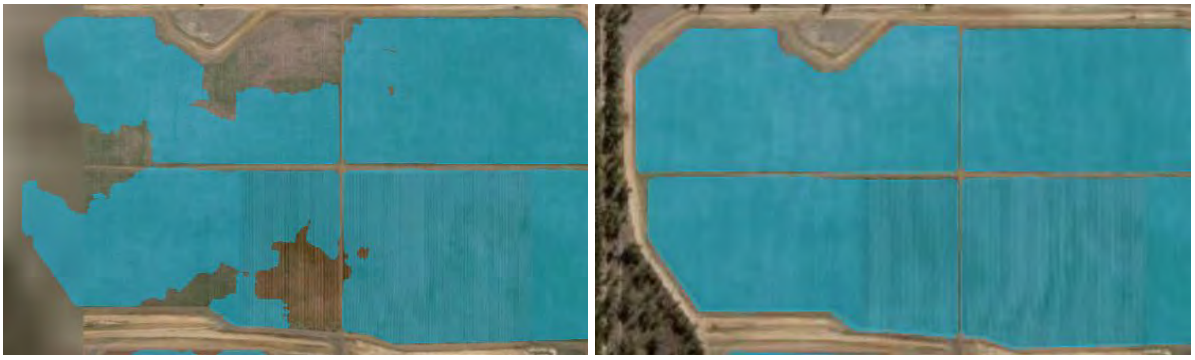


Figure 2. Vineyard block boundaries of the NVS2018 (left) compared to the *improved* NVS2019 (right).

2.1 Areas of Interest (AOIs) used for NVS2019

In undertaking the very first scan of all of Australia for NVS2018, we cast a wide net to try and find as many vineyards as we could to create a solid baseline for performing each subsequent National Vintage Scan. The algorithm that was used to create the AOIs was limited to creating rectangular AOIs. It would work to create rectangles as large as possible to encapsulate multiple smaller areas, which meant that lots of areas we didn't actually want to scan, were included, and scanned.

In preparing to perform NVS2019, we worked to improve on the AOI creation process and algorithm, with a two-fold goal: expand the search into desirable areas that were not scanned in NVS2018, reduce the search of areas scanned in NVS2018 that were undesirable. Feedback from Wine Australia was incorporated into the AOI creation process.

The expansion of the search area for NVS2019 was driven by two factors. The first factor was feedback from users. Some users indicated that a specific location or area should be scanned, so this feedback was incorporated. The second factor was adjacency. Adjacent AOIs were created for all AOIs in which a vineyard block was found. Although many adjacent AOIs represented AOIs that were already being scanned, many adjacent AOIs covered area that had not been scanned in NVS2018 (especially at the boundary of groups of AOIs). This second factor was the major contributor to the inclusion of previously unscanned area for NVS2019.

The changes made to the AOIs and thus search area between NVS2018 and NVS2019 are best explored through metrics, statistics, and visualisations. When relating to area scanned in the following, unless otherwise indicated, the area values represent unique, non-overlapping area (in hectares). That is, if some specific AOI was scanned multiple times (overlapping), the area is only accounted for once. Using unique, non-overlapping area values gives a more accurate indication of scan coverage and allows for a more meaningful comparison between NVS2018 and NVS2019.

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The following metrics and statistics provide insight as to how the AOIs used for NVS2019 compare with those used for NVS2018. Each metric or statistic is reported on a per-state and Australia-wide basis (total) basis in Table 8.

- ***NVS2018 AOIs scanned:*** the area (ha) of AOIs that were scanned for NVS2018.
- ***NVS2019 AOIs scanned***: the area (ha) of NVS2019 AOIs that were specified, had imagery from the 2019 vintage growing season and were scanned by GAIA.
- ***NVS2019 AOIs not scanned***: the area (ha) of NVS2019 AOIs that were specified, but had no imagery from the 2019 vintage growing season and were thus not scanned. These AOIs were 'backfilled' with NVS2018 data.
- ***In both NVS2018 and NVS2019***: the area (ha) of NVS2019 AOIs common to NVS2018 that were scanned.
- ***In NVS2018, not in NVS2019:*** the area (ha) of NVS2018 AOIs that were not scanned for NVS2019 (for whatever reason, be it no coverage or removed from set of specified AOIs).
- ***New to NVS2019***: the area (ha) of AOIs that scanned for NVS2019 but were not present in NVS2018.
- ***% of NVS2018 area scanned again in NVS2019***: the ratio of ***In both NVS2018 and NVS2019*** to ***NVS2018 AOIs scanned*** as a percentage.
- ***% of NVS2019 area that is newly scanned***: the ratio of ***New to NVS2019*** to ***NVS2019 AOIs scanned*** as a percentage.

Table 8. *Details of AOI areas for NVS2019, including comparisons with AOI areas for NV2018.*

	WA	TAS	SA	VIC	NSW (& ACT)	QLD	Total
NVS2018 AOIs scanned	255,332	307,304	1,181,182	824,663	1,646,184	418,625	4,633,290
NVS2019 AOIs scanned	209,901	257,423	948,558	764,693	1,249,170	274,990	3,704,735
NVS2019 AOIs not scanned	23,231	105,981	156,340	213,655	145,271	57,891	702,369
In both NVS2018 and NVS2019	196,308	152,006	764,301	400,041	904,926	178,216	2,595,798
In NVS2018, not in NVS2019	59,024	155,297	416,880	424,621	741,257	302,024	2,099,103
New to NVS2019	13,592	105,417	184,256	364,652	344,243	96,774	1,108,934
% of NVS2018 area scanned again in NVS2019	77%	49%	65%	49%	55%	43%	56%
% of NVS2019 area that is newly scanned:	6%	41%	19%	48%	28%	35%	30%

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For each of the illustrations of AOI coverage for each state in Figures 3, 5, 7, 9, 11 and 13 the following convention for colouring AOIs is used:

- The combination of the blue and green represents ***NVS2019 AOIs scanned***.
- The blue alone represents ***In both NVS2018 and NVS2019***.
- The green alone represents ***New to NVS2019***.
- The combination of yellow and red represents ***In NVS2018, not in NVS2019.***
- The red alone represents whereas ***NVS2019 AOIs not scanned***.
- The yellow alone represents AOIs from NVS2018 that were deemed to be unnecessary for NVS2019.

Figures 4, 6, 8, 10, 12 and 14 show the distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for each state. The darker green columns represent the desirable summer months, while lighter green columns represent the less desirable winter months. In summary Table 9 presents the state-by-state breakdown, with 16,934 AOIs from 836 satellite images scanned for NVS2019.

Table 9. *Breakdown of the number of satellite images and AOIs from the 2019 vintage growing season used for NVS2019 .*

State	# of satellite images	# of AOIs
WA	102	1056
TAS	62	1347
SA	98	4076
VIC	223	3973
NSW (incl ACT)	265	5872
QLD	86	610
Total	836	16934

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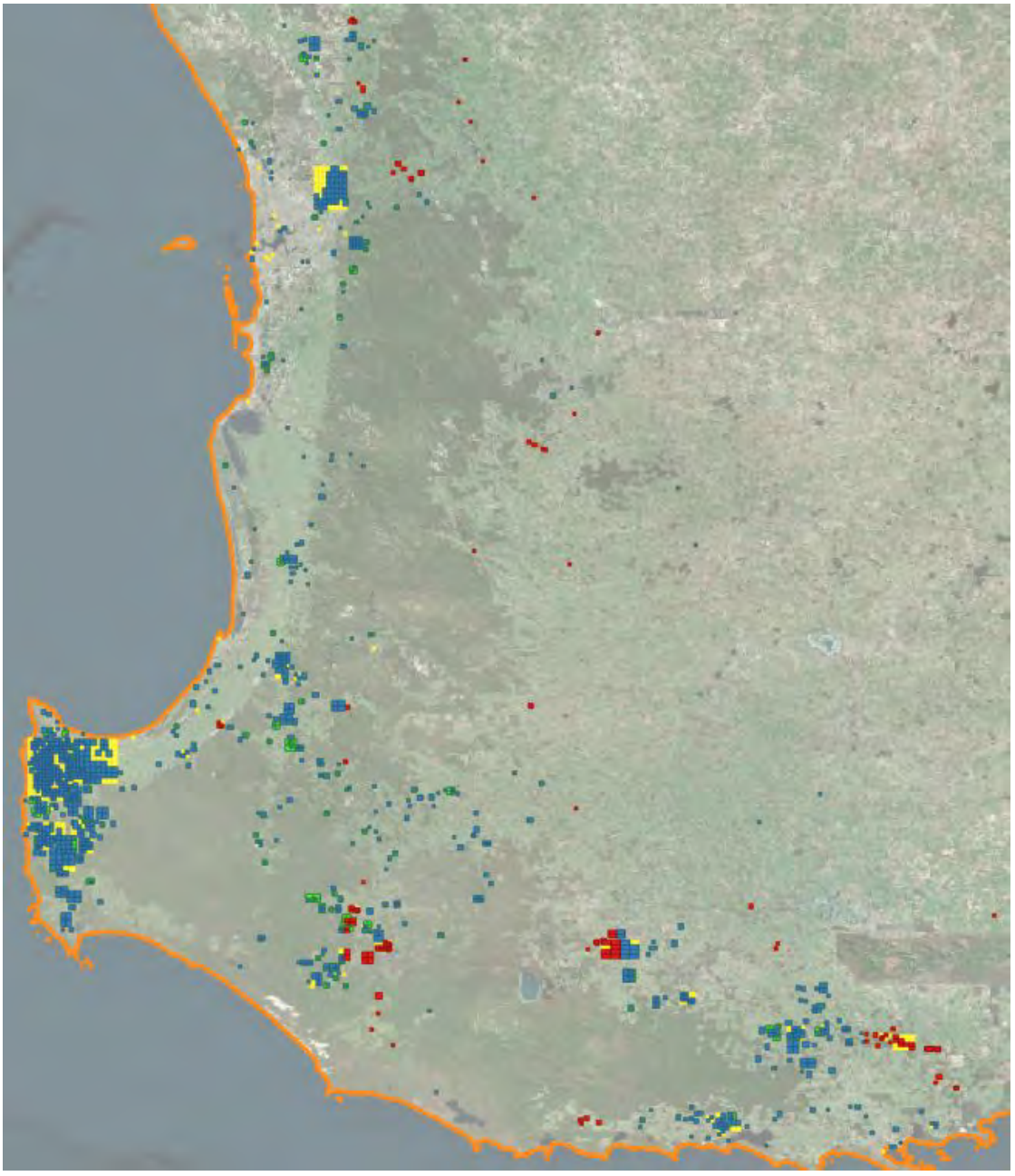


Figure 3. Some of the information presented in Table 8 pertaining to the AOIs used for NVS2018 and NVS2019 for WA.

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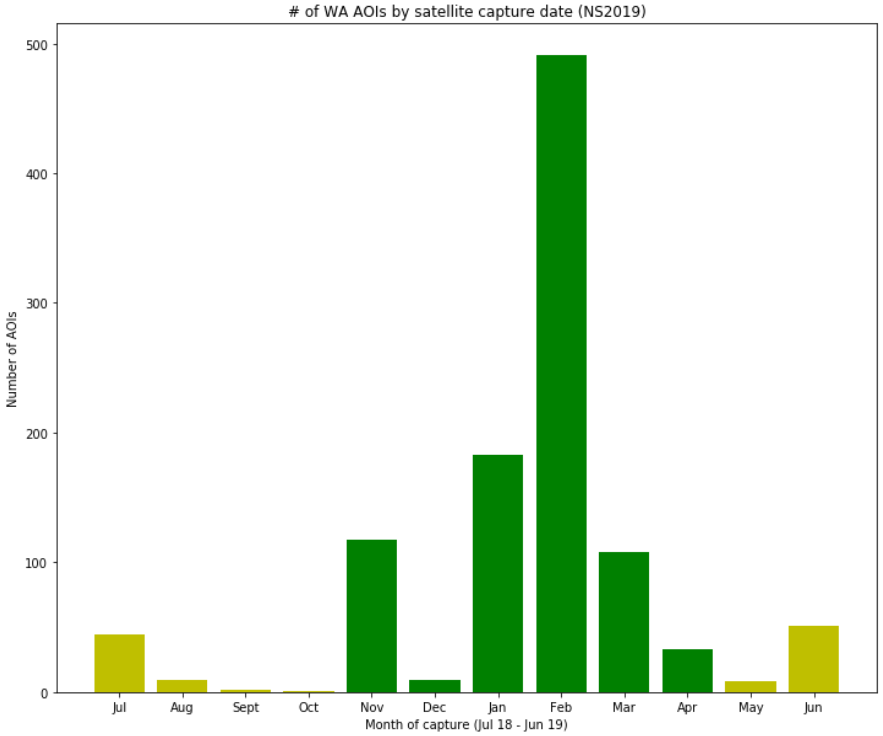


Figure 4. Distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for WA. Dark green represents the desirable summer months.

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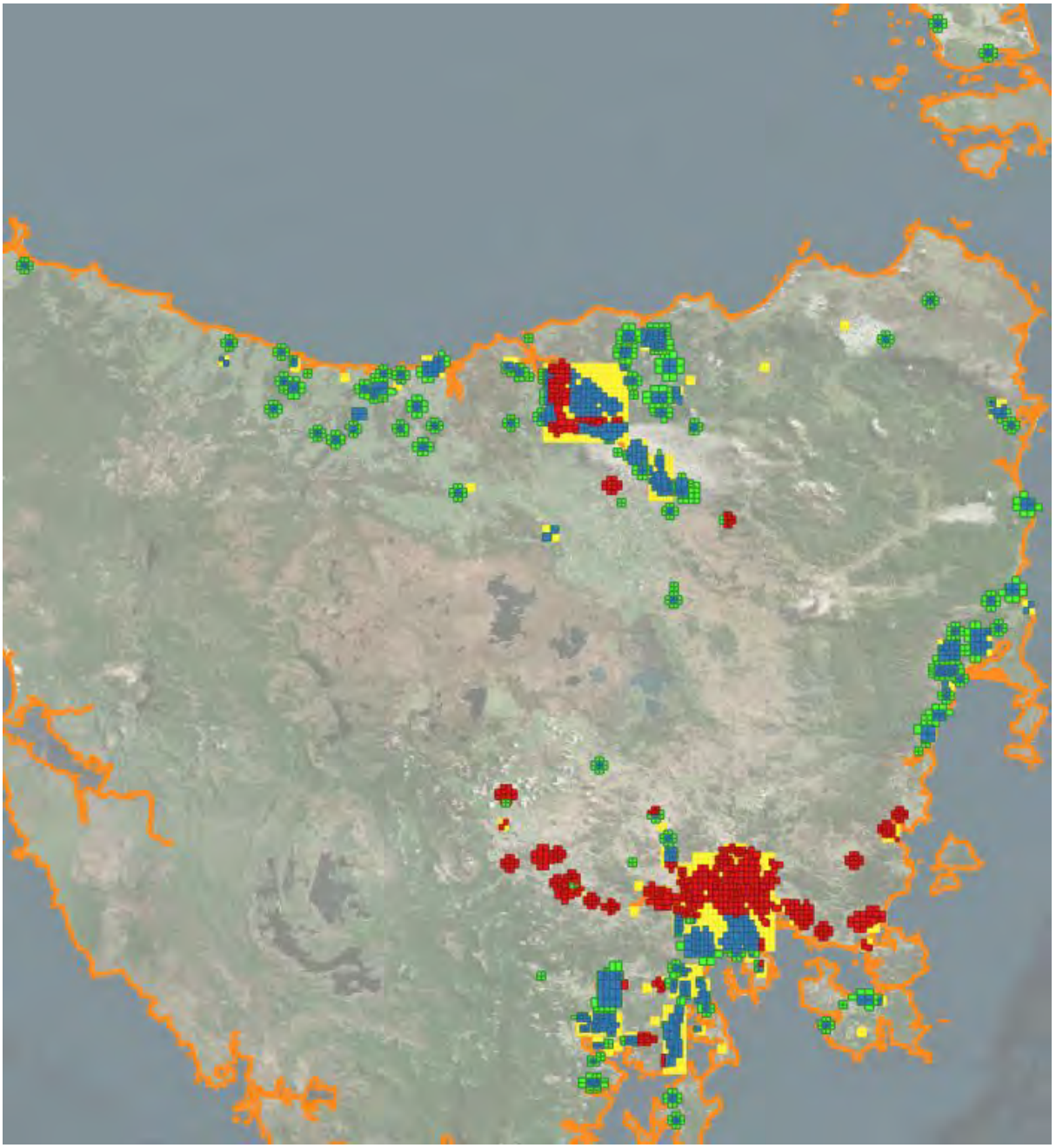


Figure 5. Some of the information presented in Table 8 pertaining to the AOIs used for NVS2018 and NVS2019 for TAS.

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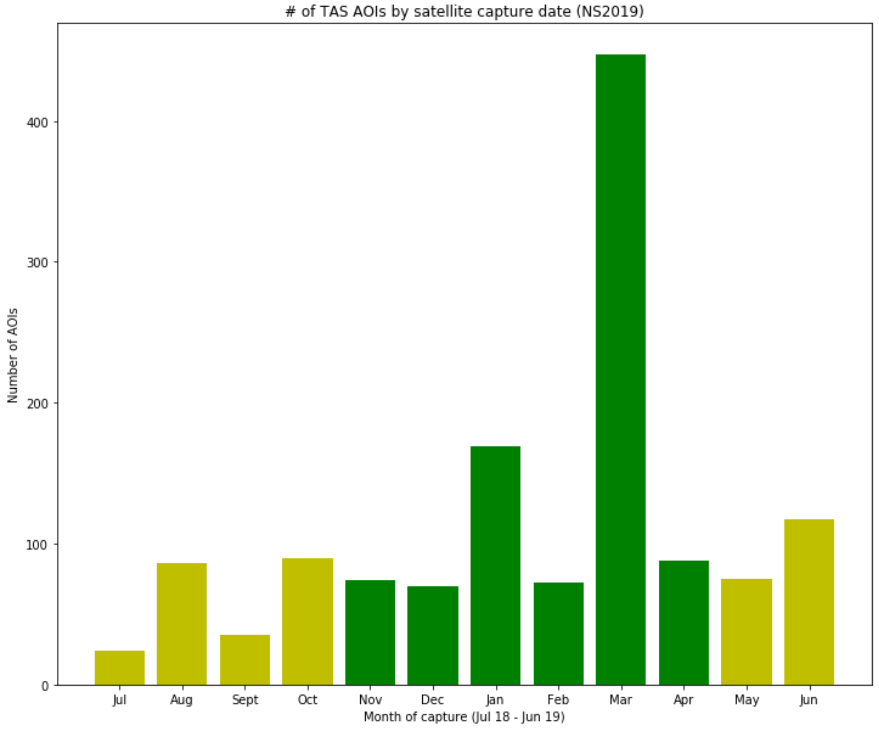


Figure 6. Distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for TAS. Dark green represents the desirable summer months.

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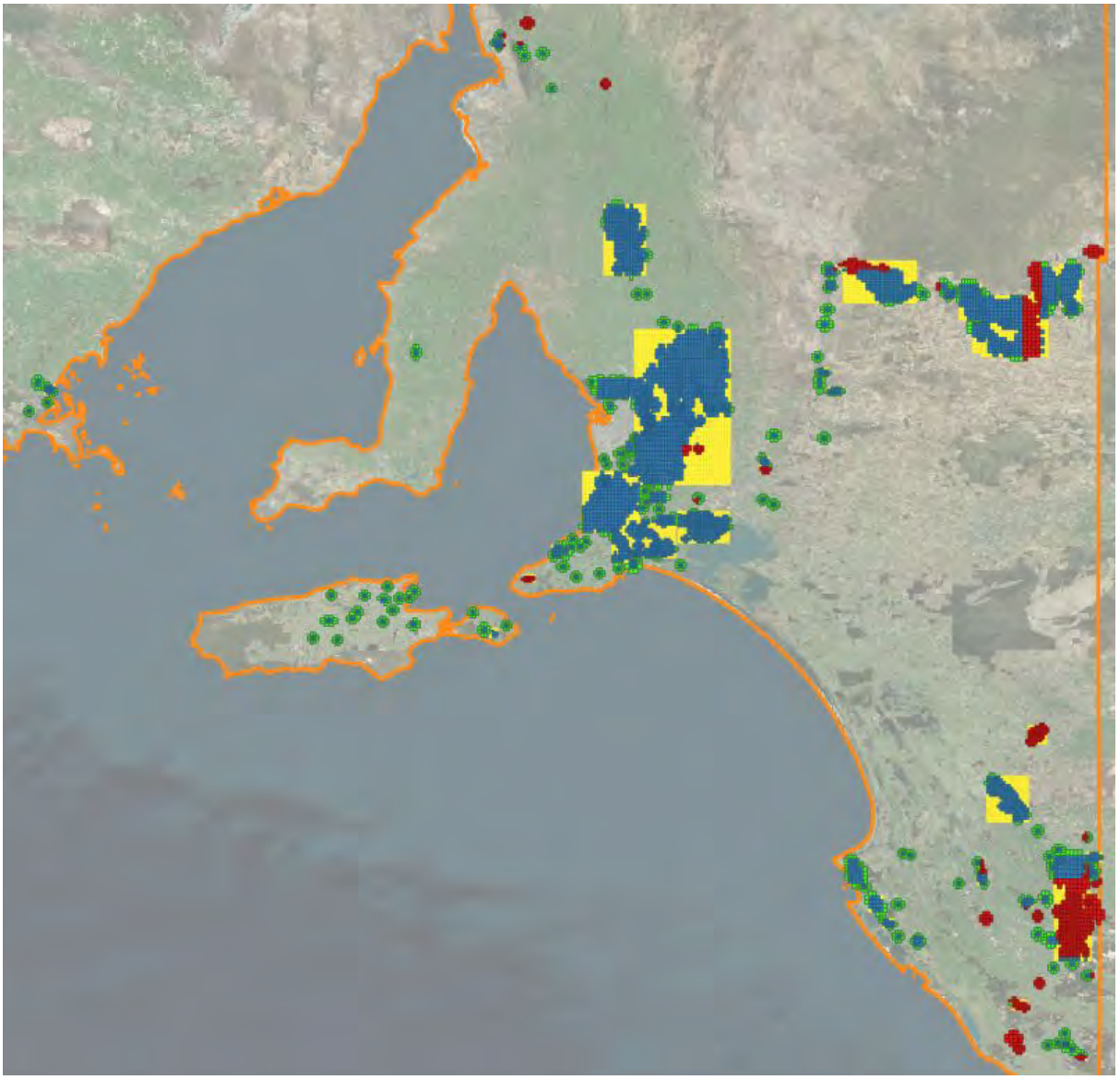


Figure 7. Some of the information presented in Table 8 pertaining to the AOIs used for NVS2018 and NVS2019 for SA.

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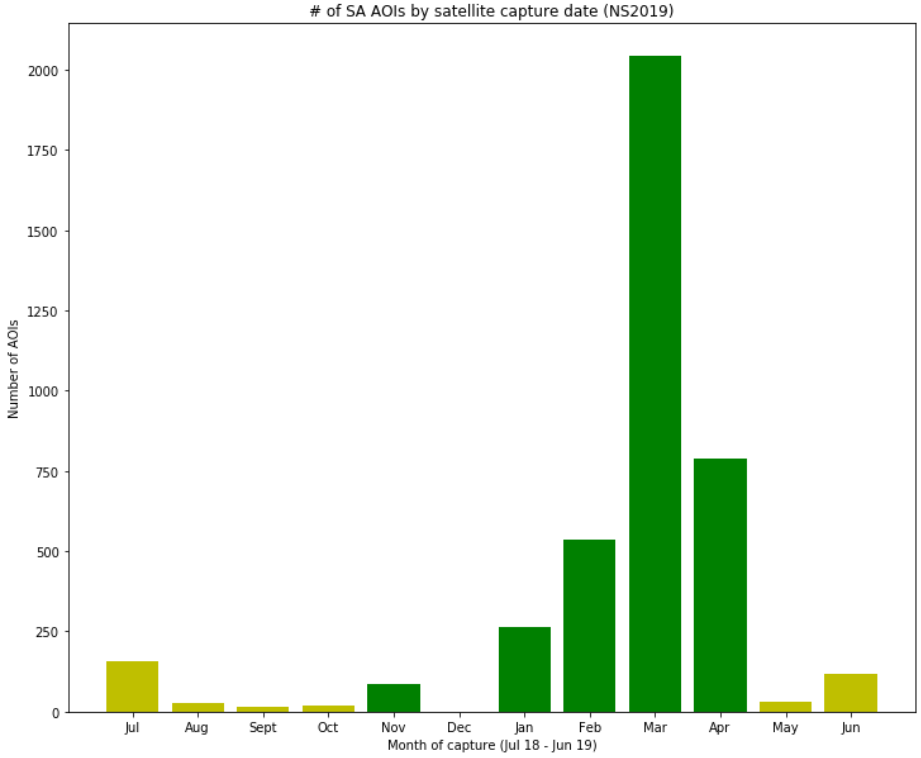


Figure 8. Distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for SA. Dark green represents the desirable summer months.

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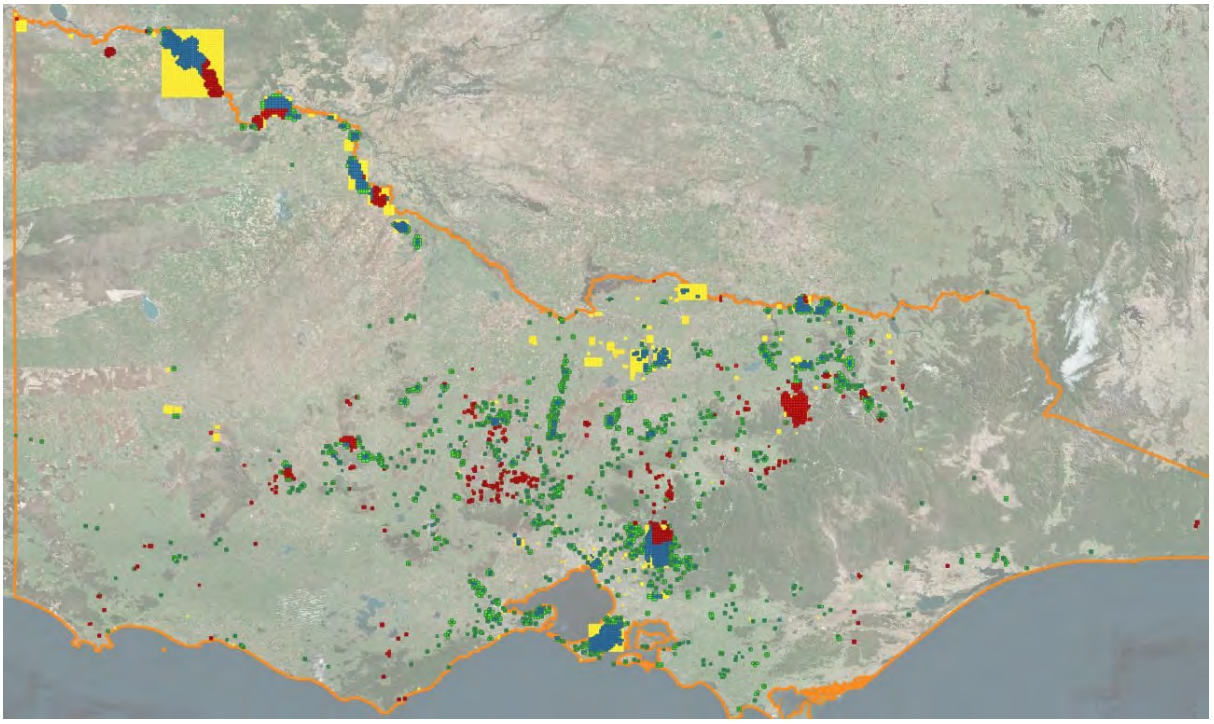


Figure 9. Some of the information presented in Table 8 pertaining to the AOIs used for NVS2018 and NVS2019 for VIC.

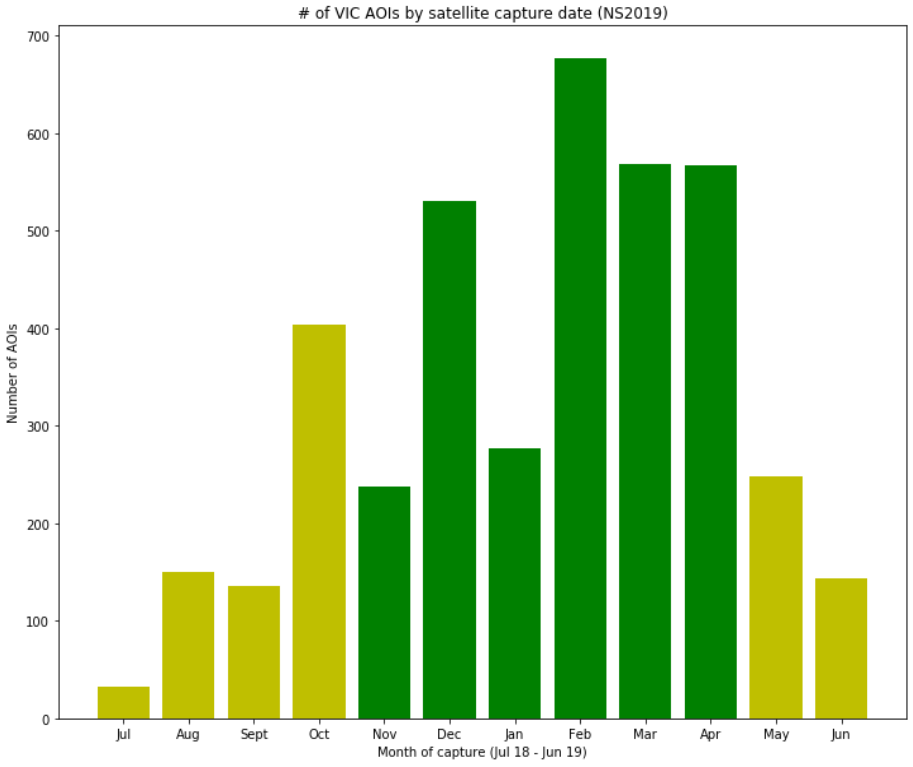


Figure 10. Distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for VIC. Dark green represents the desirable summer months.

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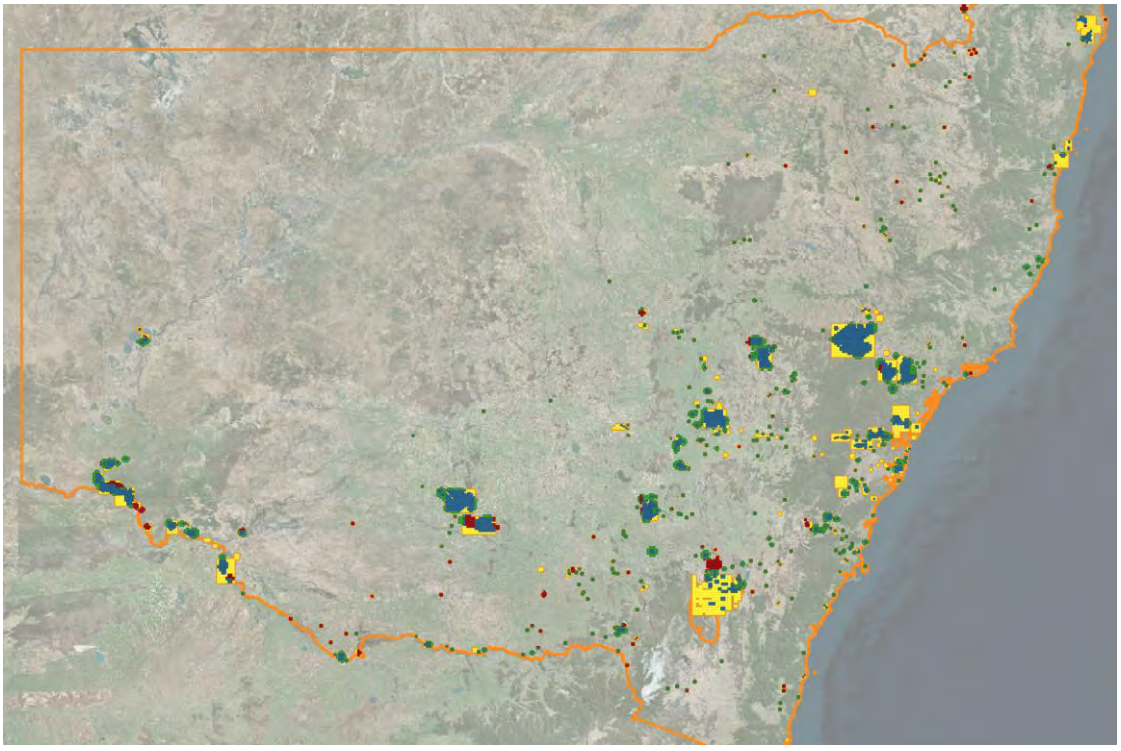


Figure 11. Some of the information presented in Table 8 pertaining to the AOIs used for NVS2018 and NVS2019 for NSW.

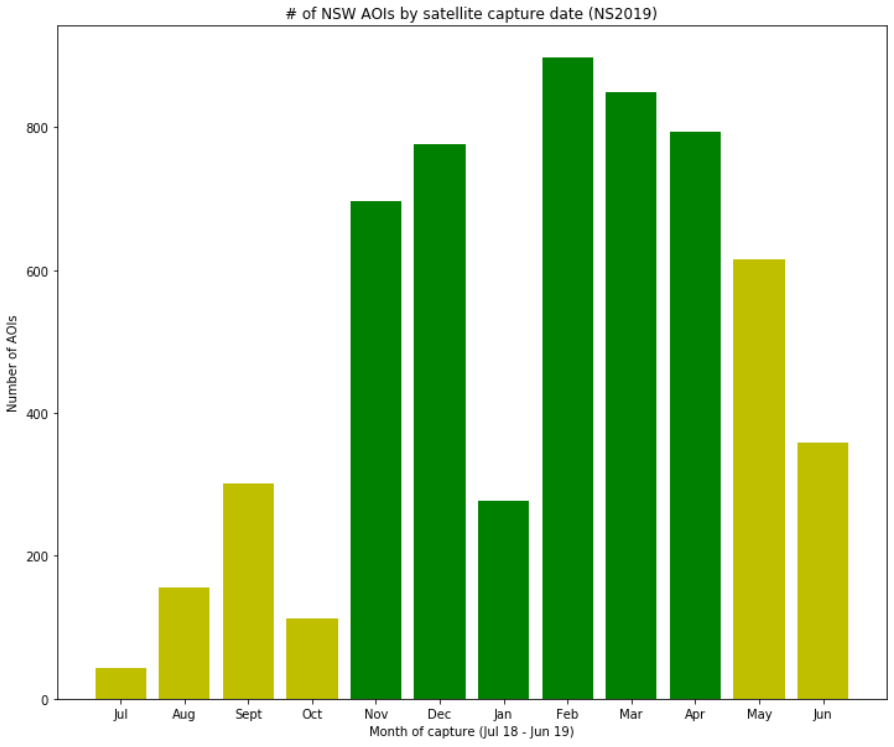


Figure 12. Distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for NSW. Dark green represents the desirable summer months.

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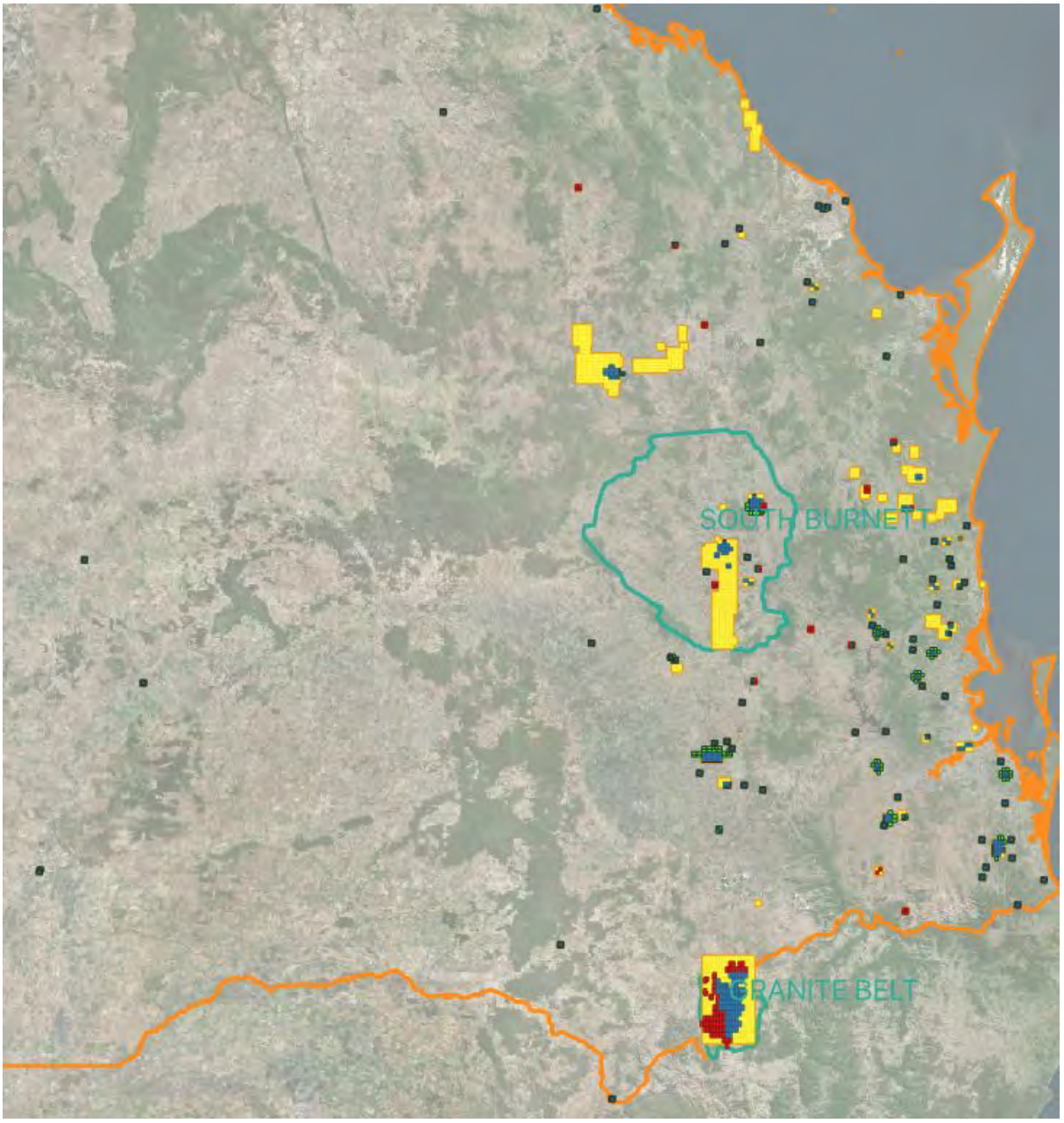


Figure 13. Some of the information presented in Table 8 pertaining to the AOIs used for NVS2018 and NVS2019 for QLD. Note that AOIs in Western and Northern Queensland have been excluded to improve visualisation.

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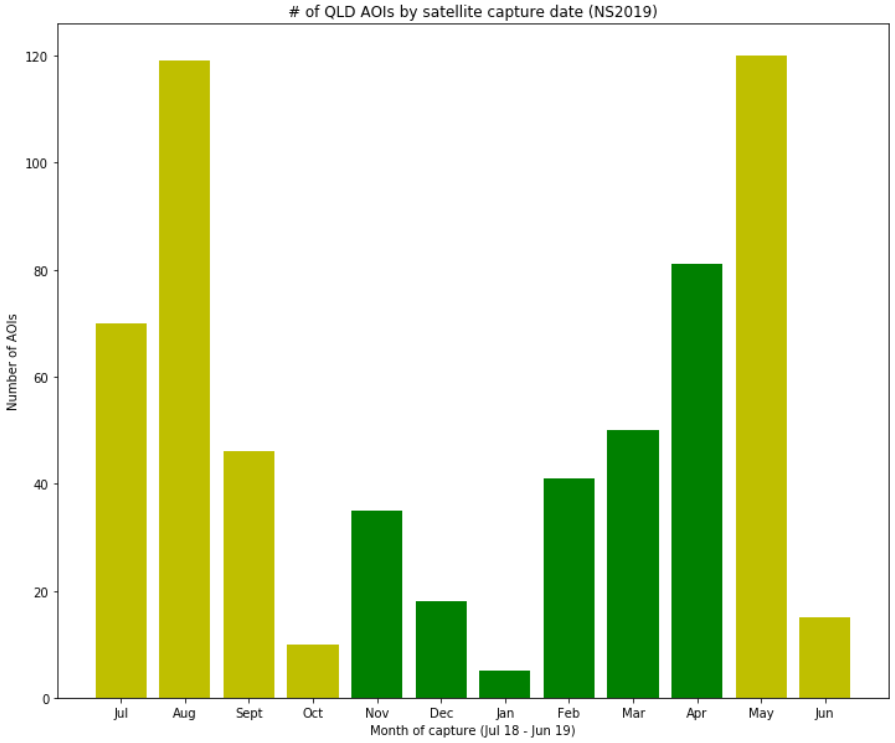


Figure 14. Distribution of AOIs by month of corresponding satellite image capture for the 2019 vintage growing season for QLD. Dark green represents the desirable summer months.

2.2 Imagery availability for NVS2019

The creation of the NVS2018 dataset by GAIA was unique as there was no pre-existing dataset of the same scale to build upon[1]. This afforded significant flexibility in the acquisition of imagery appropriate for the application of GAIAs machine learning (ML) models. Specifically, because the ML models used by GAIA give the best results when run on imagery from the summer growing months, we preferentially sought to use imagery from the summer months for the preceding 3 years (2016-2018), before any more recent winter imagery was considered. If there was absolutely no imagery for some given area of interest (AOI) from the previous 3 years, we followed the same procedure for 3 years earlier still (2013-2015). If there was still no imagery for some given AOI, as was the case in a very small number of AOIs, we proceeded to search the entire back catalog for imagery from summer months, and then expanded to winter months if necessary. It should also be noted that we had other search criteria, such as the amount of cloud cover, which excluded some imagery from consideration.

Although 80% of the imagery we used for NVS2018 was recent (from the previous 3 calendar years 2016-2018), some of the imagery we had to use was dated. For example, very small portions (by area) of total imagery scanned was from 2010 (0.11%), 2011 (0.43%), 2012 (1.31%) and 2013 (1.75%).

[1] with the exception of the EveryVine dataset for Western Australia created as precursor to GAIA.

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However, the end result of adopting such a process for imagery selection was that we found imagery for every AOI we wished to scan, and scanned it.

The creation of the NVS2019 dataset by GAIA was afforded less flexibility than NVS2018. With a large proportion of the area to scan for NVS2019 already scanned in NVS2018, we were limited to considering imagery only available since the cut-off date of NVS2018 (30th June 2018). Concretely, we were restricted to imagery from the 2019 vintage growing season: 1st July 2018 - 30th June 2019.

There were two major implications of this limitation in imagery selection. The first was that there was a significant proportion of the AOIs we wished to scan with no imagery from the 2019 vintage growing season. This scenario, referred to as the 'no coverage' scenario, necessitated the inclusion of NVS2018 data to 'backfill' the NVS2019 dataset. This need to backfill came with it's own set of significant issues, described in detail in 2.3 Change of registration data source for NVS2019.

The second implication was that a greater proportion of winter imagery was scanned by GAIA's ML models for NVS2019 than for NVS2018. The dearth of canopy on vines in winter meant that the GAIA's ML models generated poorer vineyard block boundary predictions on winter imagery than they would do on summer imagery. The impact of vineyard block boundaries generated from winter imagery is not discernable in the final NVS2019 dataset as the raw generated vineyard block boundaries underwent extensive review to produce a clean dataset.

2.3 Change of registration data source for NVS2019

A significant issue we did not foresee in planning to produce NVS2019 was a change in basemap by our satellite imagery technology partner Maxar. The change of the basemap map impacted both the commercial (crop health monitoring) components of GAIA as well as the National Vintage Scan components. The impact on the National Vintage Scan components is documented here.

The dataset generated for NVS2018 was the result of a multi-stage process, transforming the pixels present in thousands of different satellite images taken over a number of years into a single, unified set of vineyard block boundaries for each and every vineyard in Australia. One of the critical steps in this process was the spatial registration step.

The spatial registration step involved aligning scanned areas from each of the thousands of satellite images with a basemap. This alignment of satellite imagery to basemap process allowed each of the vineyard block boundaries generated by GAIA's machine learning algorithms to be aligned to a consistent reference layer. This alignment of vineyard block boundaries to a consistent reference layer was important for two reasons.

The first was that such consistency allowed the combination of polygons that represented the same vineyard block, that is, taking the union or dissolving any overlapping polygons representing the same vineyard block. This capability was critical: many of the vineyard blocks in the final dataset were composites of multiple vineyard block boundaries generated from multiple satellite images.

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The second was that the consistency allowed the final dataset to be overlaid on the reference layer (basemap), resulting in no or little mis-alignment of vineyard blocks boundaries with the basemap. This was important to building confidence in the accuracy of the entire process.

Between the completion of NVS2018 and the completion of NVS2019 approximately 6 months later, the basemap provided by Maxar changed. Specifically, the Mapbox/DigitalGlobe Recent Imagery basemap used for NVS2018 was deprecated, requiring that GAIA use the Maxar EarthWatch Vivid Imagery basemap for NVS2019.

After switching between the two basemaps, we realised that the NVS2018 dataset was no longer well-aligned with the basemap. Critically, the NVS2018 vineyard block boundaries did not exhibit a consistent translation in terms of magnitude or direction. That is, vineyard block boundaries were misaligned by between 3m and 10m, with there being no consistent direction of misalignment.

This posed a problem because, as described in 2.1 Areas of Interest (AOIs) used for NVS2019, we had incomplete coverage of all areas we wished to scan with 2019 vintage growing season imagery. This required us to backfill areas where we had no 2019 vintage growing season imagery (and thus vineyard block boundary predictions from 2019 data) with vineyard block boundaries from NVS2018. In addition, where we had vineyard block boundaries generated from both NVS2018 and NVS2019, we often wanted to take the union or dissolve the overlapping vineyard block boundaries to create a composite vineyard block boundary to correct for any small imperfections that may have existed in the NVS2018 or NVS2019 vineyard block boundaries individually. Both of these scenarios required the NVS2018 dataset to be consistently aligned to the same reference layer as the NVS2019 dataset. For the second scenario involving the creation of composite vineyard block boundaries, this alignment was critical to giving the most accurate results when taking the union or dissolving both datasets.

The spatial registration issue was resolved in collaboration with Maxar. The solution essentially involved recomputing the registration of the NVS2018 dataset against the EarthWatch Vivid Imagery basemap. This produced a version of the NVS2018 dataset that was correctly registered to this basemap, which could in turn be used to backfill the NVS2019 dataset where required.

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3. National Scan Quality Assurance

The National Scan Quality Assurance process was described in detail in 'GAIA - National Scan Quality Assurance' (CT-TR-2018-00018). Broadly, Quality Assurance for the National Vintage Scan 2019 is achieved by computing a suite of metrics on a number of regions, the National Scan Quality Assurance Regions (NSQARs). The 31 NSQARs, selected from Geographical Indications (GIs) from across Australia, are documented in Table 10.

Table 10. *National Scan Quality Assurance Regions.*

State	1st pass QA region	2nd pass QA region
WA	1. Margaret River 2. Swan Valley (#1) 3. Mount Barker 4. Geographe	1. Swan Valley (#2)
TAS	1. Tasmania "North" (Launceston) 2. Tasmania "South" (Hobart)	
SA	1. Riverland 2. Clare Valley 3. Wrattonbully 4. Barossa Valley	1. Adelaide Hills 2. Coonawarra 3. McLaren Vale
VIC	1. Murray Darling VIC (#1) 2. King Valley 3. Goulburn Valley 4. Yarra Valley	1. Strathbogie Ranges 2. The Grampians 3. Gippsland 4. Murray Darling VIC (#2) 5. Mornington Peninsula
NSW	1. Riverina 2. Canberra District 3. Hunter 4. Orange	1. Shoalhaven 2. Swan Hill NSW
QLD	1. South Burnett	1. Granite Belt
Total	**19 regions**	**12 regions**

In practice, each NSQAR is represented by a satellite image and corresponding labels generated by a human labeller. The labels generated by the human labeller are considered the ground-truth against which vineyard block predictions generated by GAIA are compared. Each NSQAR is at least 300 hectares as specified in *'GAIA - National Scan Quality Assurance'*, with the exception of Swan Hill NSW, which comes in at 281 hectares. Pertinent details relating to the satellite imagery/labels, such as

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imagery date, total area of imagery and total area of vineyards is included in the results table for each NSQAR.

For NVS2019 there were a small number of changes to the NSQARs as compared to their use for NVS2018. As described in *'GAIA - National Scan Quality Assurance'*, periodic updates are made to NSQARs to ensure that ground truth labels accurately reflect on-ground conditions present during the scan period. Specifically, more recent satellite imagery corresponding to the exact area defined by an existing NSQAR is acquired, and the existing ground truth labels are updated such that they reflect what is seen in the more recent imagery.

For NVS2019, we aimed to update those NSQARs that, upon an initial computation of the statistics and metrics for the existing NSQARs, yielded an area accuracy of less than 90%. NSQARs that had an area accuracy of less than 90% upon initial computation were: Swan Valley #1 (WA), Swan Valley #2 (WA) and Tasmania South.

Both of the Swan Valley NSQARs were updated such that new satellite imagery was acquired and modified ground truth labels were created, with further details provided in 4. Quality Assurance in Western Australia. However, Tasmania South was not updated for technical reasons. Concretely, Tasmania South is one of the NSQAR regions that was selected in the very early stages of the GAIA and Wine Australia partnership. At the time, it was only possible to procure entire satellite images and not just small portions, hence the Tasmania South NSQAR is a very large area of 96,188 hectares, which is ~320x larger than the specified area of 300 hectares for each NSQAR. The size of this NSQAR makes it impractical to be manually reviewed. It was decided that an update to this NSQAR, as well as other NSQARs of similar history, including Margaret River (25,961 ha) and Tasmania North (109,242 ha), be undertaken as part of a renewal process for NVS2020.

3.1 Quality Assurance Summary Statistics

For each NSQAR, a suite of metrics and properties is reported. For metrics such as Recall, Precision, Category Accuracy, Area Accuracy and Jaccard and False Positive Rate, direct summary statistics taken across all 31 samples are computable and insightful. However, direct summary statistics are not meaningful for the remaining metrics or properties that have units of area (ha): Total Area (ha), Truth Area (ha), Prediction Area (ha), Misses Area (ha), Mistakes Area (ha), Union Area (ha), Intersection Area (ha). For some such properties, specifically truth, prediction, misses and mistakes areas, per-area representations can be meaningful, so these are also presented. The QA summary statistics are presented in Table 11. Not shown in Table 11 is the standard error calculated for area accuracy, which is 0.5098.

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Table 11. Summary statistics of QA metrics/properties.

	Mean	StdDev	Min	Max
Truth / ha	0.14546	0.16508	0.00201	0.77456
Prediction /ha	0.14315	0.16220	0.00219	0.74838
Misses / ha	0.01187	0.01510	0.00019	0.06668
Mistakes / ha	0.00925	0.01337	0.00024	0.05514
Recall	91.1884	3.8152	82.6135	97.5006
Precision	93.3557	3.8636	83.3342	99.4190
Category accuracy	98.3192	1.8232	92.6506	99.9447
Area accuracy	95.2918	2.8383	89.9848	99.7020
Jaccard	85.6418	4.9854	76.7145	94.2156
False Positive Rate (/m^2)	0.00925	0.01337	0.00024	0.05514

3.2 Vineyard Area Error Analysis

A conservative estimate of total area in Australia can be computed using a lower bound estimate of area accuracy (**94.29**%). This gives a range of **137,897** to **154,591** hectares, based on the observed measurement of **146,244** hectares for the total area of vineyards identified in the national scan search region.

The area accuracy bounds were estimated by calculating the standard error (0.5098) and using the 95% confidence interval. This provides both an upper and lower estimate of the true area accuracy. The assumptions include that the area accuracy is normally distributed and that the 31 samples used are representative of the entire search region used for the national scan. This gives a lower bound estimate of area accuracy of **94.29%** and an upper bound of area accuracy of **96.29%**.

The key statistic of mean area accuracy, and indeed all summary statistics, for NVS2019 are very similar to those observed for NVS2018. This is to be expected: the same machine learning models used for NVS2018 were also used for NVS2019.

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4. Quality Assurance in Western Australia

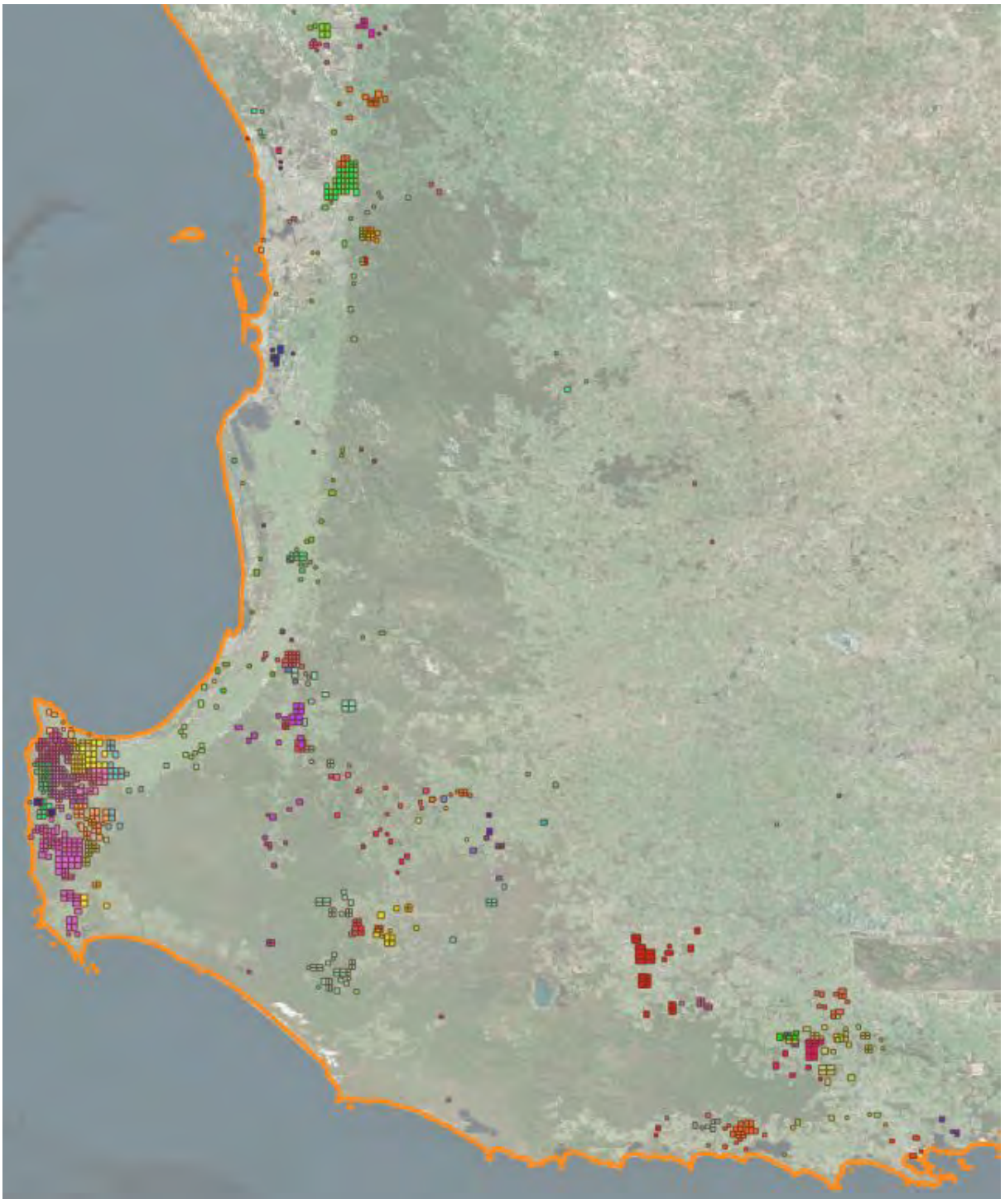


Figure 15: A visualisation of the AOIs in Western Australia that were scanned by GAIA for NVS2019. The different colours represent different satellite images that were used to scan each AOI.

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4.1 Margaret River

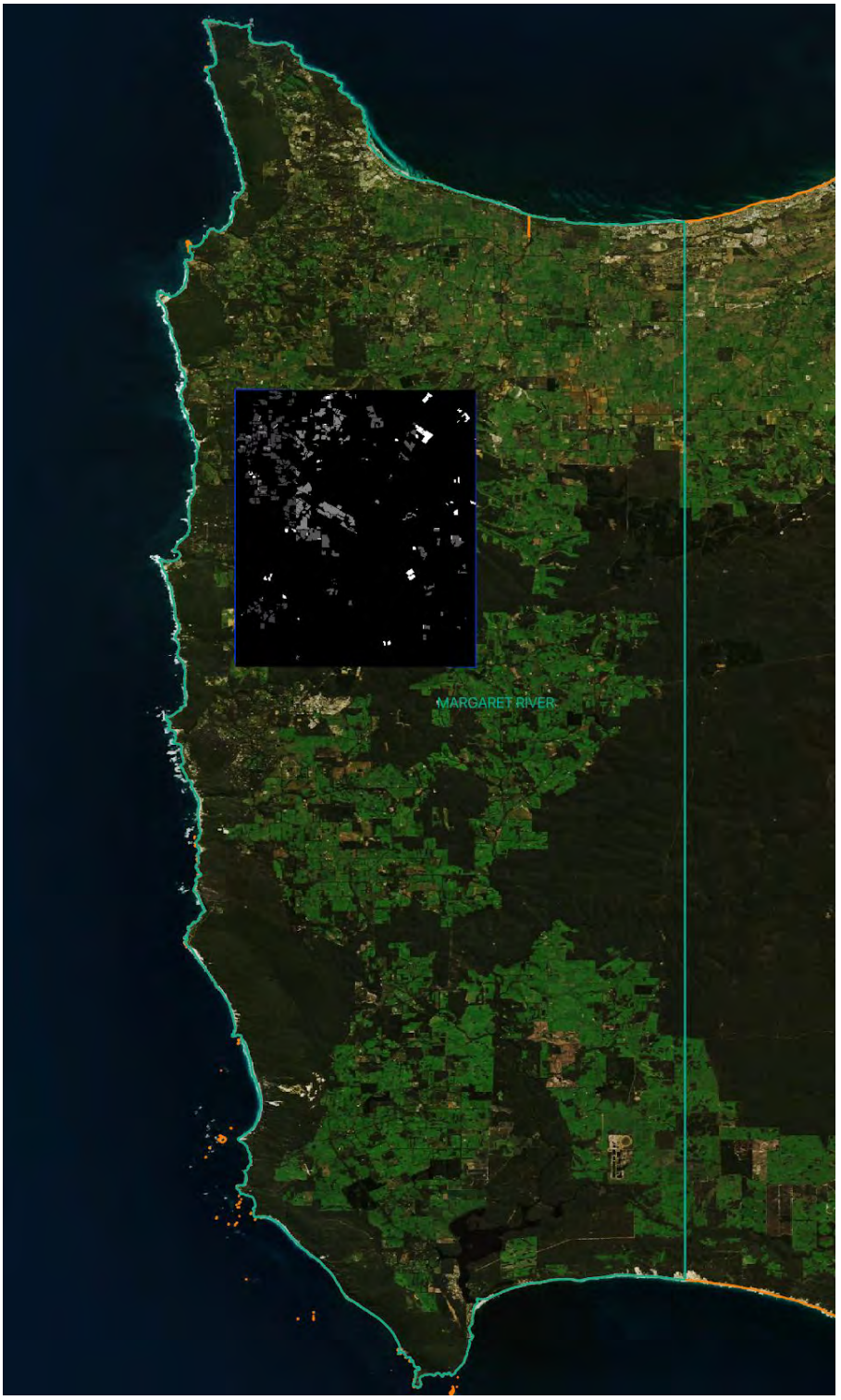


Figure A.1. The Margaret River NSQAR in the context of the Margaret River GI. The entire labelled region (greyscale rectangle) is used for Quality Assurance to maintain consistency with earlier reporting.

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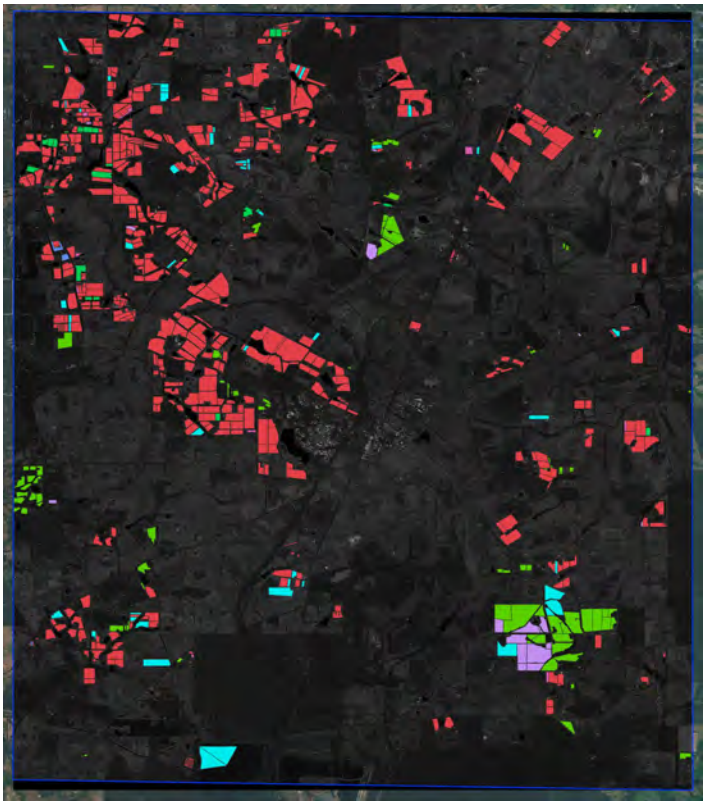


Figure A.2. The Margaret River labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2017-01-15T02:50:50.846Z
Total area (ha)	25961.62
Truth area (ha)	1570.15
Prediction area (ha)	1545.56
Misses area (ha)	121.14
Mistakes area (ha)	96.28
Union area (ha)	1666.72
Intersection area (ha)	1449.19
Recall	92.29
Precision	93.77
Category accuracy	99.21
Area accuracy	98.43
Jaccard	86.95

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4.2 Swan Valley #1

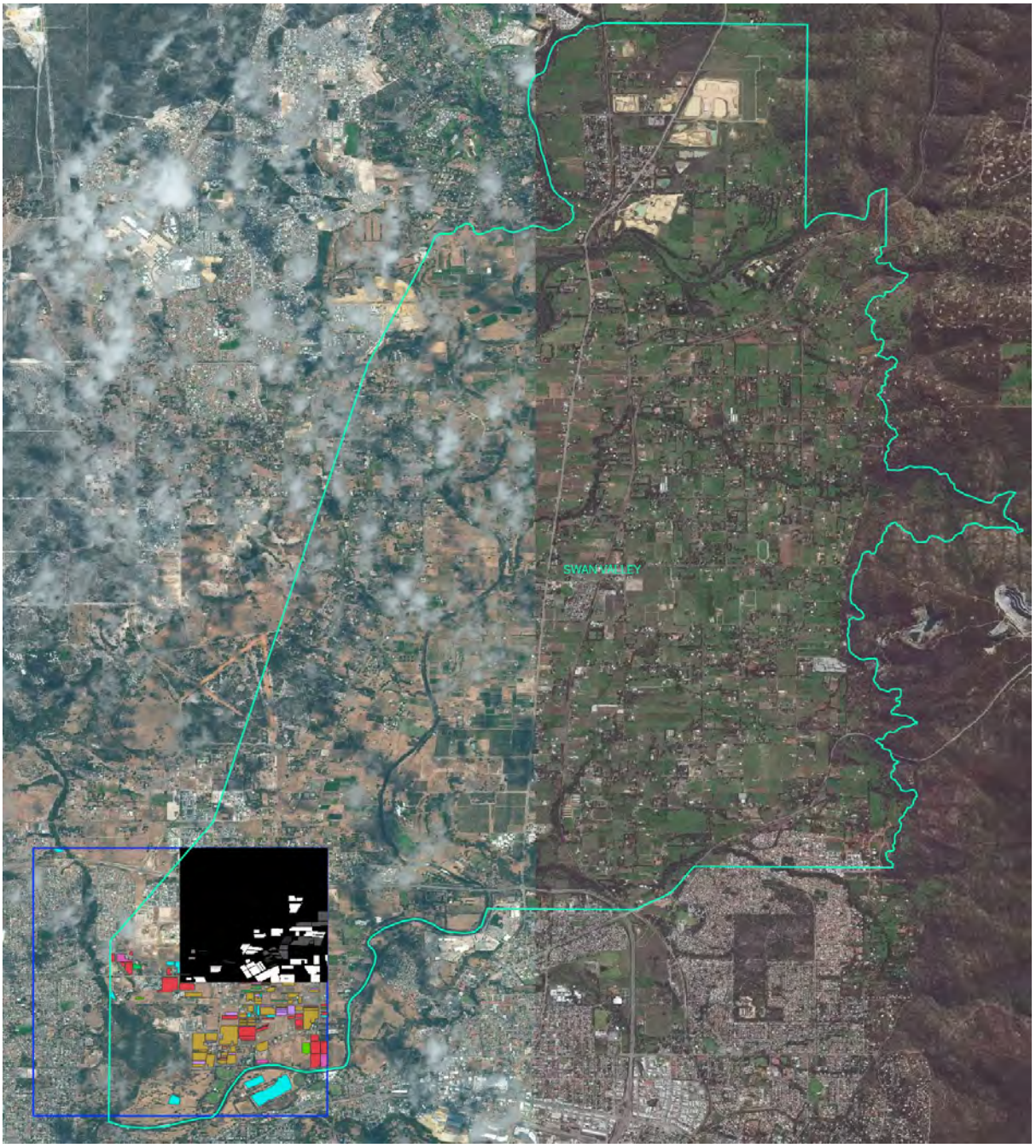


Figure B.1. The Swan Valley #1 NSQAR in the context of the Swan Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top right greyscale rectangle is used for Quality Assurance.

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Figure B.2. The Swan Valley #1 labels overlaid on the Panchromatic satellite imagery. These labels correspond with the ground truth as represented in the DPIRD dataset.

Date of imagery used for ground truth	2020-01-06T02:33:05.000Z
Total area (ha)	354.59
Truth area (ha)	5.52
Prediction area (ha)	5.22
Misses area (ha)	0.51
Mistakes area (ha)	0.21
Union area (ha)	5.73
Intersection area (ha)	5.01
Recall	90.78
Precision	95.98
Category accuracy	99.80
Area accuracy	94.58
Jaccard	87.46
False positive rate (/m2)	0.00059

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4.3 Mount Barker



Figure C.1. The Mount Barker NSQAR in the context of the Mount Barker GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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Figure C.2. The Mount Barker labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2018-01-24T02:27:00.000Z
Total area (ha)	344.05
Truth area (ha)	38.60
Prediction area (ha)	35.86
Misses area (ha)	3.63
Mistakes area (ha)	0.89
Union area (ha)	39.49
Intersection area (ha)	34.97
Recall	90.59
Precision	97.51
Category accuracy	98.80
Area accuracy	92.90
Jaccard	88.53
False positive rate (/m2)	0.0026

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4.4 Geographe



Figure D.1. The Geographe NSQAR in the context of the Geographe GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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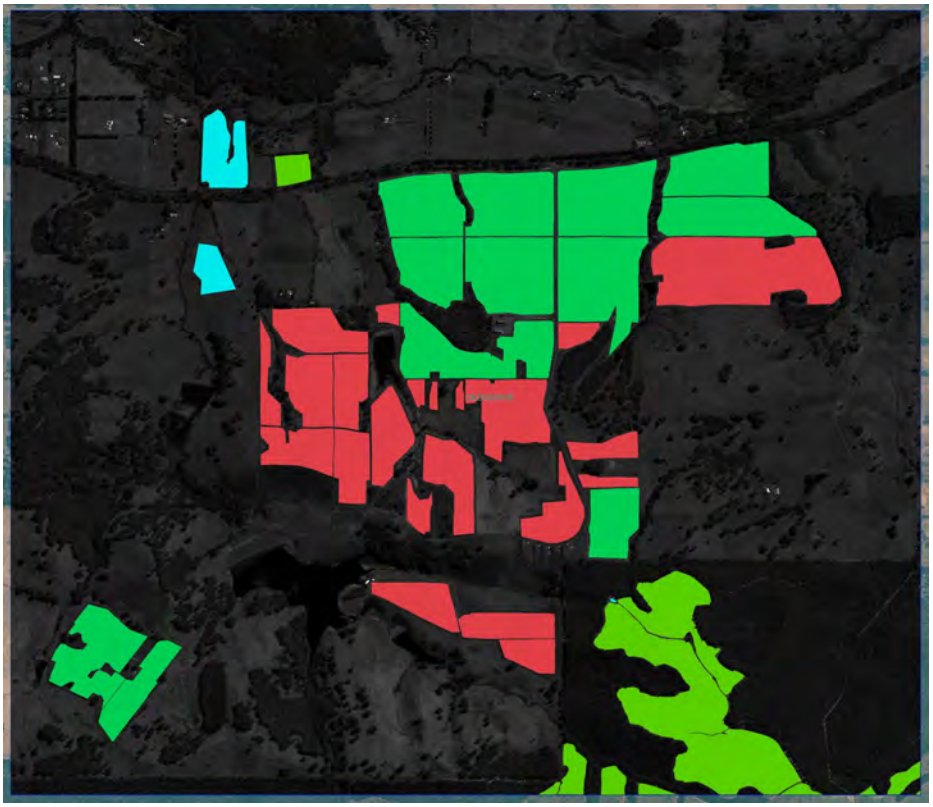


Figure D.2. The Geographe labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2016-03-09T02:22:14.748Z
Total area (ha)	340.19
Truth area (ha)	40.88
Prediction area (ha)	39.98
Misses area (ha)	1.95
Mistakes area (ha)	0.99
Union area (ha)	41.87
Intersection area (ha)	38.99
Recall	95.23
Precision	97.52
Category accuracy	99.17
Area accuracy	97.81
Jaccard	92.97
False positive rate (/m2)	0.0029

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4.5 Swan Valley #2

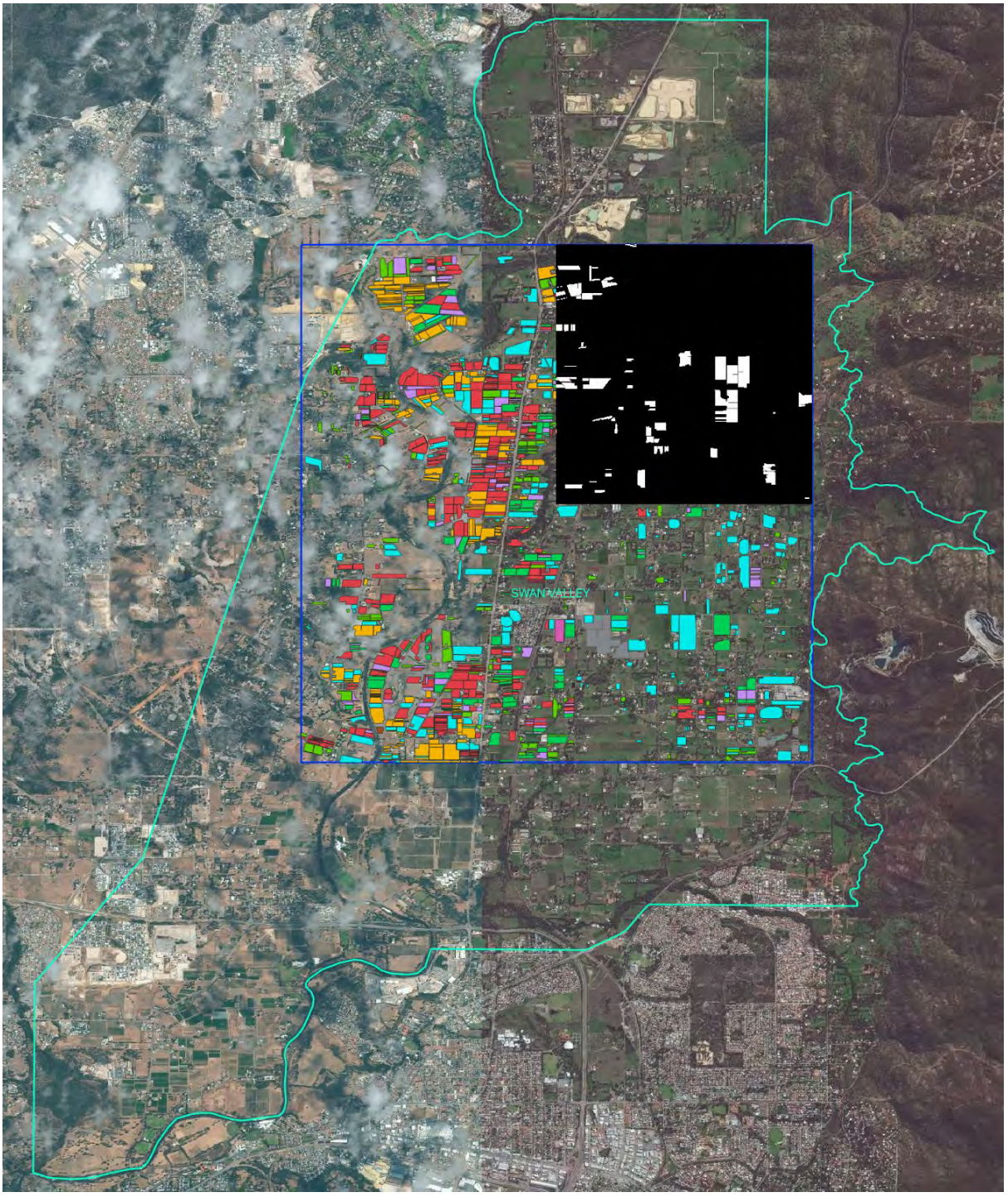


Figure E.1. The Swan Valley #2 NSQAR in the context of the Swan Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top right greyscale rectangle is used for Quality Assurance.

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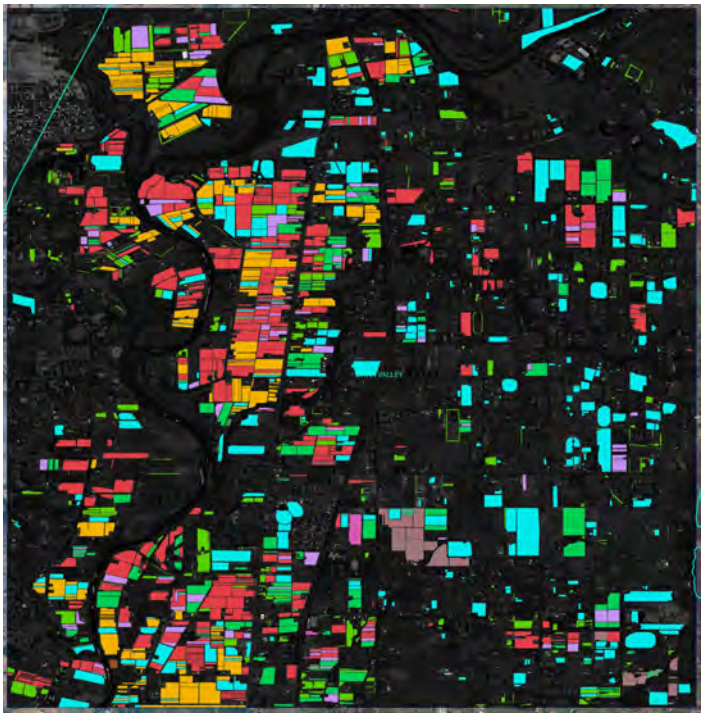


Figure E.2. The Swan Valley #2 labels overlaid on the Panchromatic satellite imagery. These labels correspond with the ground truth as represented in the DPIRD dataset.

Date of imagery used for ground truth	2020-01-06T02:33:05.000Z
Total area (ha)	1082.13
Truth area (ha)	43.61
Prediction area (ha)	39.40
Misses area (ha)	6.53
Mistakes area (ha)	0.65
Union area (ha)	44.26
Intersection area (ha)	38.75
Recall	85.59
Precision	98.35
Category accuracy	99.36
Area accuracy	90.34
Jaccard	84.38
False positive rate (/m2)	0.00060

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5. Quality Assurance in Tasmania

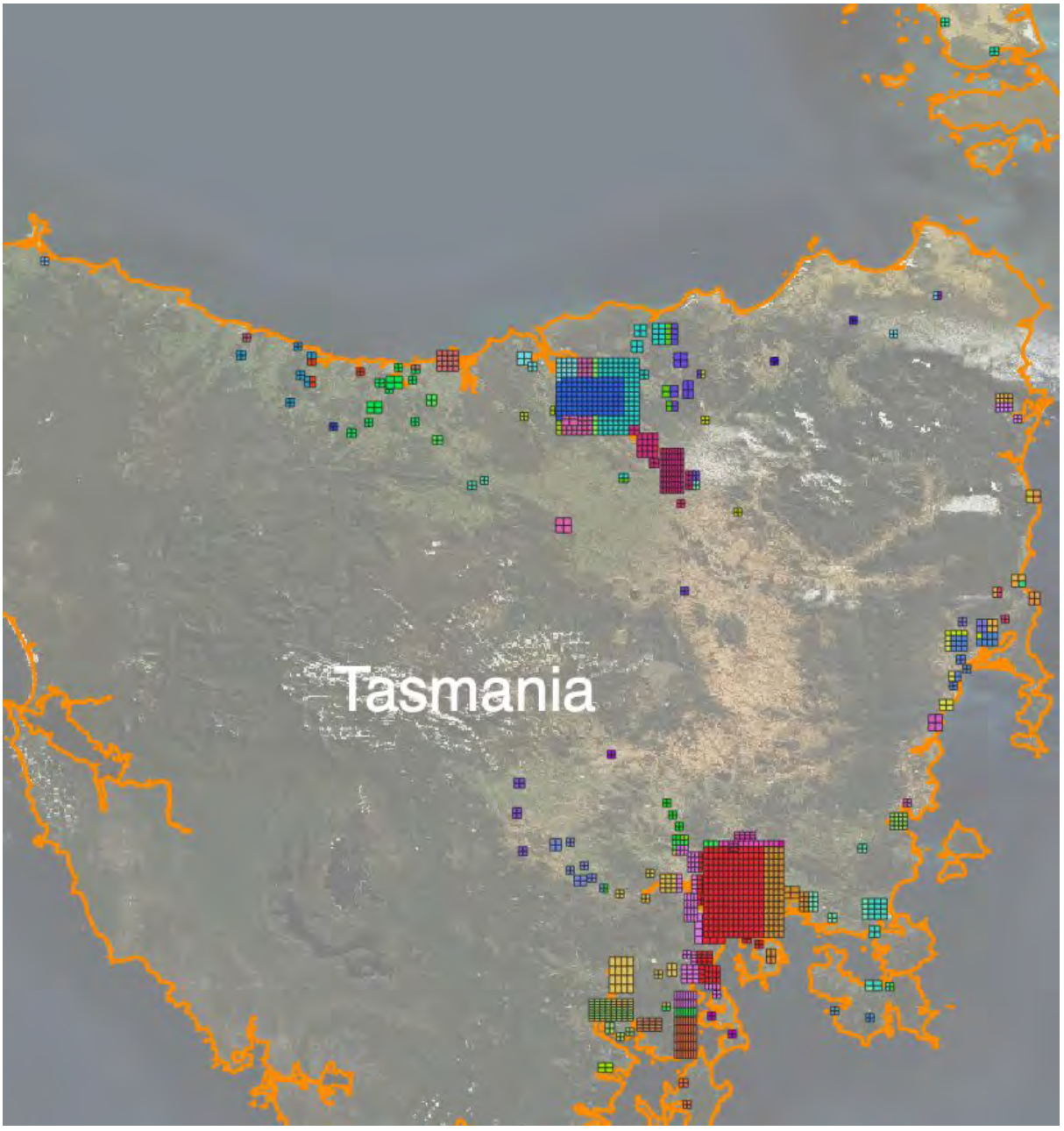


Figure 16: A visualisation of the AOIs in Tasmania that were scanned by GAIA. The different colours represent different satellite images that were used to scan each AOI.

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Figure F.1. The Tasmania North and Tasmania South NSQARs in the context of Tasmania. The entire areas within the coloured rectangles has been labelled (details shown in Figures F.2 and F.3), and the entire areas are used for Quality Assurance to maintain consistency with earlier reporting.

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5.1 Tasmania North

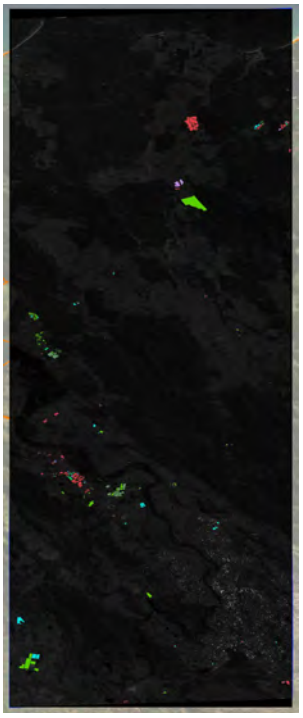


Figure F.2. Tasmania North labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2017-02-14T00:23:00.539Z
Total area (ha)	109242.42
Truth area (ha)	219.63
Prediction area (ha)	239.51
Misses area (ha)	20.67
Mistakes area (ha)	39.92
Union area (ha)	259.60
Intersection area (ha)	199.59
Recall	90.62
Precision	83.33
Category accuracy	99.94
Area accuracy	91.70
Jaccard	76.71
False positive rate (/m2)	0.00037

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5.2 Tasmania South

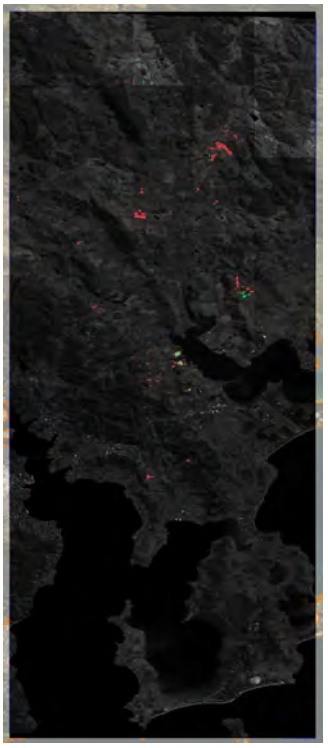


Figure F.3. Tasmania South labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2017-02-28T00:06:35.760Z
Total area (ha)	96188.95
Truth area (ha)	363.25
Prediction area (ha)	326.87
Misses area (ha)	63.39
Mistakes area (ha)	25.71
Union area (ha)	388.91
Intersection area (ha)	301.19
Recall	82.61
Precision	92.14
Category accuracy	99.91
Area accuracy	89.98
Jaccard	77.17
False positive rate (/m2)	0.00027

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6. Quality Assurance in South Australia

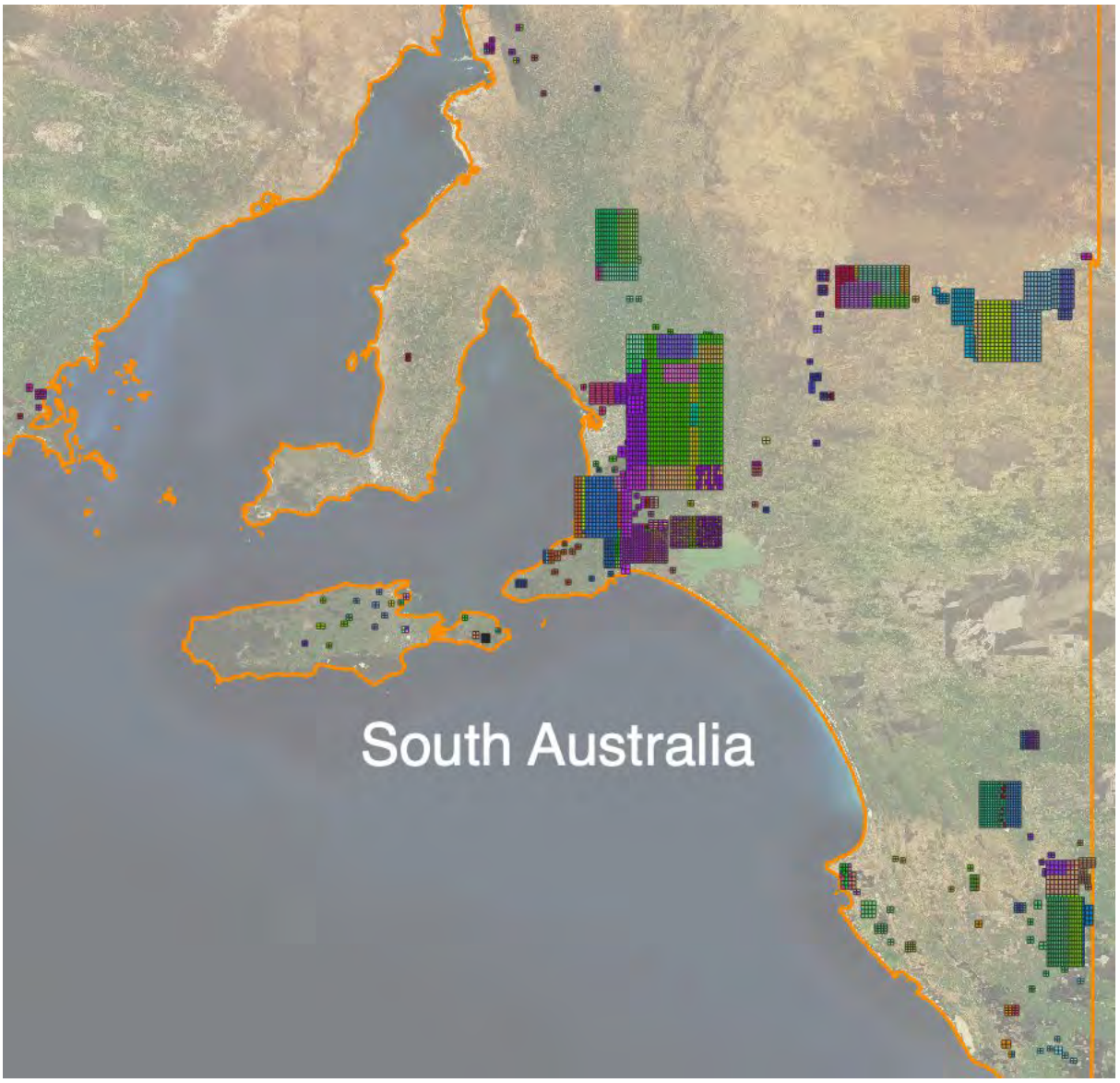


Figure 17: A visualisation of the AOIs in South Australia that were scanned by GAIA. The different colours represent different satellite images that were used to scan each AOI.

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6.1 Riverland



Figure G.1. The Riverland NSQAR in the context of the Riverland GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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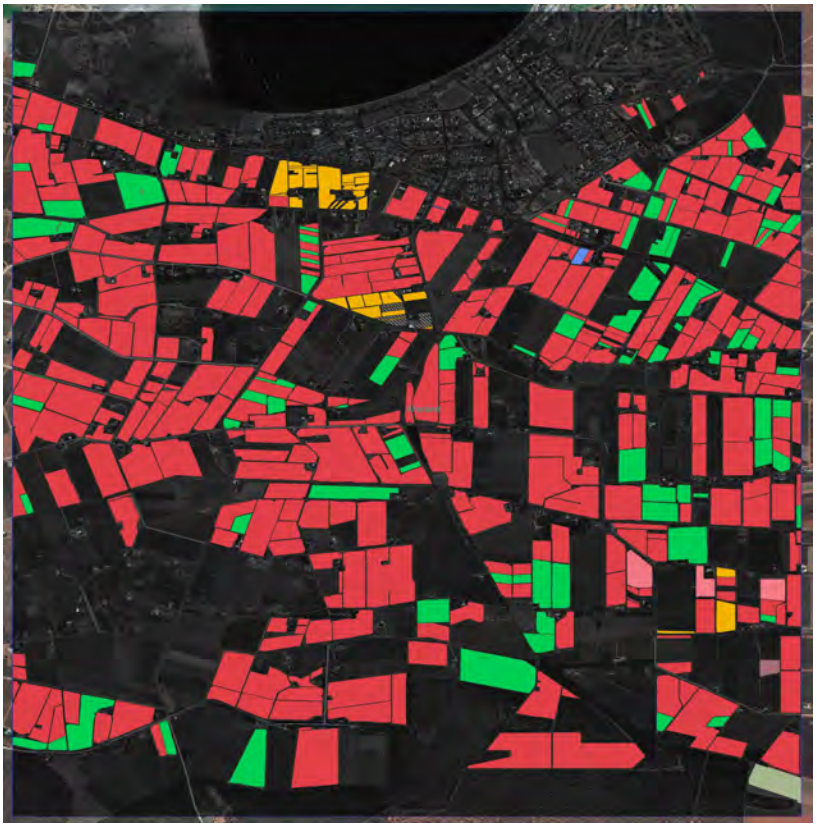


Figure G.2. Riverland labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2014-01-15T01:02:35.127Z
Total area (ha)	729.34
Truth area (ha)	245.22
Prediction area (ha)	265.27
Misses area (ha)	12.72
Mistakes area (ha)	32.59
Union area (ha)	277.89
Intersection area (ha)	232.58
Recall	94.81
Precision	87.71
Category accuracy	95.12
Area accuracy	92.44
Jaccard	83.69
False positive rate (/m2)	0.045

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6.2 Clare Valley

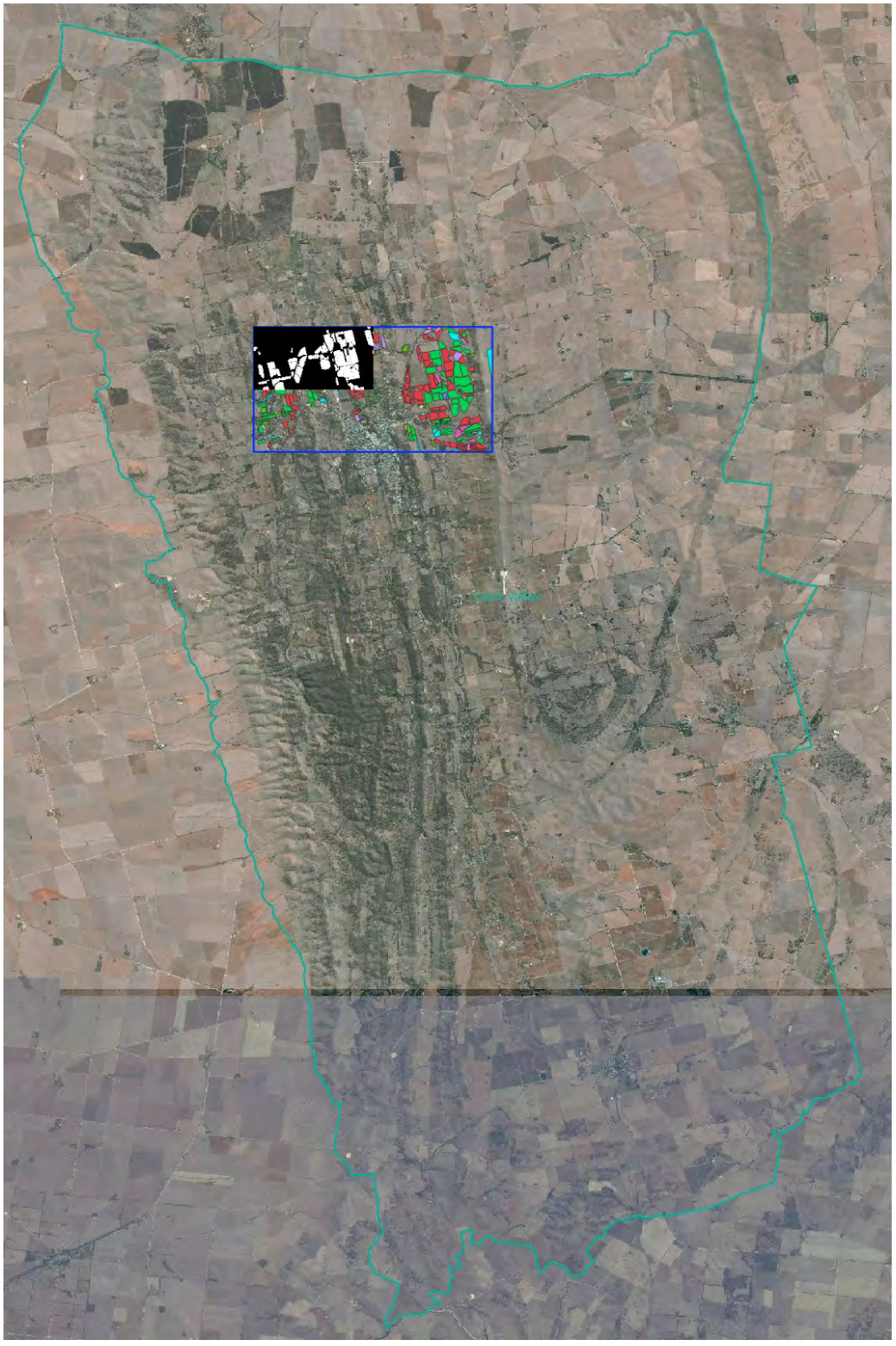


Figure H.1. The Clare Valley NSQAR in the context of the Clare Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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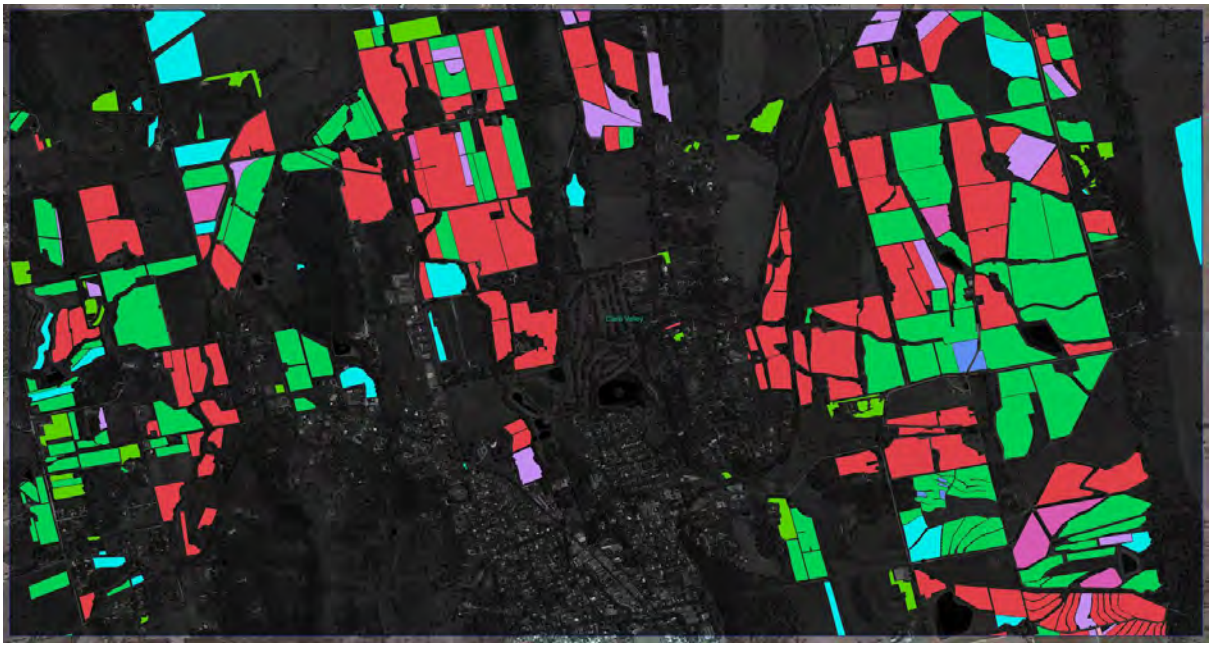


Figure H.2. Clare Valley labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2016-02-08T00:47:01.404Z
Total area (ha)	725.35
Truth area (ha)	180.25
Prediction area (ha)	171.29
Misses area (ha)	22.18
Mistakes area (ha)	11.91
Union area (ha)	192.41
Intersection area (ha)	159.34
Recall	87.78
Precision	93.05
Category accuracy	96.21
Area accuracy	95.03
Jaccard	82.38
False positive rate (/m2)	0.016

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6.3 Wrattonbully

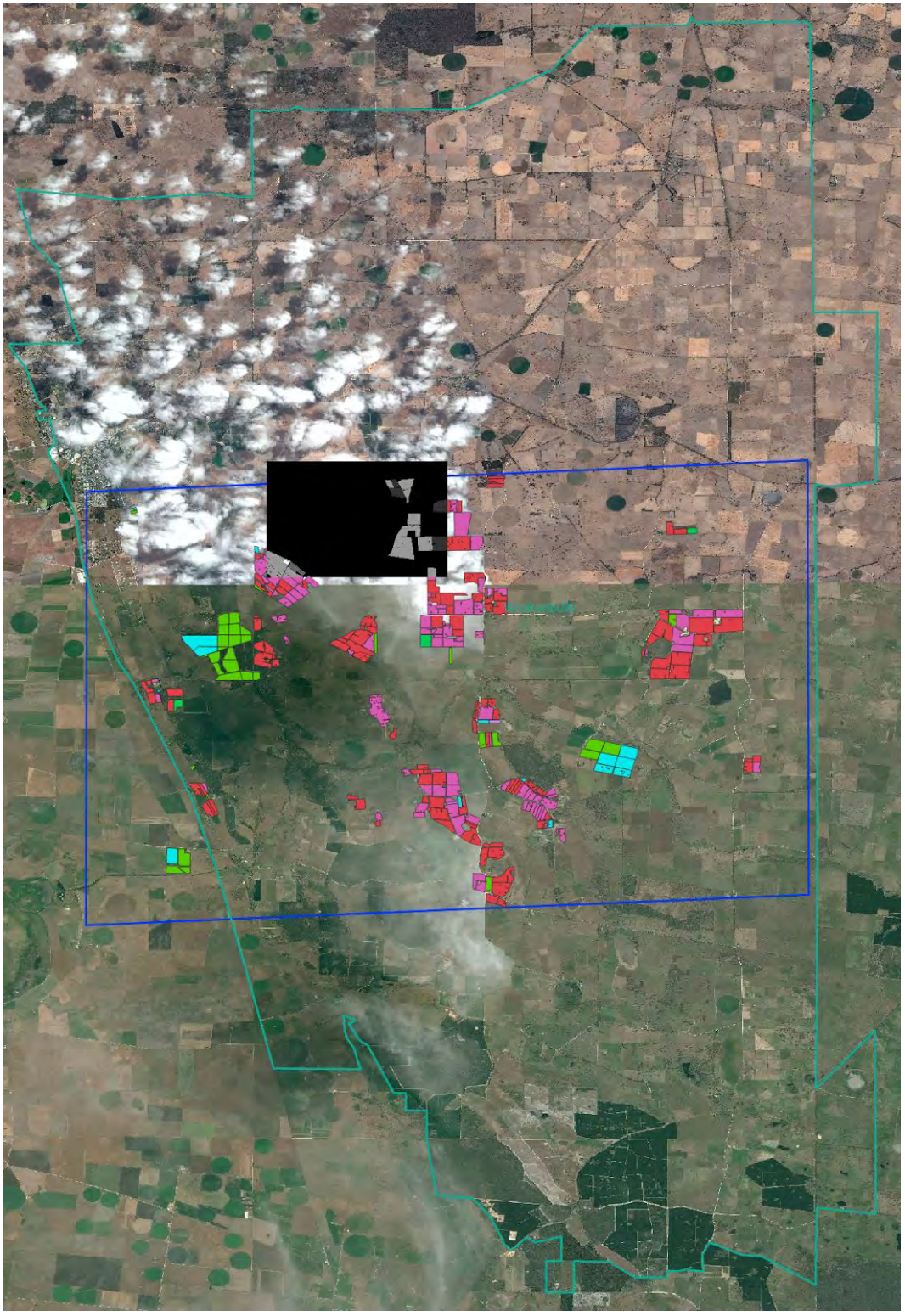


Figure I.1. The Wrattonbully NSQAR in the context of the Wrattonbully GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the greyscale rectangle is used for Quality Assurance to maintain consistency with earlier reporting.

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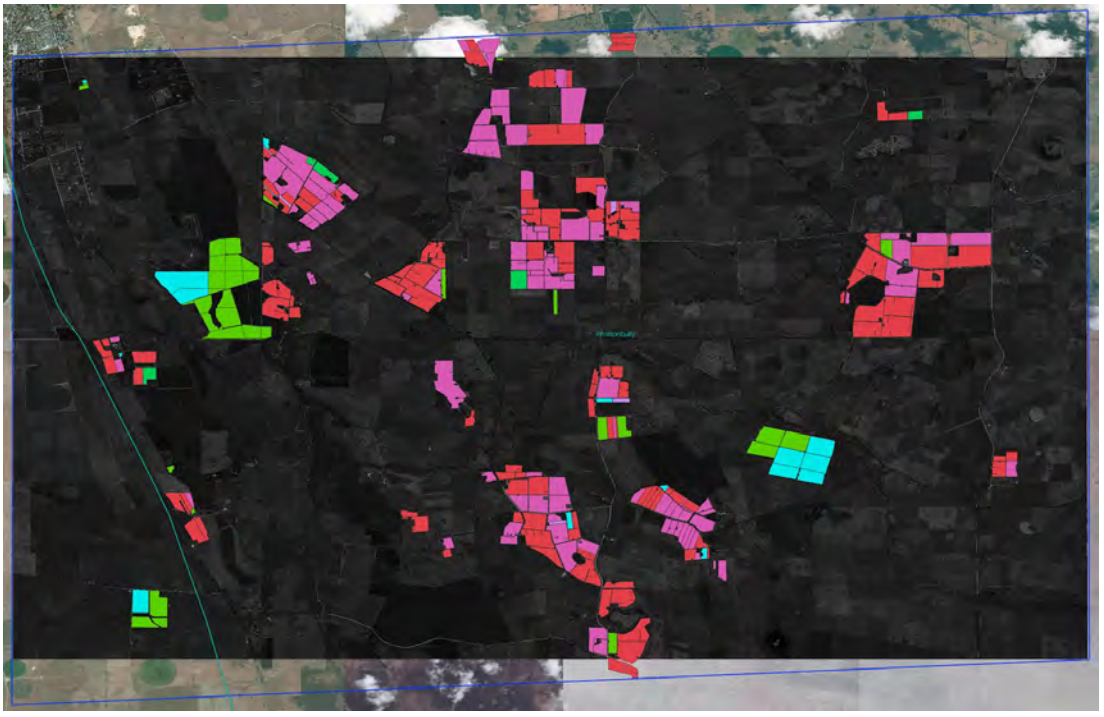


Figure I.2. Wrattonbully labels overlaid on the Panchromatic satellite imagery. The skewed bounds (dark blue) shows the bounds of the entire capture that was taken by the satellite WorldView 2: most other NSQARs are small extractions, with the exception of Margaret River, Tasmania North and South, Barossa Valley and Adelaide Hills.

Date of imagery used for ground truth	2016-02-08T00:47:01.404Z
Total area (ha)	1810.37
Truth area (ha)	284.37
Prediction area (ha)	283.49
Misses area (ha)	9.53
Mistakes area (ha)	7.41
Union area (ha)	291.96
Intersection area (ha)	275.90
Recall	96.66
Precision	97.38
Category accuracy	99.14
Area accuracy	99.69
Jaccard	94.22
False positive rate (/m2)	0.0041

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6.4 Barossa Valley

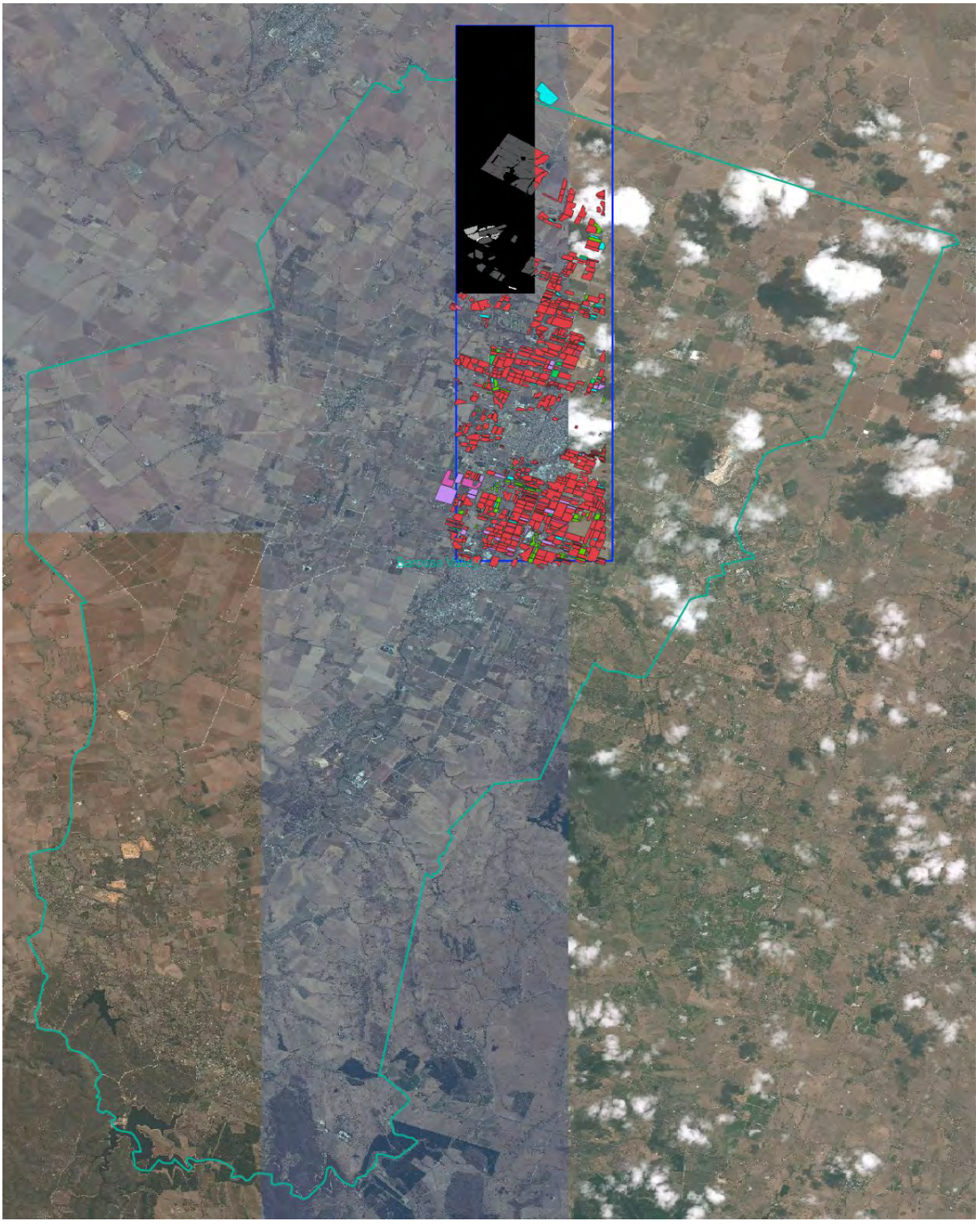


Figure J.1. The Barossa Valley NSQAR in the context of the Barossa Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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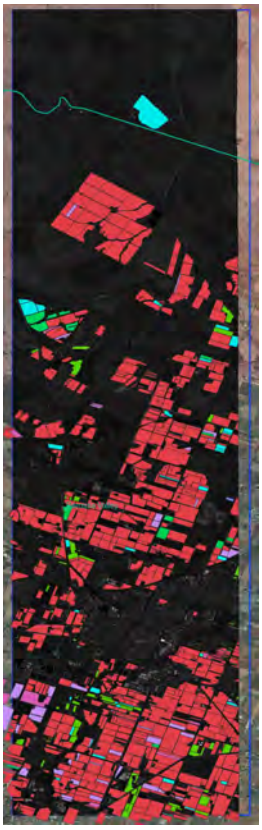


Figure J.2. Barossa Valley labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2017-02-10T01:08:22.132Z
Total area (ha)	2188.70
Truth area (ha)	254.81
Prediction area (ha)	244.73
Misses area (ha)	30.06
Mistakes area (ha)	17.78
Union area (ha)	272.60
Intersection area (ha)	226.92
Recall	88.30
Precision	92.73
Category accuracy	98.03
Area accuracy	96.04
Jaccard	82.59
False positive rate (/m2)	0.0081

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6.5 Adelaide Hills

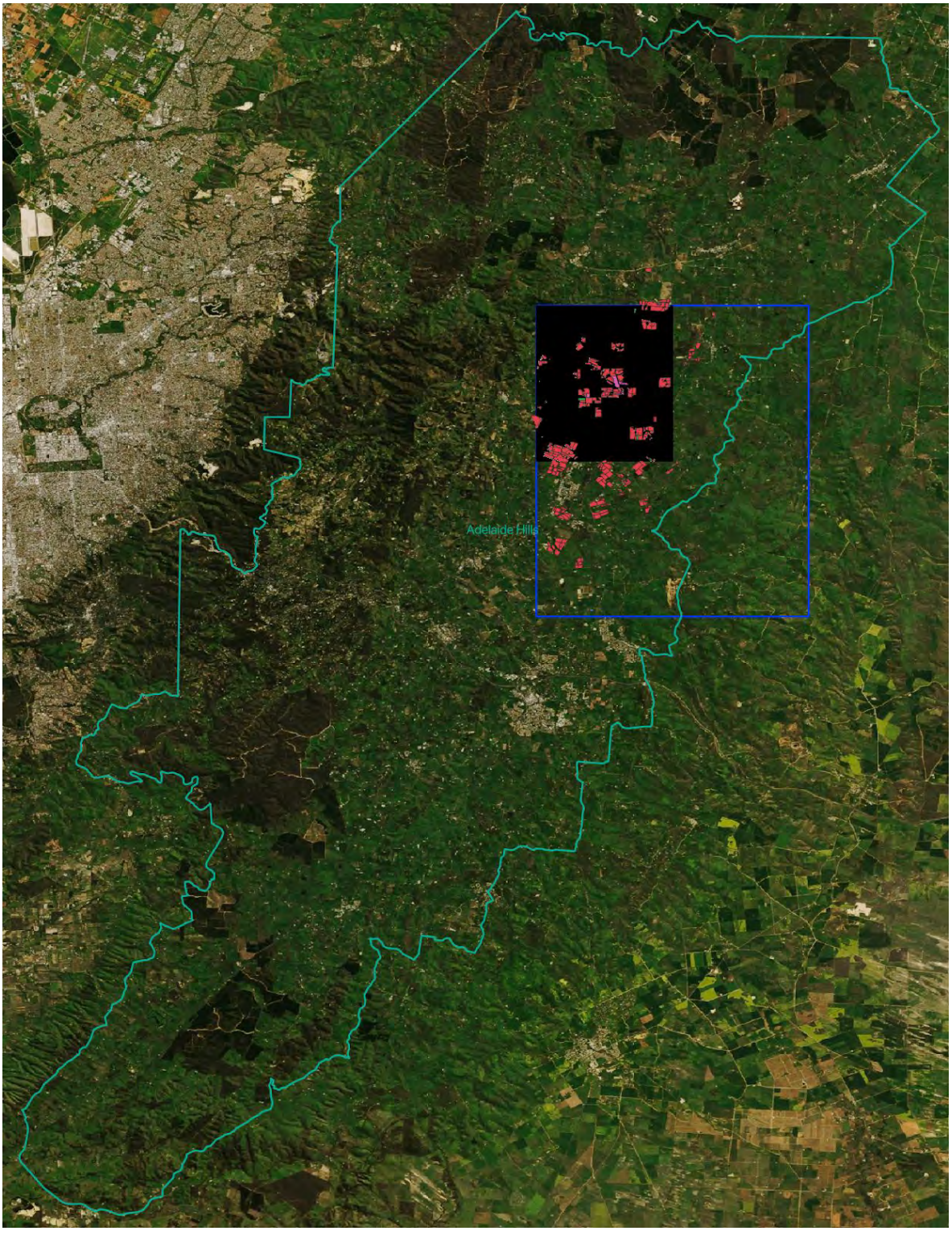


Figure K.1. The Adelaide Hills NSQAR in the context of the Adelaide Hills GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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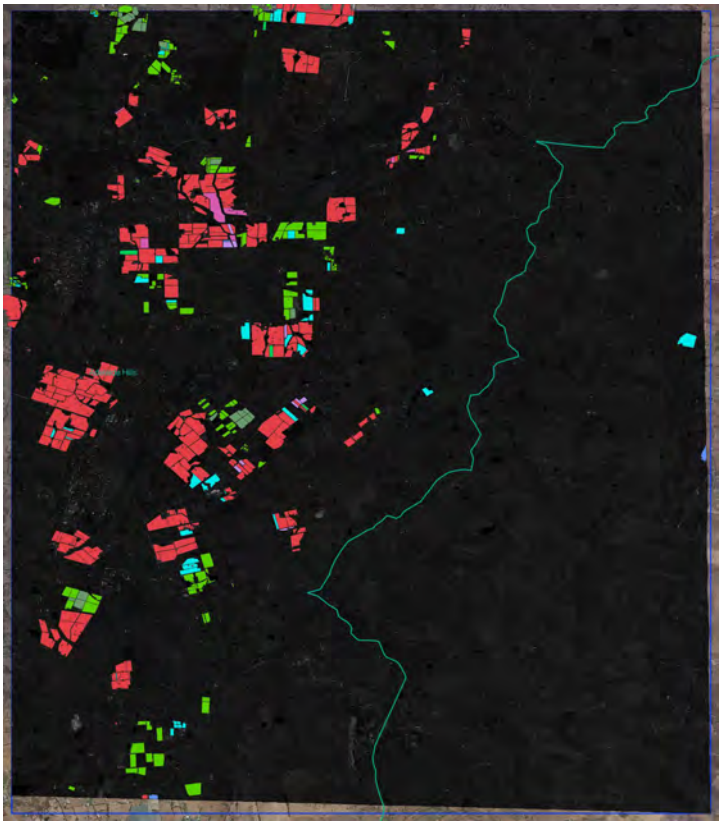


Figure K.2. Adelaide Hills labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2017-02-10T01:08:22.132Z
Total area (ha)	6507.00
Truth area (ha)	579.72
Prediction area (ha)	605.45
Misses area (ha)	18.92
Mistakes area (ha)	41.20
Union area (ha)	621.31
Intersection area (ha)	563.60
Recall	96.75
Precision	93.19
Category accuracy	99.15
Area accuracy	95.75
Jaccard	90.36
False positive rate (/m2)	0.0063

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6.6 Coonawarra

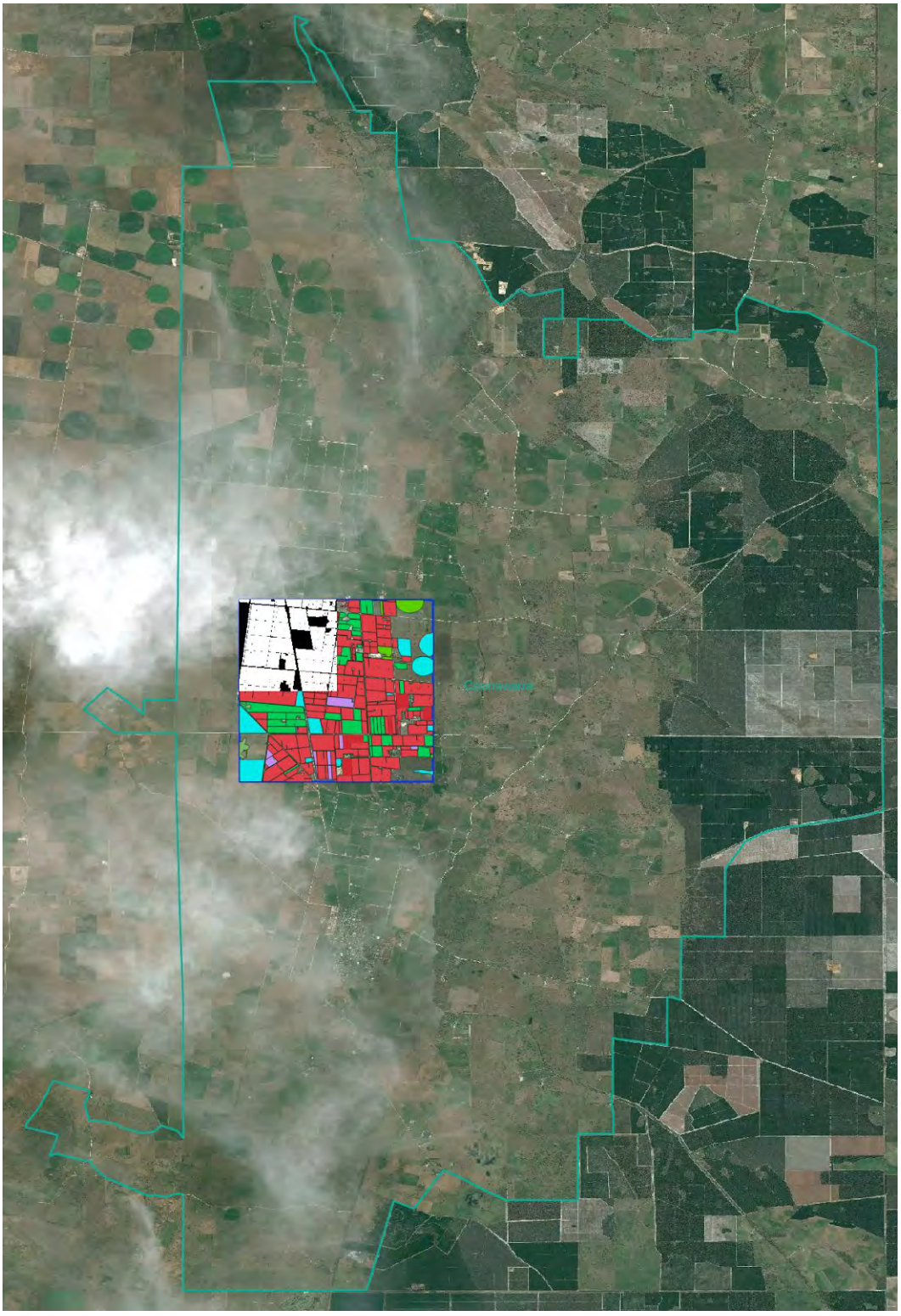


Figure L.1. The Coonawarra NSQAR in the context of the Coonawarra GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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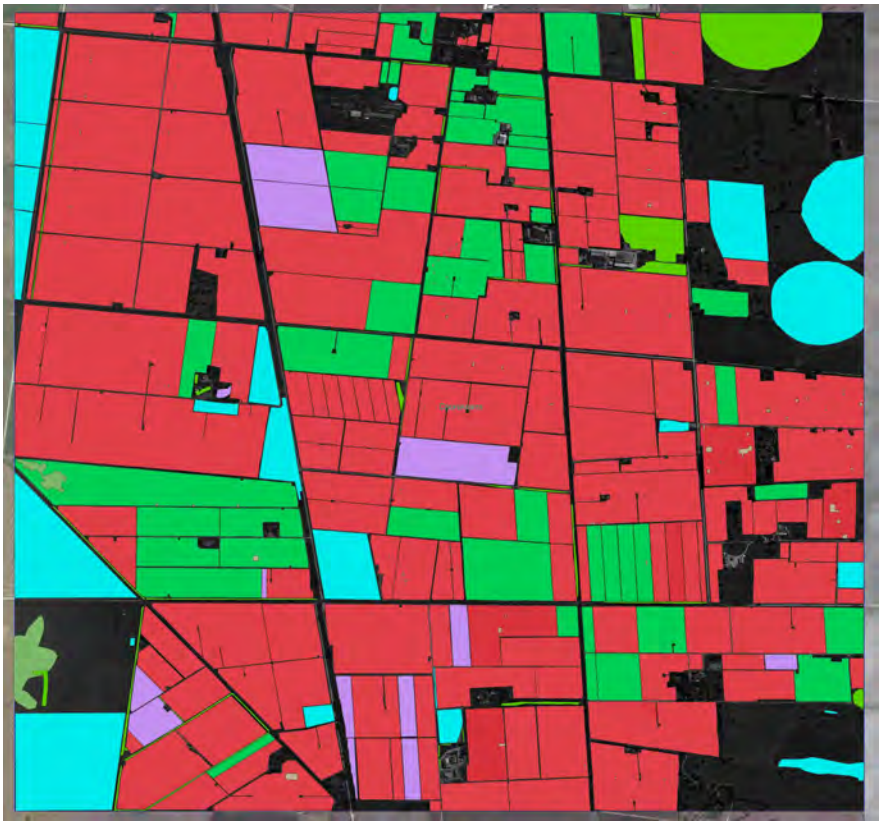


Figure L.2. Coonawarra labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2016-03-17T00:47:50.808Z
Total area (ha)	571.34
Truth area (ha)	442.54
Prediction area (ha)	427.58
Misses area (ha)	38.10
Mistakes area (ha)	22.15
Union area (ha)	464.75
Intersection area (ha)	405.32
Recall	91.41
Precision	94.82
Category accuracy	93.71
Area accuracy	96.62
Jaccard	87.06
False positive rate (/m2)	0.039

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6.7 McLaren Vale

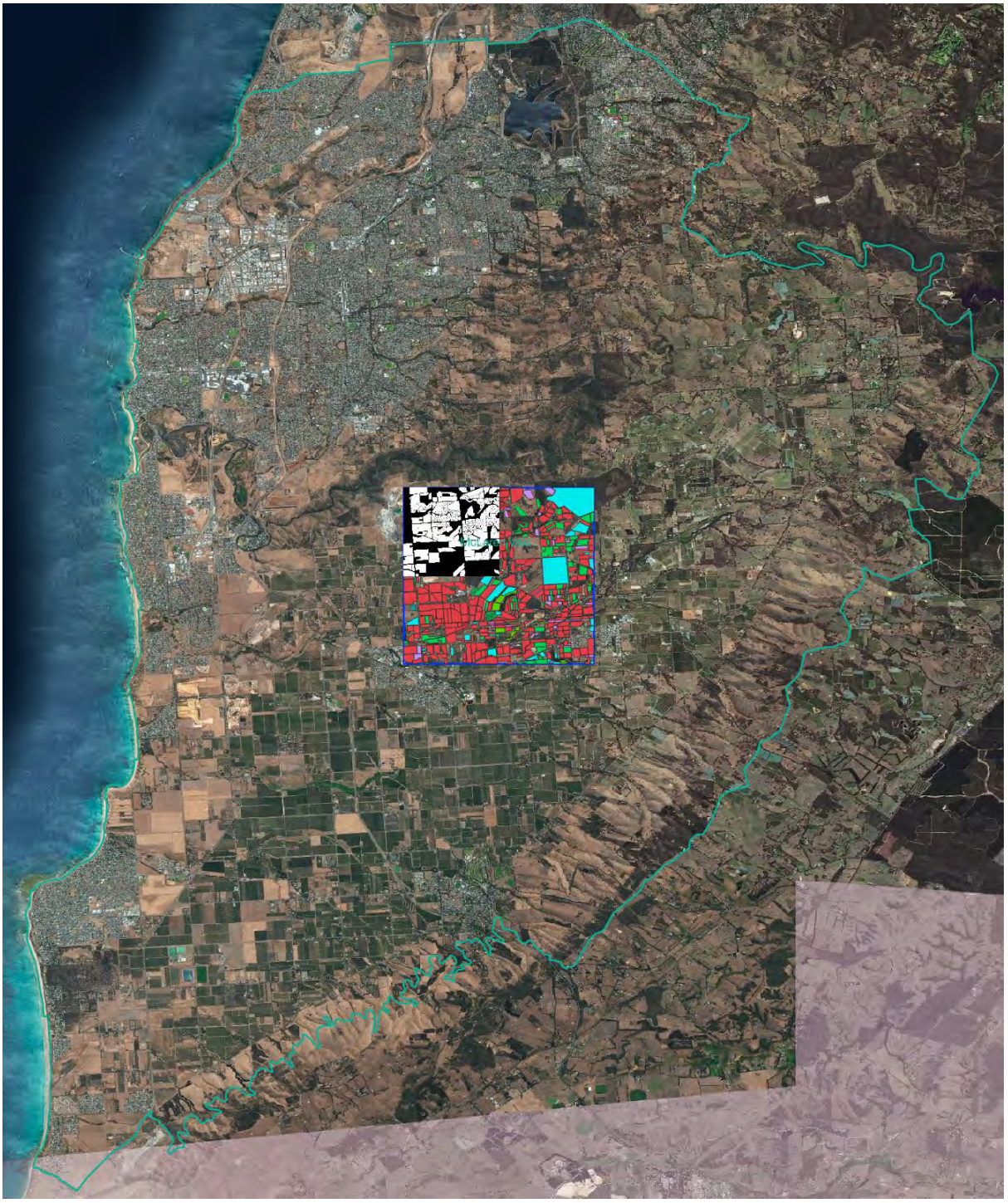


Figure M.1. The McLaren Vale NSQAR in the context of the McLaren Vale GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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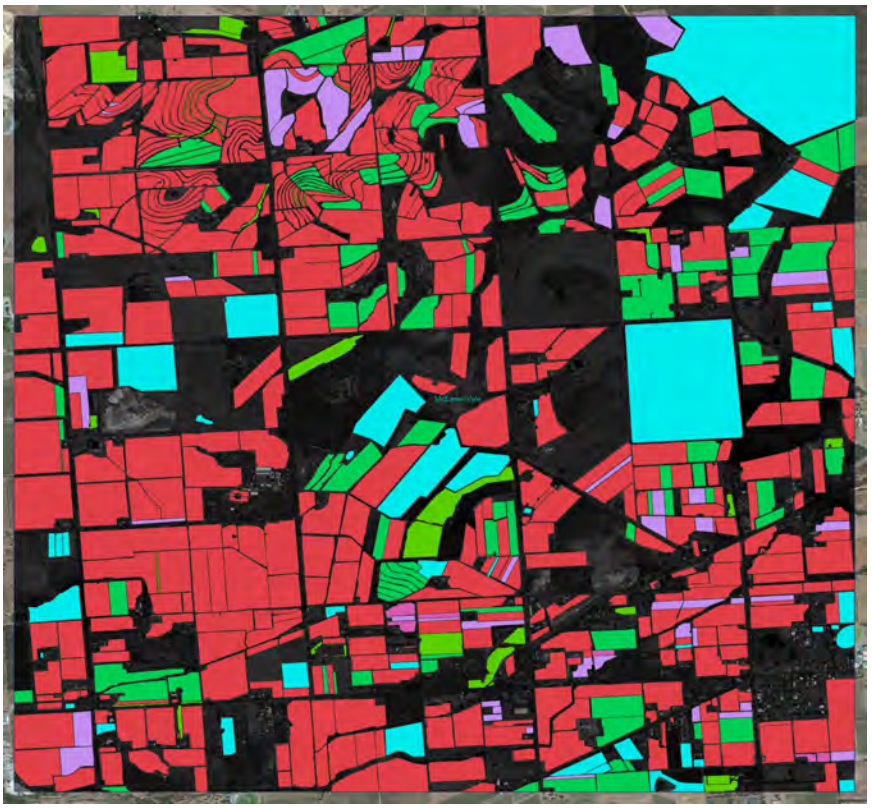


Figure M.2. McLaren Vale labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2017-01-06T01:00:55.382Z
Total area (ha)	557.84
Truth area (ha)	272.93
Prediction area (ha)	276.42
Misses area (ha)	27.89
Mistakes area (ha)	30.76
Union area (ha)	304.72
Intersection area (ha)	245.25
Recall	89.79
Precision	88.86
Category accuracy	92.65
Area accuracy	98.74
Jaccard	80.70
False positive rate (/m2)	0.055

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7. Quality Assurance in Victoria



Figure 18: A visualisation of the AOIs in Victoria that were scanned by GAIA. The different colours represent different satellite images that were used to scan each AOI.

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7.1 Murray Darling VIC #1



Figure N.1. The Murray Darling #1 NSQAR in the context of the Murray Darling GI (VIC). The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

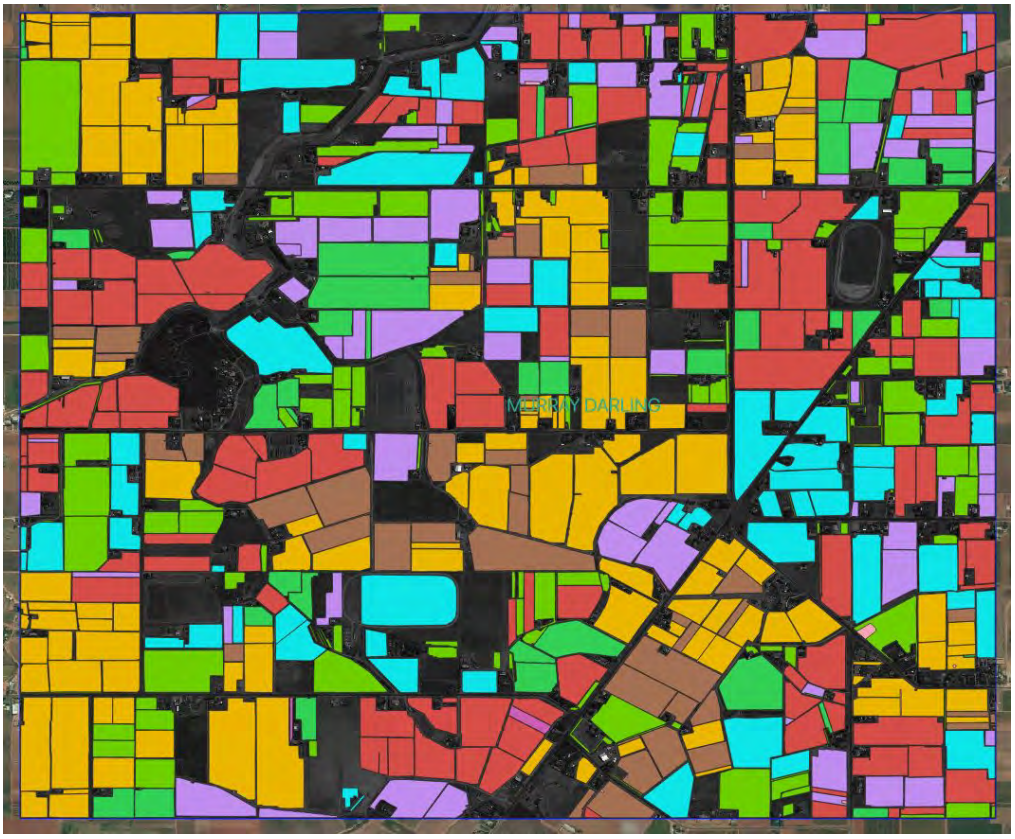


Figure N.2. Murray Darling #1 labels overlaid on the Panchromatic satellite imagery. These labels correspond with the ground truth as represented in the SunRISE Mapping dataset.

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Date of imagery used for ground truth	2018-09-07T00:38:29.000Z
Total area (ha)	413.44
Truth area (ha)	24.52
Prediction area (ha)	24.89
Misses area (ha)	1.25
Mistakes area (ha)	1.62
Union area (ha)	26.15
Intersection area (ha)	23.27
Recall	94.89
Precision	93.48
Category accuracy	99.35
Area accuracy	98.51
Jaccard	89.00
False positive rate (/m2)	0.0039

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7.2 King Valley

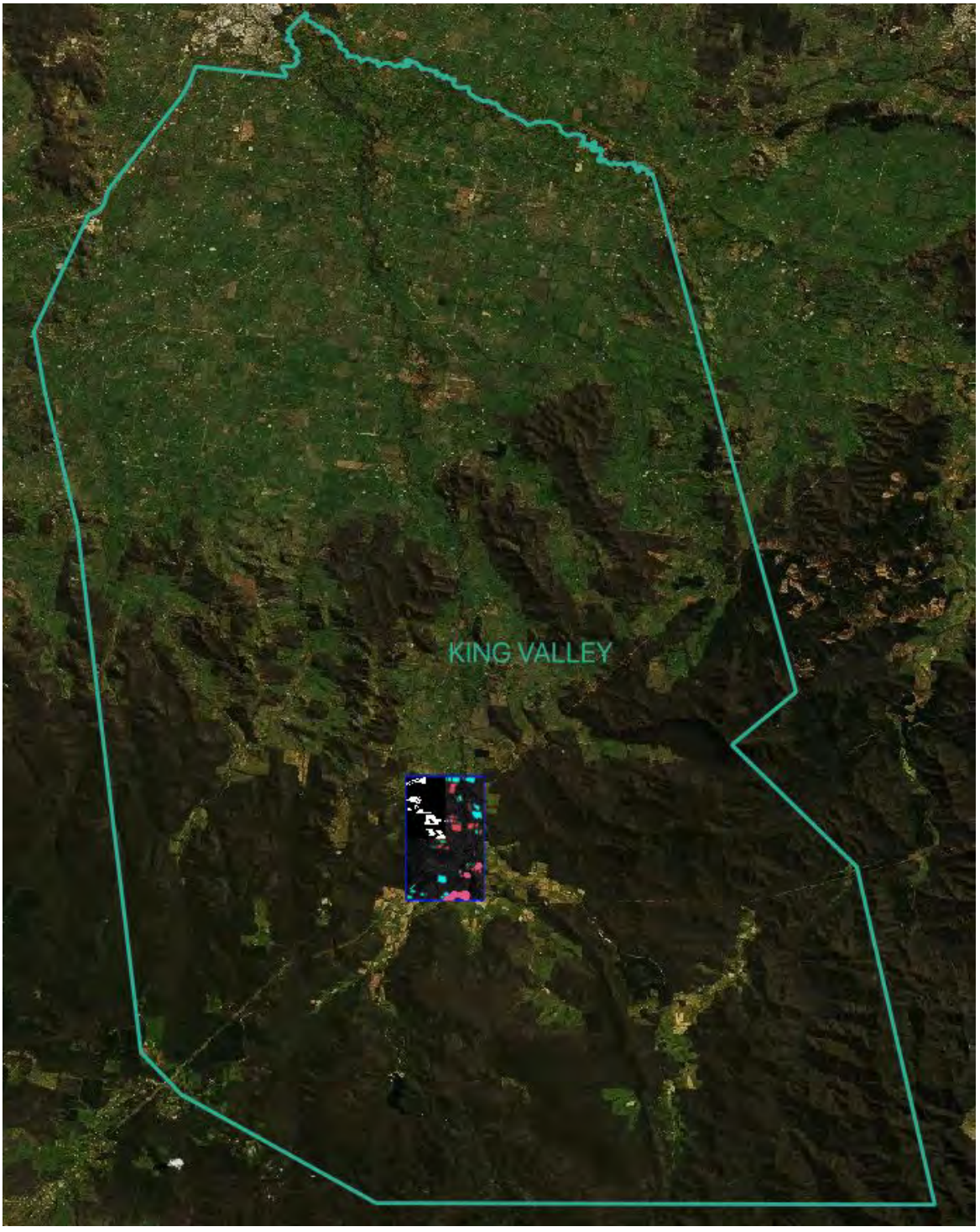


Figure O.1. The King Valley NSQAR in the context of the King Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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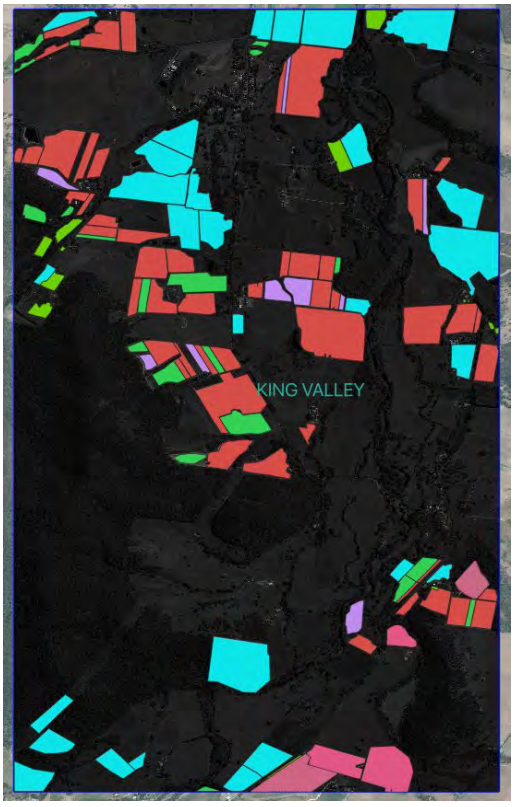


Figure O.2. King Valley labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2015-02-02T00:34:20.060Z
Total area (ha)	630.69
Truth area (ha)	99.92
Prediction area (ha)	95.33
Misses area (ha)	8.21
Mistakes area (ha)	3.62
Union area (ha)	103.54
Intersection area (ha)	91.71
Recall	91.79
Precision	96.21
Category accuracy	98.36
Area accuracy	95.40
Jaccard	88.58
False positive rate (/m2)	0.006

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7.3 Goulburn Valley

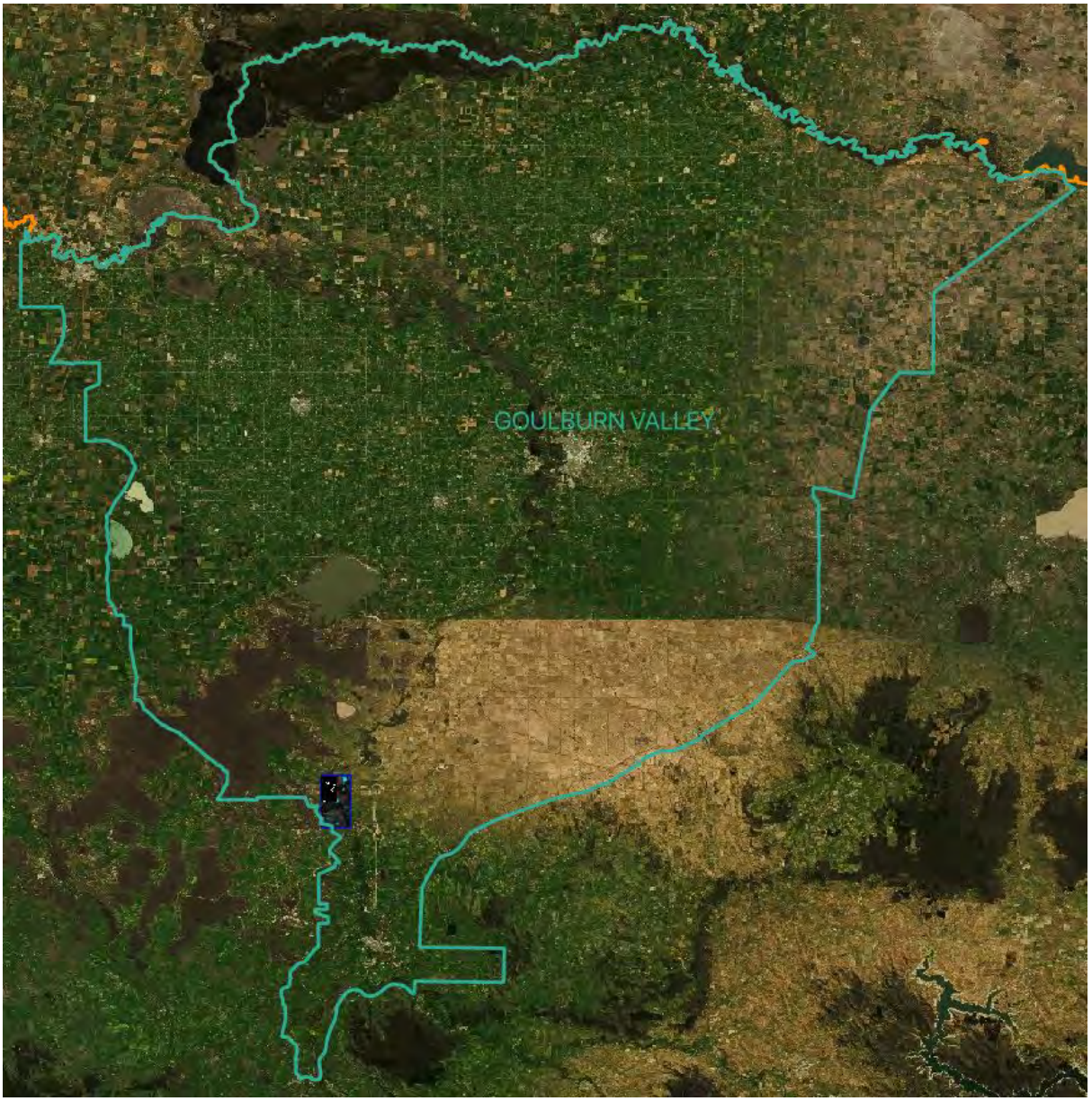


Figure P.1. The Goulburn Valley NSQAR in the context of the Goulburn Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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Figure P.2. Goulburn Valley labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2018-04-02T00:48:09.000Z
Total area (ha)	634.80
Truth area (ha)	37.10
Prediction area (ha)	39.49
Misses area (ha)	3.02
Mistakes area (ha)	5.37
Union area (ha)	42.47
Intersection area (ha)	34.11
Recall	91.87
Precision	86.39
Category accuracy	98.75
Area accuracy	93.95
Jaccard	80.26
False positive rate (/m2)	0.008

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7.4 Yarra Valley



Figure Q.1. The Yarra Valley NSQAR in the context of the Yarra Valley GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

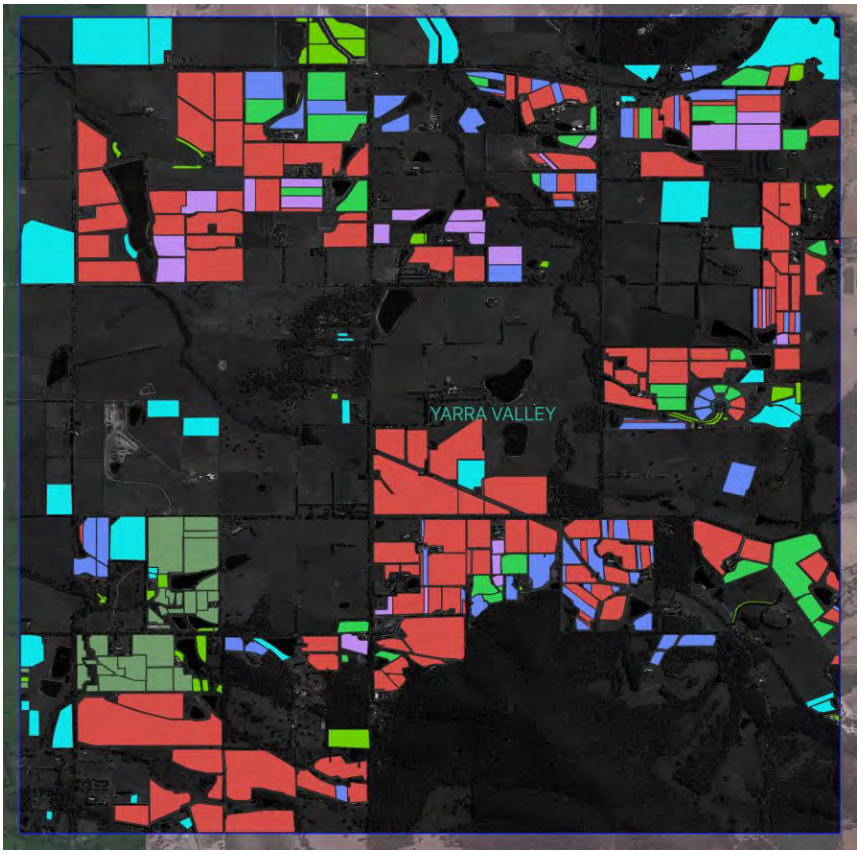


Figure Q.2. Yarra Valley labels overlaid on the Panchromatic satellite imagery.

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Date of imagery used for ground truth	2017-03-02T00:31:05.911Z
Total area (ha)	637.39
Truth area (ha)	110.47
Prediction area (ha)	115.39
Misses area (ha)	3.76
Mistakes area (ha)	8.68
Union area (ha)	119.15
Intersection area (ha)	106.71
Recall	96.60
Precision	92.48
Category accuracy	98.35
Area accuracy	95.74
Jaccard	89.56
False positive rate (/m2)	0.014

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7.5 Strathbogie Ranges



Figure R.1. The Strathbogie Ranges NSQAR in the context of the Strathbogie Ranges GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top right greyscale rectangle is used for Quality Assurance.

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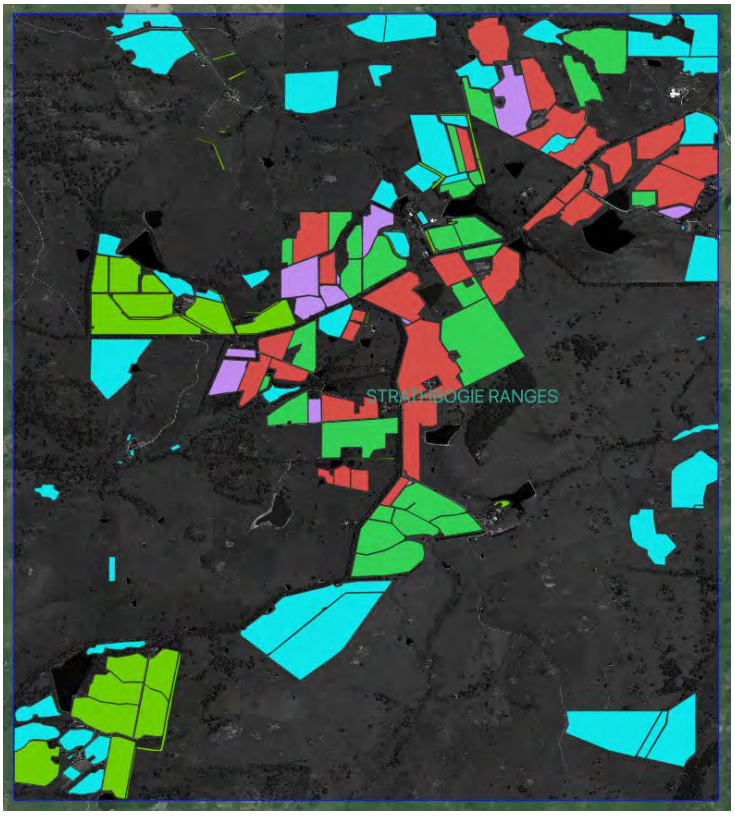


Figure R.2. Strathbogie Ranges labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2016-11-19T00:33:01.540Z
Total area (ha)	706.26
Truth area (ha)	171.34
Prediction area (ha)	167.59
Misses area (ha)	17.93
Mistakes area (ha)	13.84
Union area (ha)	185.18
Intersection area (ha)	153.74
Recall	89.55
Precision	91.74
Category accuracy	96.15
Area accuracy	97.81
Jaccard	82.87
False positive rate (/m2)	0.020

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7.6 Grampians



Figure S.1. The Grampians NSQAR in the context of the Grampians GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the bottom right greyscale rectangle is used for Quality Assurance.

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Figure S.2. Grampians labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2014-02-11T01:08:40.583Z
Total area (ha)	689.59
Truth area (ha)	152.59
Prediction area (ha)	145.71
Misses area (ha)	9.38
Mistakes area (ha)	2.50
Union area (ha)	155.10
Intersection area (ha)	143.22
Recall	93.85
Precision	98.29
Category accuracy	98.59
Area accuracy	95.49
Jaccard	92.34
False positive rate (/m2)	0.0036

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7.7 Gippsland



Figure T.1. The Gippsland NSQAR in the context of the Gippsland GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

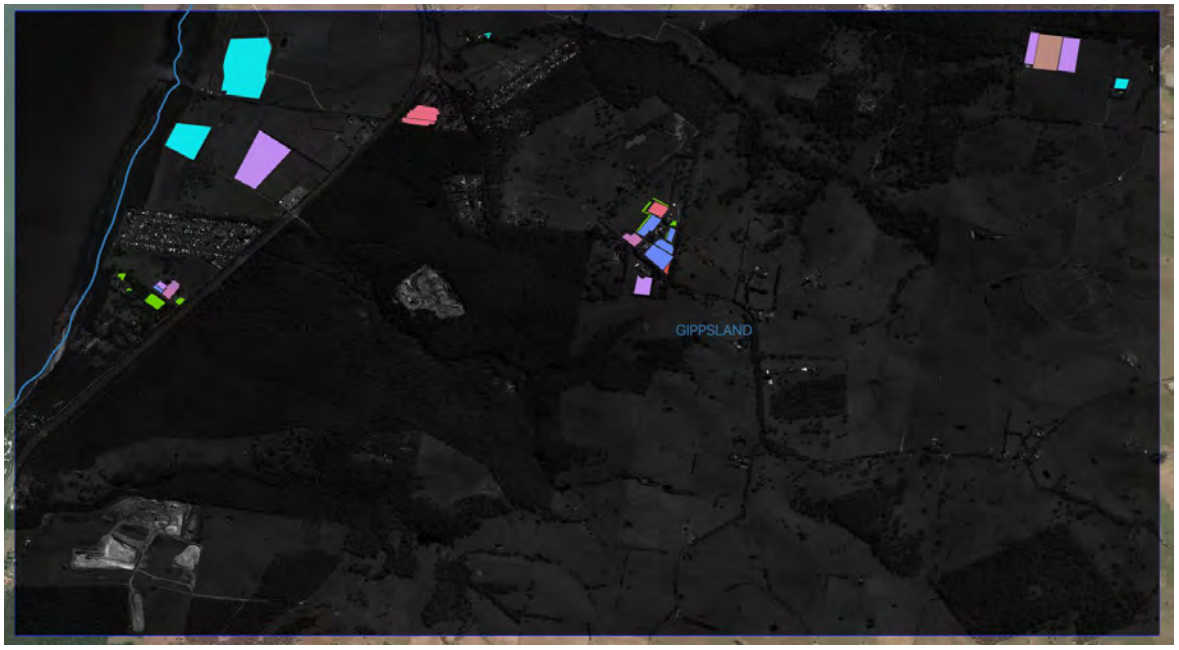


Figure T.2. Gippsland labels overlaid on the Panchromatic satellite imagery.

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Date of imagery used for ground truth	2017-02-22T00:27:29.001Z
Total area (ha)	2426.53
Truth area (ha)	9.20
Prediction area (ha)	8.71
Misses area (ha)	1.06
Mistakes area (ha)	0.58
Union area (ha)	9.78
Intersection area (ha)	8.13
Recall	88.43
Precision	93.36
Category accuracy	99.93
Area accuracy	94.72
Jaccard	83.19
False positive rate (/m2)	0.00024

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7.8 Mornington Peninsula



Figure U.1. The Mornington Peninsula NSQAR in the context of the Mornington Peninsula GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

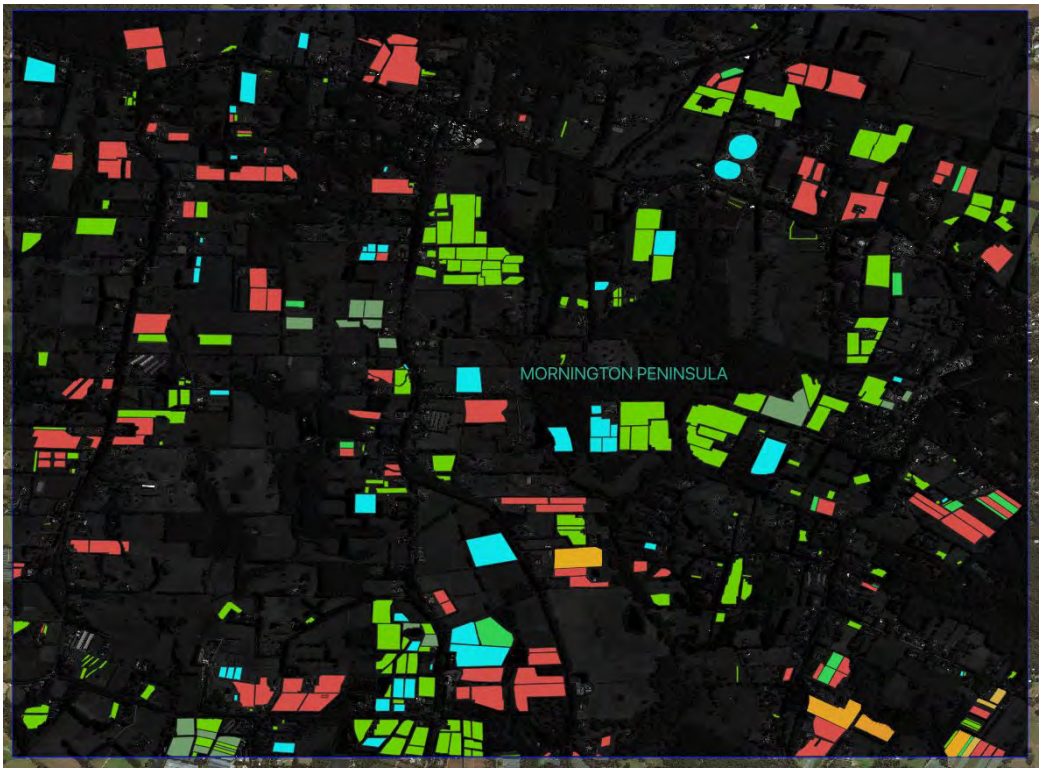


Figure U.2. Mornington Peninsula labels overlaid on the Panchromatic satellite imagery.

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Date of imagery used for ground truth	2017-02-08T00:43:34.980Z
Total area (ha)	649.79
Truth area (ha)	29.93
Prediction area (ha)	29.77
Misses area (ha)	3.38
Mistakes area (ha)	3.22
Union area (ha)	33.16
Intersection area (ha)	26.55
Recall	88.70
Precision	89.17
Category accuracy	99.03
Area accuracy	99.47
Jaccard	80.07
False positive rate (/m2)	0.0050

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7.9 Murray Darling VIC #2



Figure V.1. The Murray Darling #2 NSQAR in the context of the Murray Darling GI (VIC). The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.



Figure V.2. Murray Darling #2 labels overlaid on the Panchromatic satellite imagery. These labels correspond with the ground truth as represented in the SunRISE Mapping dataset.

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Date of imagery used for ground truth	2018-02-04T00:41:01.000Z
Total area (ha)	413.19
Truth area (ha)	41.18
Prediction area (ha)	37.81
Misses area (ha)	6.25
Mistakes area (ha)	2.88
Union area (ha)	44.07
Intersection area (ha)	34.93
Recall	84.83
Precision	92.38
Category accuracy	97.98
Area accuracy	91.82
Jaccard	79.28
False positive rate (/m2)	0.0070

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8. Quality Assurance in New South Wales

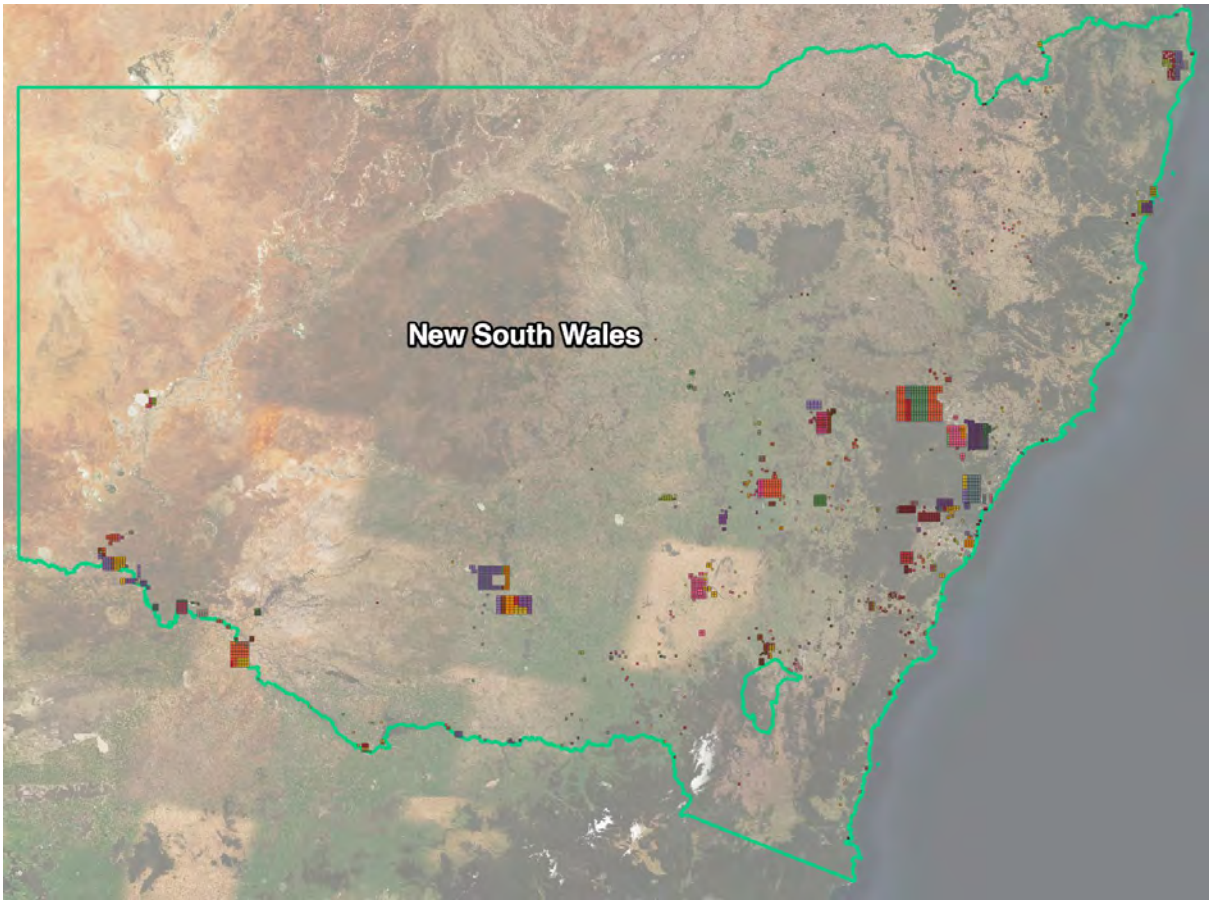


Figure 19: A visualisation of the AOIs in New South Wales that were scanned by GAIA. The different colours represent different satellite images that were used to scan each AOI.

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8.1 Riverina

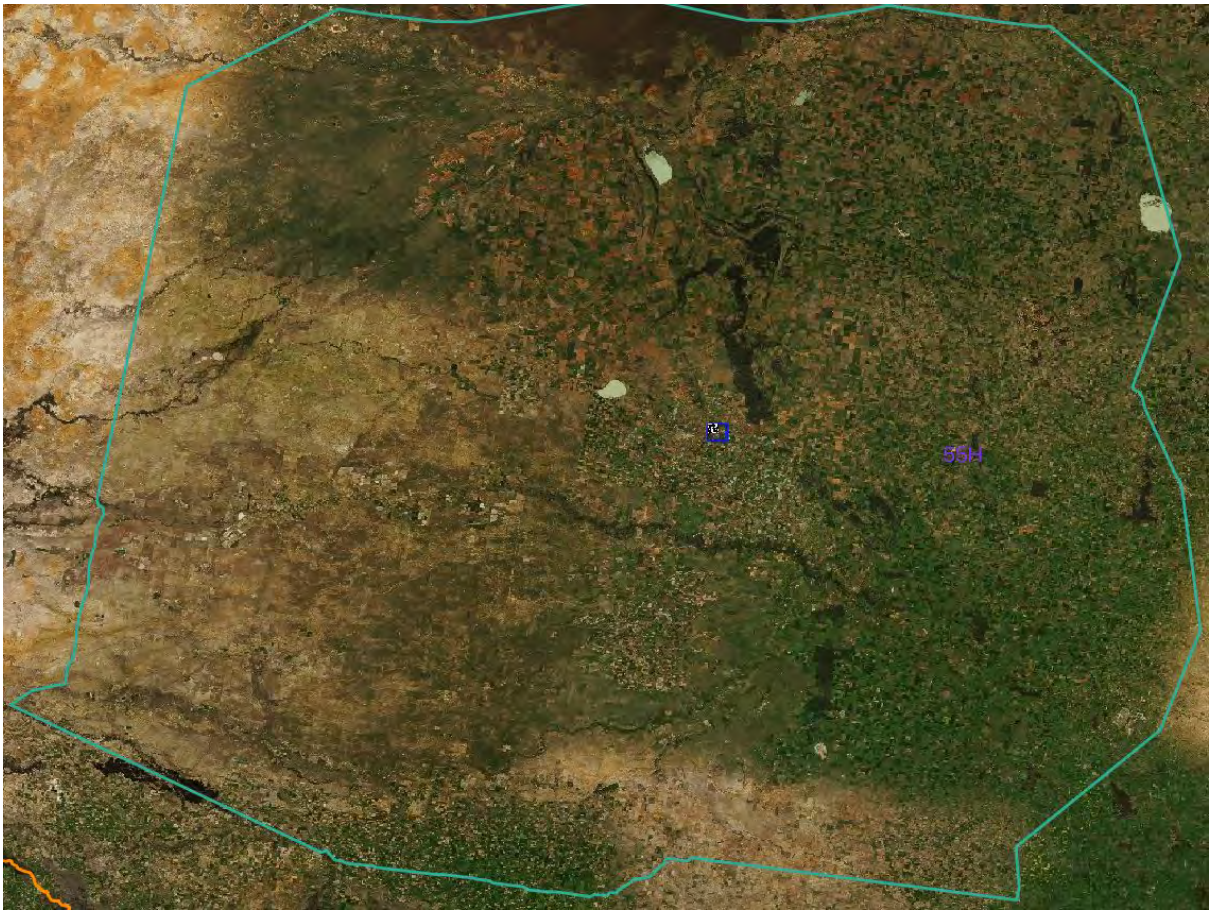


Figure W.1. The Riverina NSQAR in the context of the Riverina GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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Figure W.2. Riverina labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2018-02-07T00:31:20.000Z
Total area (ha)	680.39
Truth area (ha)	263.06
Prediction area (ha)	248.74
Misses area (ha)	21.79
Mistakes area (ha)	7.46
Union area (ha)	270.54
Intersection area (ha)	241.28
Recall	91.72
Precision	97.00
Category accuracy	96.54
Area accuracy	94.56
Jaccard	89.19
False positive rate (/m2)	0.011

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8.2 Canberra District

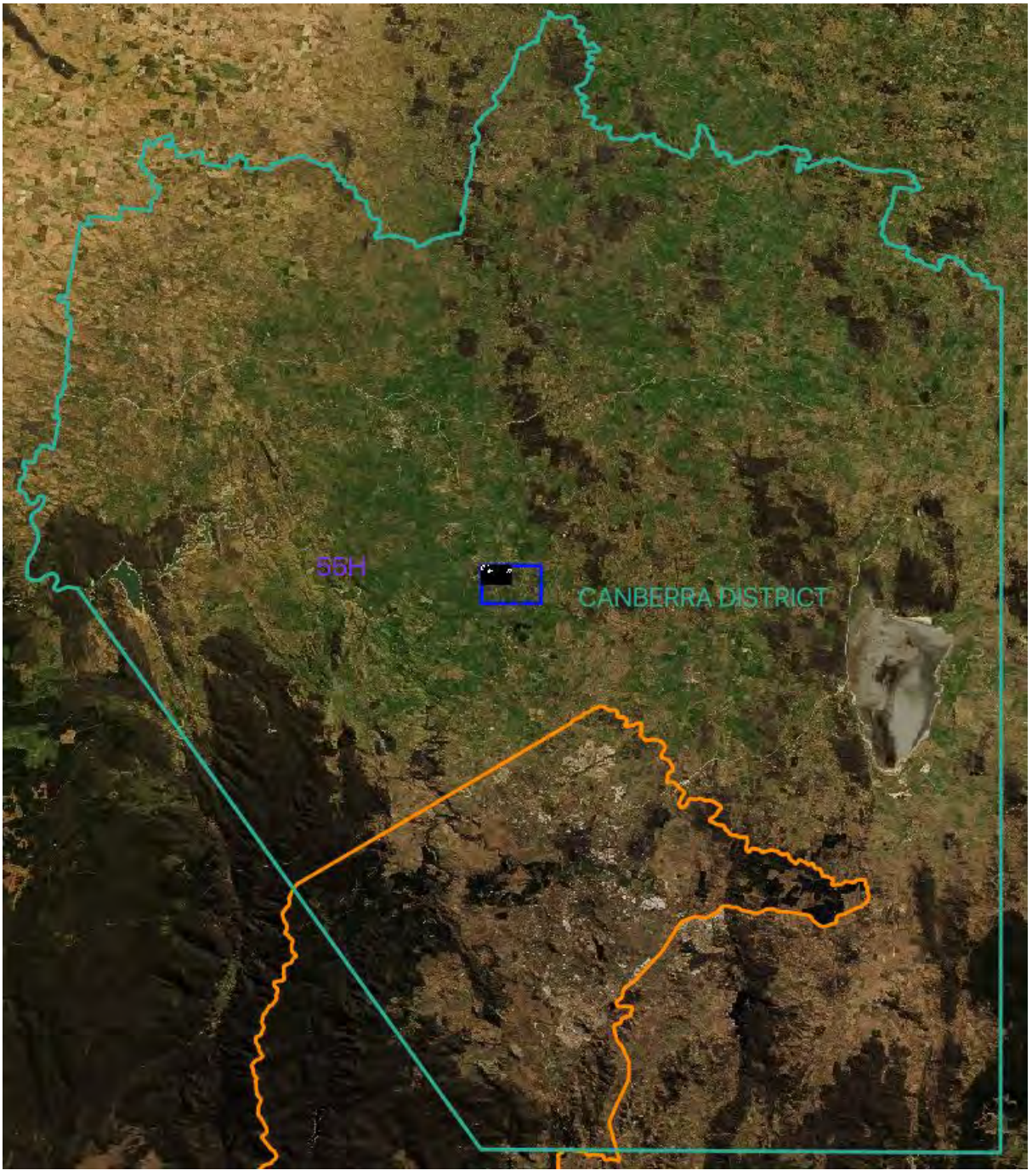


Figure X.1. The Canberra District NSQAR in the context of the Canberra District GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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Figure X.2. Canberra District labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2016-03-31T23:53:59.781Z
Total area (ha)	605.30
Truth area (ha)	45.15
Prediction area (ha)	42.35
Misses area (ha)	4.18
Mistakes area (ha)	1.36
Union area (ha)	46.53
Intersection area (ha)	40.98
Recall	90.74
Precision	96.80
Category accuracy	99.14
Area accuracy	93.80
Jaccard	88.09
False positive rate (/m2)	0.0022

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8.3 Hunter

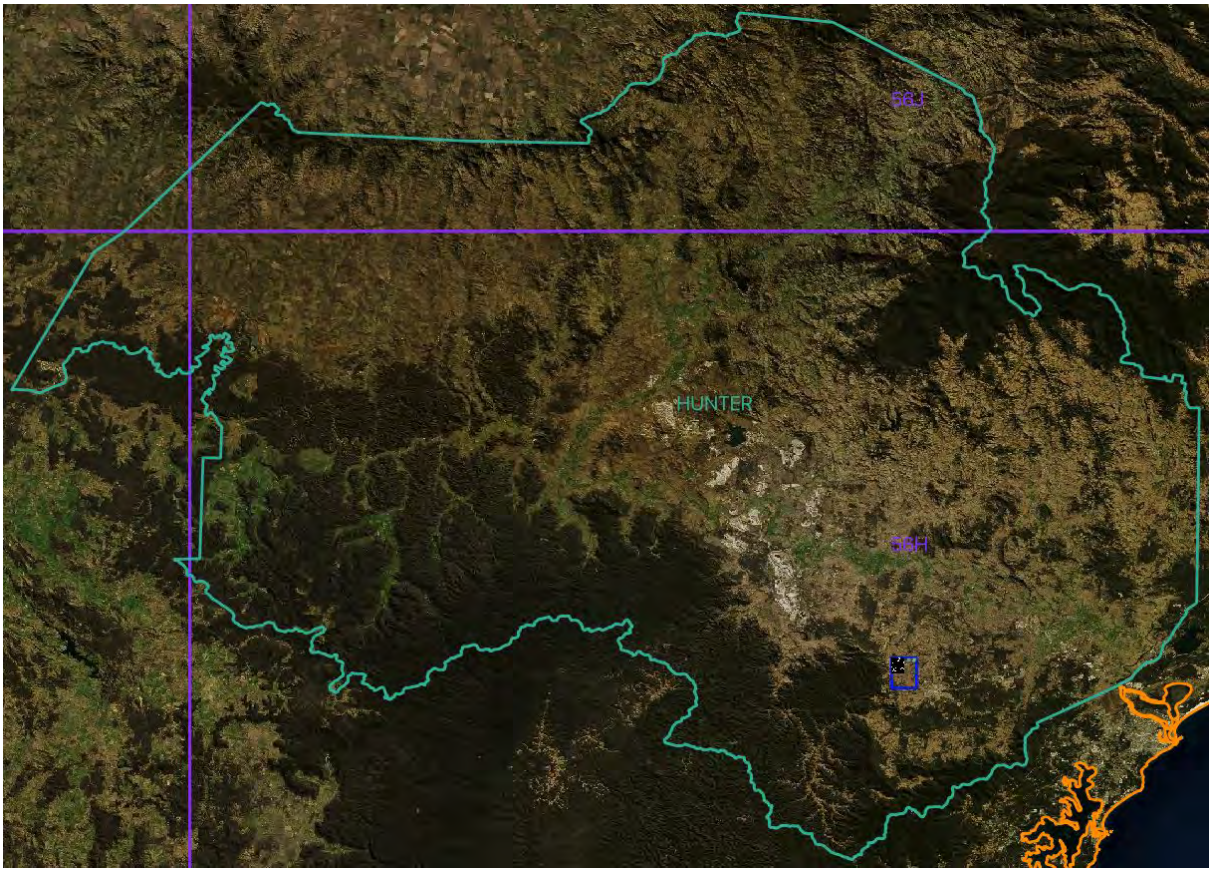


Figure Y.1. The Hunter NSQAR in the context of the Hunter (Region) GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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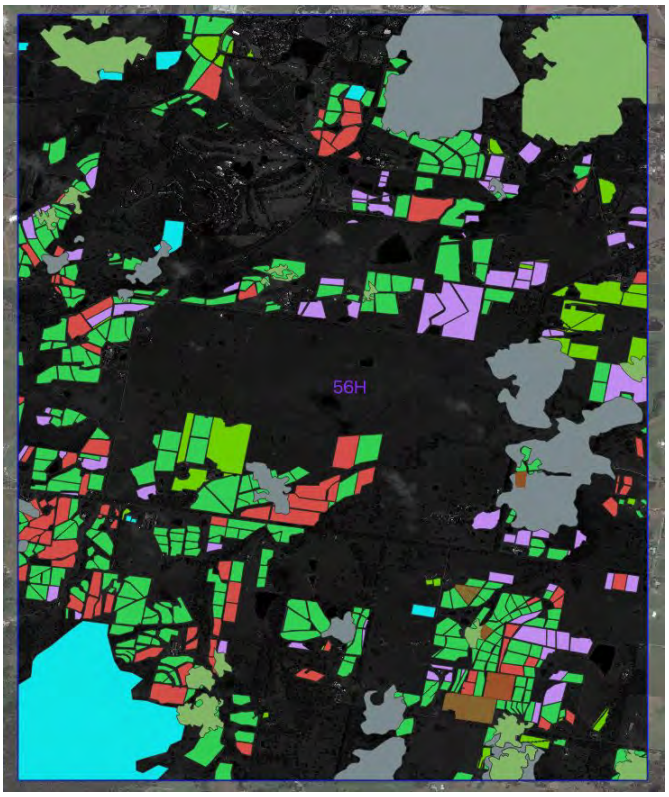


Figure Y.2. Hunter labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2018-02-10T00:20:19.000Z
Total area (ha)	645.76
Truth area (ha)	64.33
Prediction area (ha)	62.89
Misses area (ha)	6.66
Mistakes area (ha)	5.20
Union area (ha)	69.53
Intersection area (ha)	57.68
Recall	89.65
Precision	91.74
Category accuracy	98.33
Area accuracy	97.76
Jaccard	82.95
False positive rate (/m2)	0.0080

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8.4 Orange

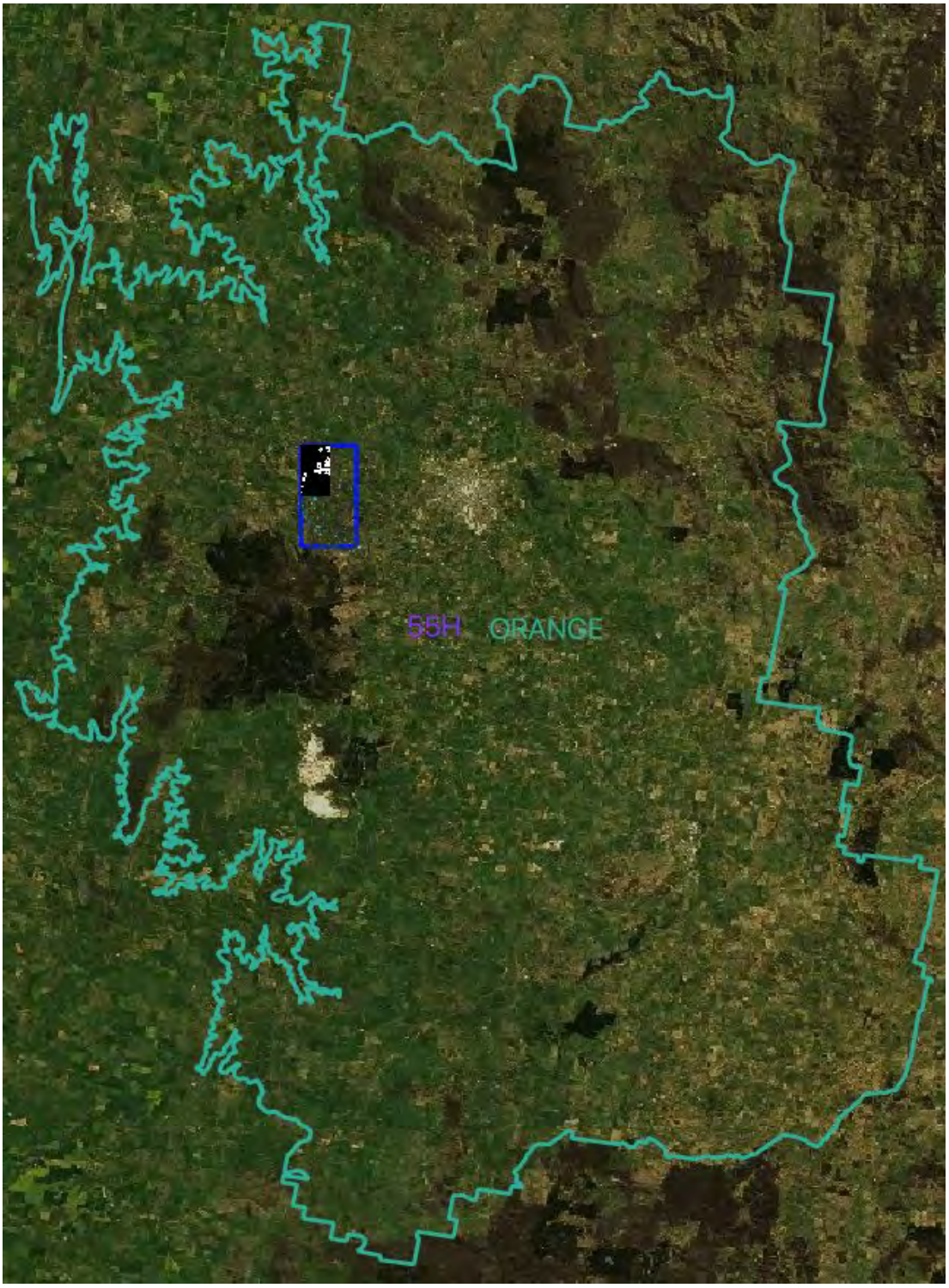


Figure Z.1. The Orange NSQAR in the context of the Orange GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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Figure Z.2. Orange labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2018-03-09T00:27:50.000Z
Total area (ha)	666.99
Truth area (ha)	90.52
Prediction area (ha)	88.65
Misses area (ha)	4.33
Mistakes area (ha)	2.46
Union area (ha)	92.99
Intersection area (ha)	86.19
Recall	95.21
Precision	97.22
Category accuracy	99.04
Area accuracy	97.93
Jaccard	92.70
False positive rate (/m2)	0.0037

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8.5 Shoalhaven Coast



Figure AA.1. The Shoalhaven Coast NSQAR in the context of the Shoalhaven Coast GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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Figure AA.2. Shoalhaven Coast labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2018-03-15T00:09:21.000Z
Total area (ha)	2527.55
Truth area (ha)	14.67
Prediction area (ha)	13.50
Misses area (ha)	2.29
Mistakes area (ha)	1.06
Union area (ha)	15.74
Intersection area (ha)	12.42
Recall	84.45
Precision	92.12
Category accuracy	99.87
Area accuracy	91.97
Jaccard	78.76
False positive rate (/m2)	0.00042

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8.6 Swan Hill (NSW)



Figure AB.1. The Swan Hill (NSW) NSQAR in the context of the Swan Hill GI (NSW). The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top right greyscale rectangle is used for Quality Assurance.

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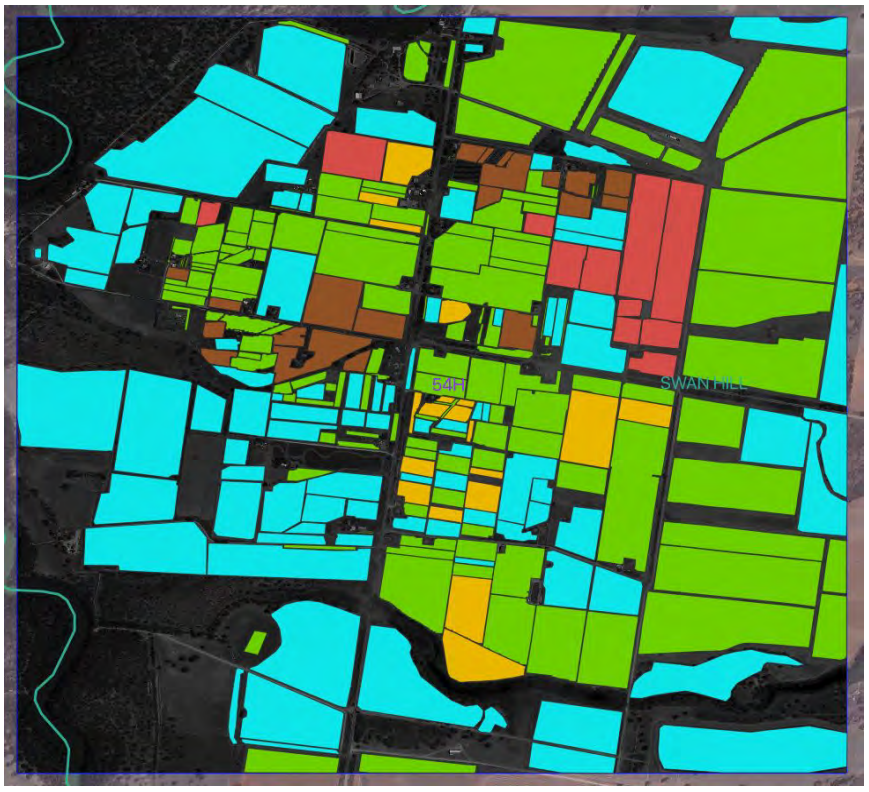


Figure AB.2. Swan Hill (NSW) labels overlaid on the Panchromatic satellite imagery. These labels correspond with the ground truth as represented in the SunRISE Mapping dataset.

Date of imagery used for ground truth	2018-12-19T00:51:08.000Z
Total area (ha)	281.40
Truth area (ha)	28.10
Prediction area (ha)	26.39
Misses area (ha)	1.86
Mistakes area (ha)	0.15
Union area (ha)	28.25
Intersection area (ha)	26.23
Recall	93.37
Precision	99.42
Category accuracy	99.35
Area accuracy	93.92
Jaccard	92.87
False positive rate (/m2)	0.00054

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9. Quality Assurance in Queensland



Figure 20: A visualisation of the AOIs in Queensland that were scanned by GAIA. The different colours represent different satellite images that were used to scan each AOI.

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9.1 South Burnett

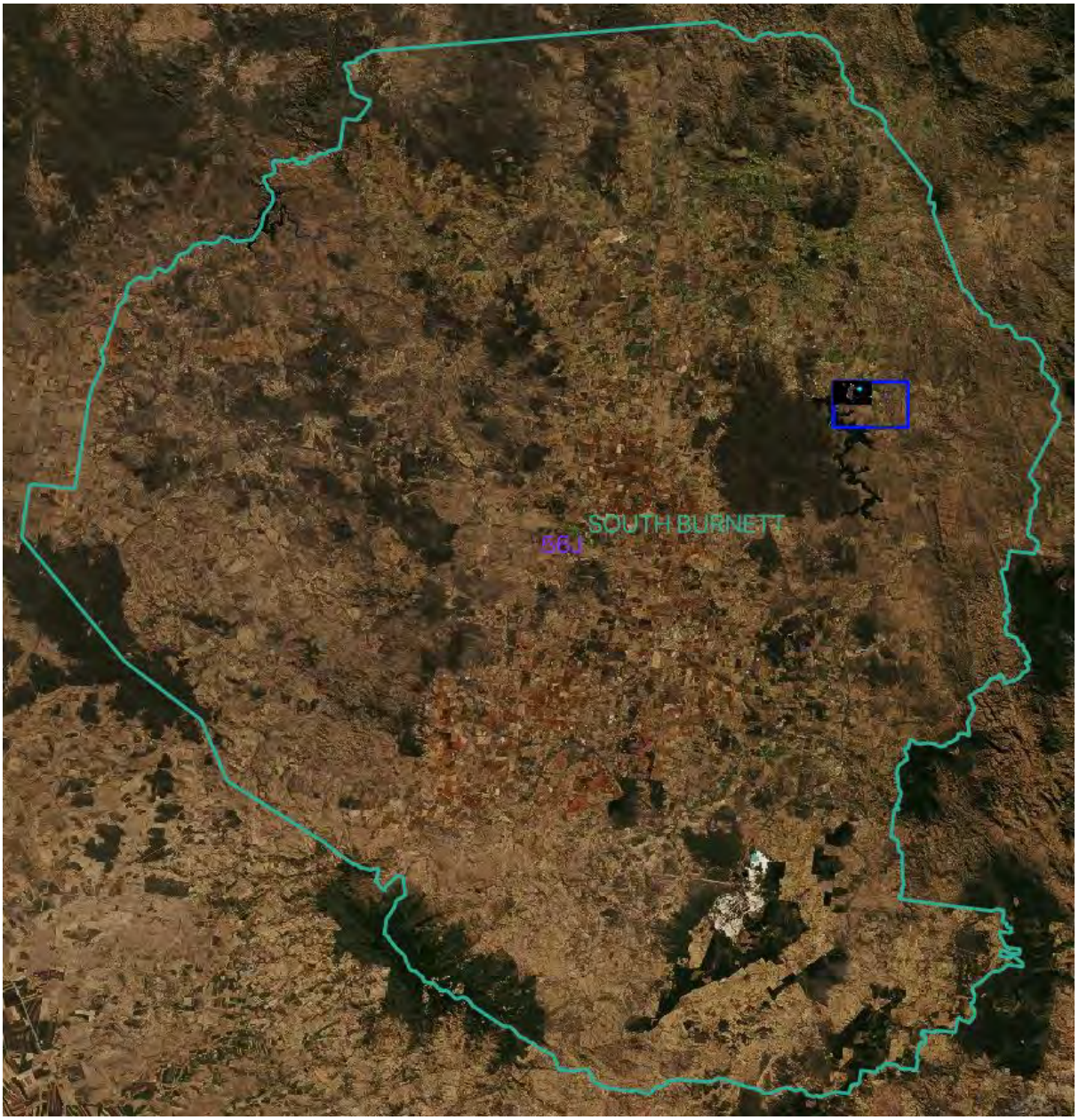


Figure AC.1. The South Burnett NSQAR in the context of the South Burnett GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the top left greyscale rectangle is used for Quality Assurance.

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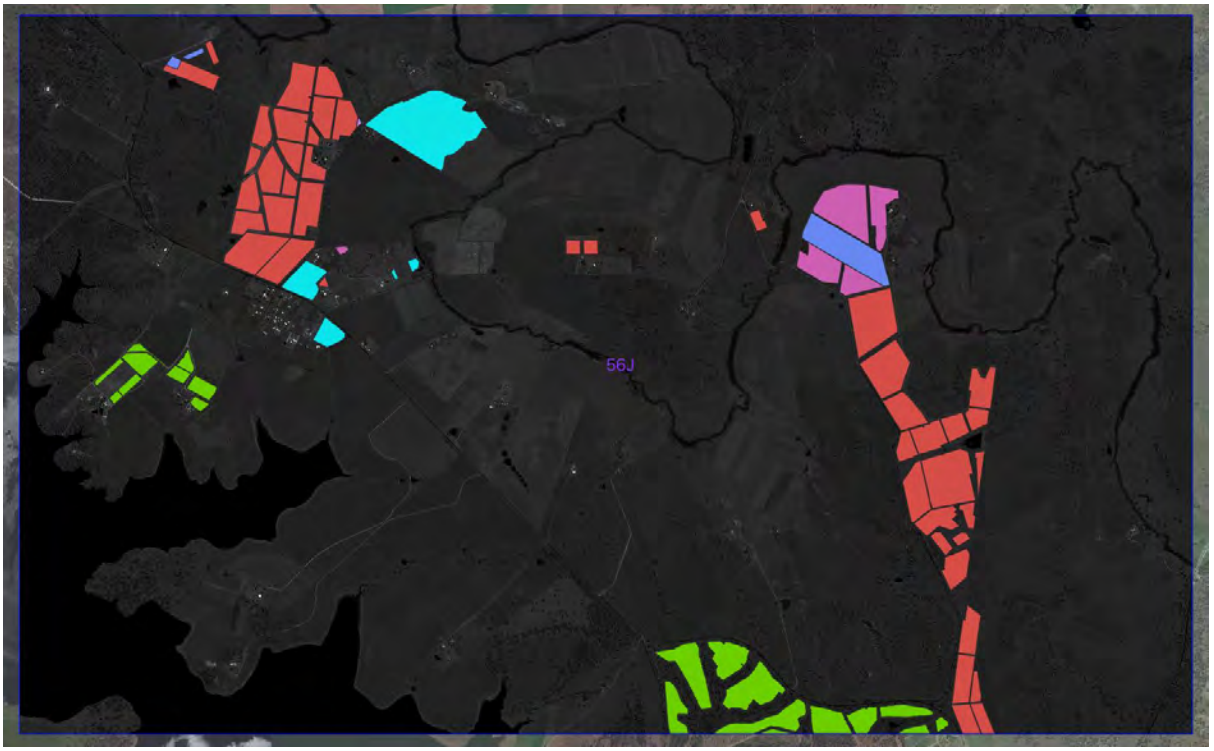


Figure AC 2. South Burnett labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2012-04-02T00:18:57.429Z
Total area (ha)	926.84
Truth area (ha)	67.15
Prediction area (ha)	73.45
Misses area (ha)	1.68
Mistakes area (ha)	7.98
Union area (ha)	75.13
Intersection area (ha)	65.47
Recall	97.50
Precision	89.14
Category accuracy	99.03
Area accuracy	91.42
Jaccard	87.15
False positive rate (/m2)	0.0086

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9.2 Granite Belt

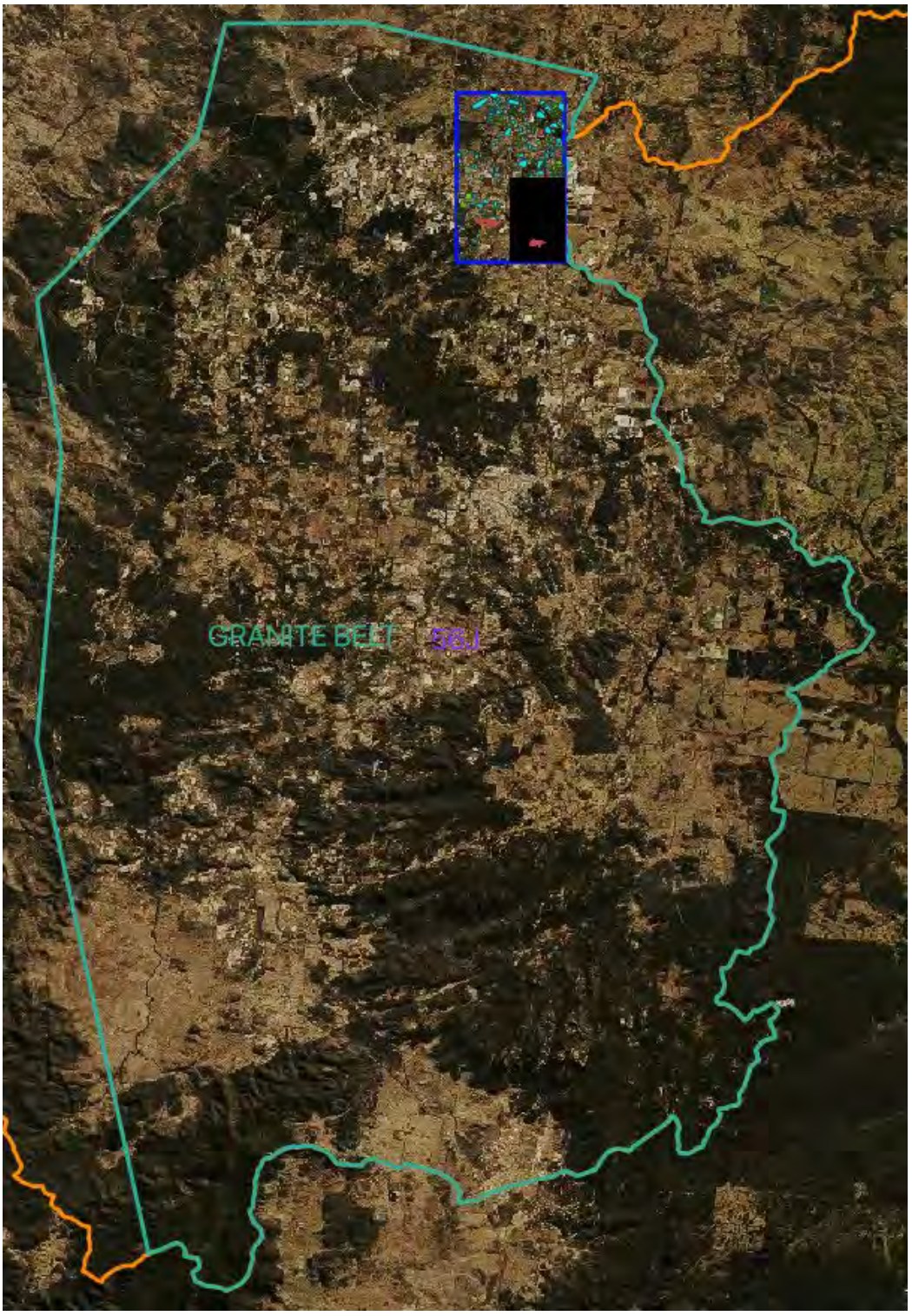


Figure AD 1. The Granite Belt NSQAR in the context of the Granite Belt GI. The entire area within the blue rectangle has been labelled (labels shown as multi-coloured shapes), but only the bottom right greyscale rectangle is used for Quality Assurance.

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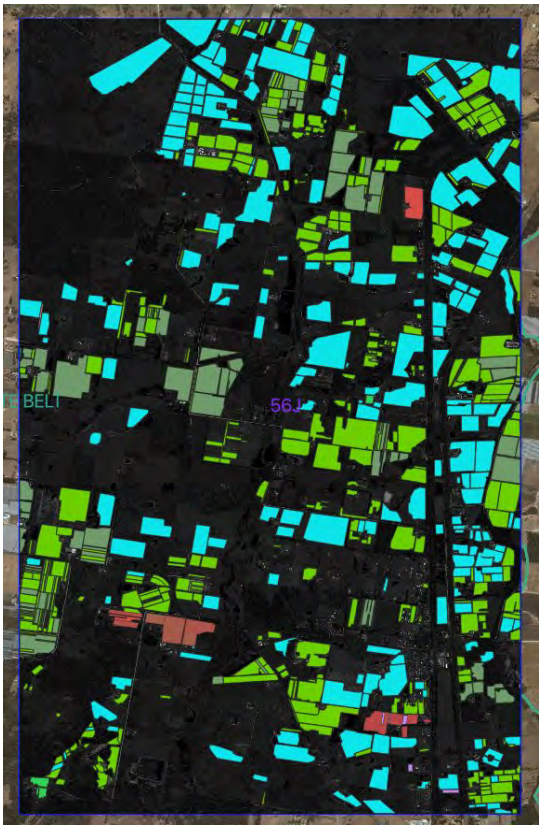


Figure AD.2. Granite Belt labels overlaid on the Panchromatic satellite imagery.

Date of imagery used for ground truth	2016-11-17T00:05:17.787Z
Total area (ha)	741.72
Truth area (ha)	4.62
Prediction area (ha)	4.61
Misses area (ha)	0.44
Mistakes area (ha)	0.43
Union area (ha)	5.05
Intersection area (ha)	4.18
Recall	90.48
Precision	90.75
Category accuracy	99.88
Area accuracy	99.70
Jaccard	82.85
False positive rate (/m2)	0.00057

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Appendix 1 - Document Revision History

Version 1.0 - 22 January 2020

- **Initial document version.**