Year 1 Koala Health Assessments and Movement Data Summaries

Koala Monitoring Program, Yarrabilba PDA

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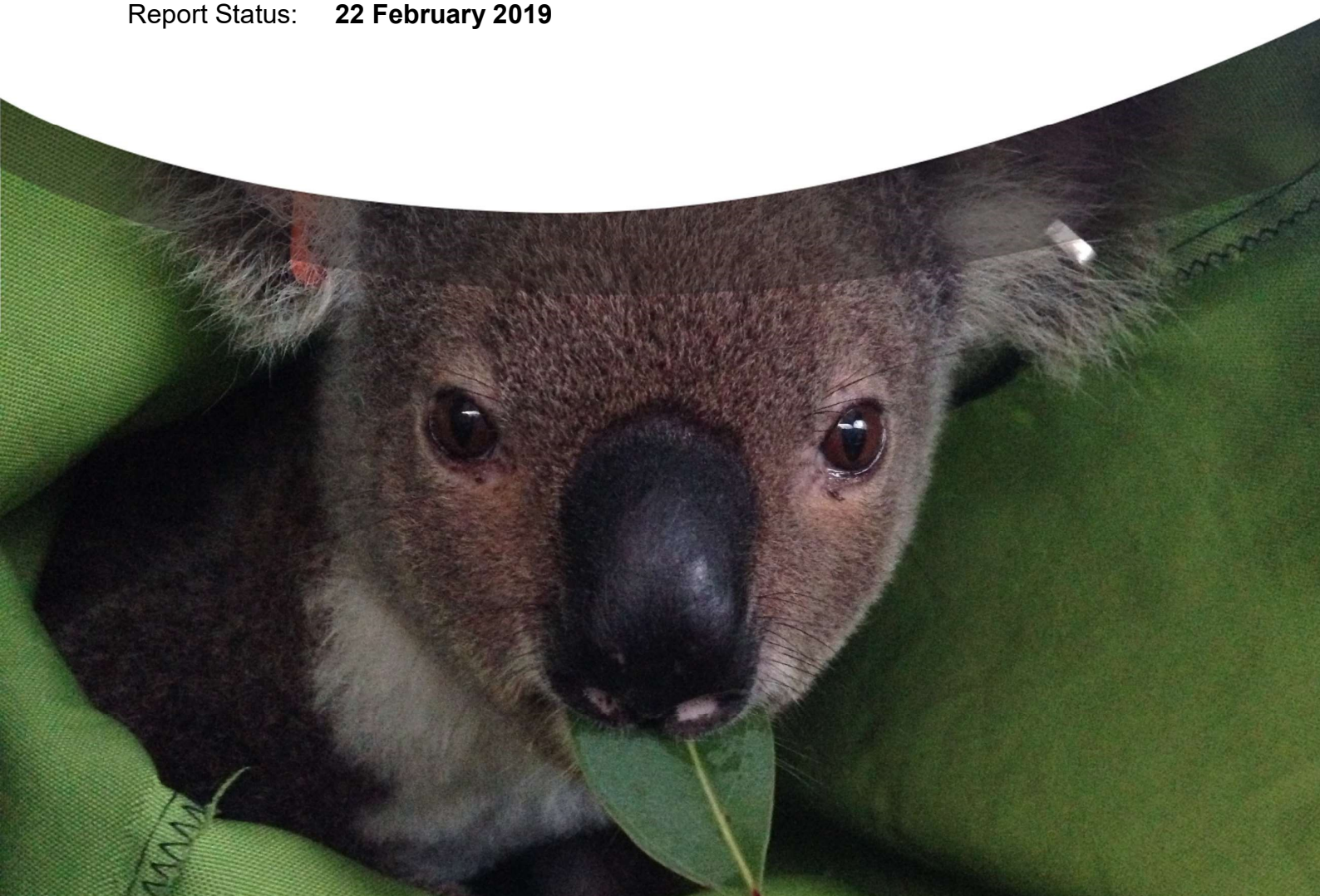
Report Status: **22 February 2019**



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1. Introduction

A *Koala Monitoring Program*[1] has been developed collaboratively between Austecology, University of Queensland's Koala Ecology Group, and Professor Frank Carrick to ensure it provides a robust, scientific, research program to comply with Condition 1b of the EPBC 2013/6791 Approval. The aims of the *Koala Monitoring Program* cover detailed investigations into the ecology, health, and population characteristics of koalas on the site.

In summary, the *Koala Monitoring Program* comprises a field program extending over a 3-year period – September 2017 to October 2021, and includes the implementation of three field investigation streams, being:

- The capture of koalas for the purpose of health assessments and to tag and / or attach monitoring collars in order to assess home range, dispersal into and out of the site, and habitat use. This work includes laboratory analyses of swabs taken from captured koalas in order assess koala health, genetic diversity of koalas on the site.
- A monthly program of fieldwork to radio track koalas in order to visually assess koala condition and collect information on tree species usage.
- Bi-annual systematic surveys across the site to investigate koala abundance and distribution.

This report presents summaries prepared by Dr Sean FitzGibbon of the health assessment and radio-tracking data collected during Year 1 2018 of the *Koala Monitoring Program*, though also including data collected during preliminary site investigations in 2017.

Details of survey and sampling methodologies are provided in the reporting stream, including the Koala Capture / Monitoring Event reports for October 2017, and March, June, August, and October 2018. All reporting for the Koala Monitoring Program is provided on the Lendlease website.

[1] Austecology (2017). Koala Monitoring Program Yarrabilba UDA. Report prepared by Lindsay Agnew (Austecology) and Bill Ellis (University of Queensland's Koala Ecology Group).

2. Koala Health Assessments

Table 2-1 provides the details on the health of all koalas that have been examined during the Yarrabilba *Koala Monitoring Program* to date. The details relate to their health at the date of first capture (listed). Several koalas have been re-captured since their first examination.

The key points in regard to demography and health are as follows:

- Approximately even sex ratio in independent koalas, i.e. 4 males and 6 females.
- Good demographic spread, including young adults (e.g. Heath and Scarlet), with most mid-aged koalas (3 – 6 years old) and few older individuals, i.e.Bomber and Sue-Bob).
- Half (50%) of independent females had young at first capture; Scarlet went on to produce a young, raising reproductive rate to 4 of 6 female koalas (67%).
- Two females, Jean and Sue-Bob, are known to have produced two young (one in 2017, and one in 2018).
- Mosts koalas were in fair-to-good body condition (body scores ≥6), with only Sue-Bob in poor condition (3/10).
- Most koalas (9 of 10) did not show overt signs of disease. Eight of these returned negative results for chlamydial swab tests.
- One koala,Kobe, showed no signs of disease but returned a strong positive result for urogential tract swab test. She was taken into care for treatment. Ultrasound examination revealed she had reproductive tract cysts (i.e. was infertile). She died while in captivty. Her case highlights that koalas can look healthy but be diseased internally.
- One koala, Cain, presented overt signs of disease (very inflammed right eye) and returned a positive result on the swab test of this eye. He was taken into care and successfully treated with antibiotics, then returned to site (December 2017). At recent check (January 2019) both eyes were clear / free of infection.
- Tissue samples / DNA biopsies were collected from 11 koalas.

Table 2-1 Koala Capture and Health Data Summary

Date first capture	UQ #	Koala name	Gender	Mass (kg)	Age (years)	Carrying young	Body score	Signs of disease	Left eye swab	Right eye swab	UGT / penial swab	DNA biopsy
17/05/2017	13007	Heath	M	3.7	2 +		8.5	Nil				Yes
18/05/2017	13008	Bomber	M	9.1	6 +		7	Nil	Negative		Negative	Yes
18/05/2017	13009	Caitlin	F	5.7	4	No	7.5	Nil				Yes
9/10/2017	13486	Jean	F	5.6	3 - 6	Yes	6	Nil	Negative	Negative	Negative	Yes
9/10/2017	13487	Emily[2]	F	1.1	1		8	Nil	Negative	Negative		No
9/10/2017	13488	Cain	M	8.1	2 - 4		7	Major inflammation right eye	Negative	Chlamydia positive		Yes
10/10/2017	13489	Scarlet	F	4.8	1-3	No	6.5	Nil	Negative	Negative	Negative	Yes
10/10/2017	13490	Sue-Bob	F	5.7	5 - 10	Yes	3	Nil	Negative	Negative	Negative	Yes
20/03/2018	13495	Kobe	F	5.1	3 - 6	No	7.5	Nil	Negative	Negative	Chlamydia positive	Yes
6/06/2018	13304	Zara	F	6.2	4 - 8	Yes	7	Nil	Negative	Negative	Negative	Yes
8/10/2018	13496	Squeak[3]	F	0.8	< 1		9.5	Nil				Yes
10/10/2018	13497	Lindsay	M	5.8	2 - 4		8	Nil	Pending	Pending	Pending	Yes

UGT = urogenital tract, i.e. area where swab was collected from females.

[2] Progeny of Jean.
[3] Progeny of Zara.

3. Koala Movement

Table 3-1 provides details on the movement of all koalas that have been fitted with a GPS collar at the study site to date (February 2019). Note, the duration of collaring varies between individuals, depending on whether they "dropped" their collar at any point and if they were able to be re-captured and collared again.

Collars were programmed to record location twice daily (at approximately 1000hrs and 2000hrs AEST). As with all GPS devices, logged locations can be inaccurate for reasons such as poor GPS satellite reception (e.g. due to heavy cloud or thick canopy) or unfavourable satellite geometries (e.g. satellites low on the horizon).

Because of this, not all of the locations (i.e. fixes) that were logged on the collars were used in subsequent analyses, due to unacceptably high location error for some fixes (determined from HDOP value assigned to each fix). Only those fixes with an estimated accuracy of approximately 20m or less were retained for mapping and analytical purposes. These retained data points were used to plot movements and to estimate home ranges for the monitored koalas.

To examine fix accuracy and the relationship to HDOP values, two stationary tests were conducted, i.e. two collar tags were strapped to the trunk of a small but solid tree (4m above ground), in a representative forested area at the site. Tags were left in place for several weeks.

Home ranges were estimated using two common techniques:
1. minimum convex polygon (MCP) home range estimator; and
2. kernal utilisation distribution (KUD) home range estimator.

Otherwise known as a convex hull, the MCP home range estimate uses the smallest convex area that contains all the specified location data. This was one of the earliest methods developed for examining home ranges and is sometimes criticised for the extent of non-habitat that can be included in ranges, especially in heavily fragmented landscapes. It is common to use the 95% MCP, which excludes the most outlying 5% of locations, on the basis that these may have been atypical/exploratory movements that do not constitute part of the home range.

The 95% KUD home range estimate defines the outer boundary of the area where the koala would be expected to be found 95% of the time. The 50% KUD estimate is generally used to determine core home range areas. The fixed kernel density estimator is a non-parametric method of home-range analysis, which uses the utilisation distribution to estimate the probability that an animal will be found at a specific geographical location. This fixed method of kernel smoothing ignores the temporal sequence whereby locations were obtained, and assumes that all locations from that individual are spatially autocorrelated.

This means that the location of an individual koala at a particular point implies an increased probability that the koala frequents neighbouring locations as well. The kernel utilisation distribution (KUD) accurately estimates areas of high use by the focal animal, providing that the level of smoothing is appropriate.

All movement plots and home range analyses were conducted in the ZoaTrack software package (https://zoatrack.org/).

Figures 3-1 to 3-27 provide movement plots for all radio-tracked koalas during the survey period October 2017 to February 2019.

Table 3-1 Koala Movement Datasets and Home Range Estimations

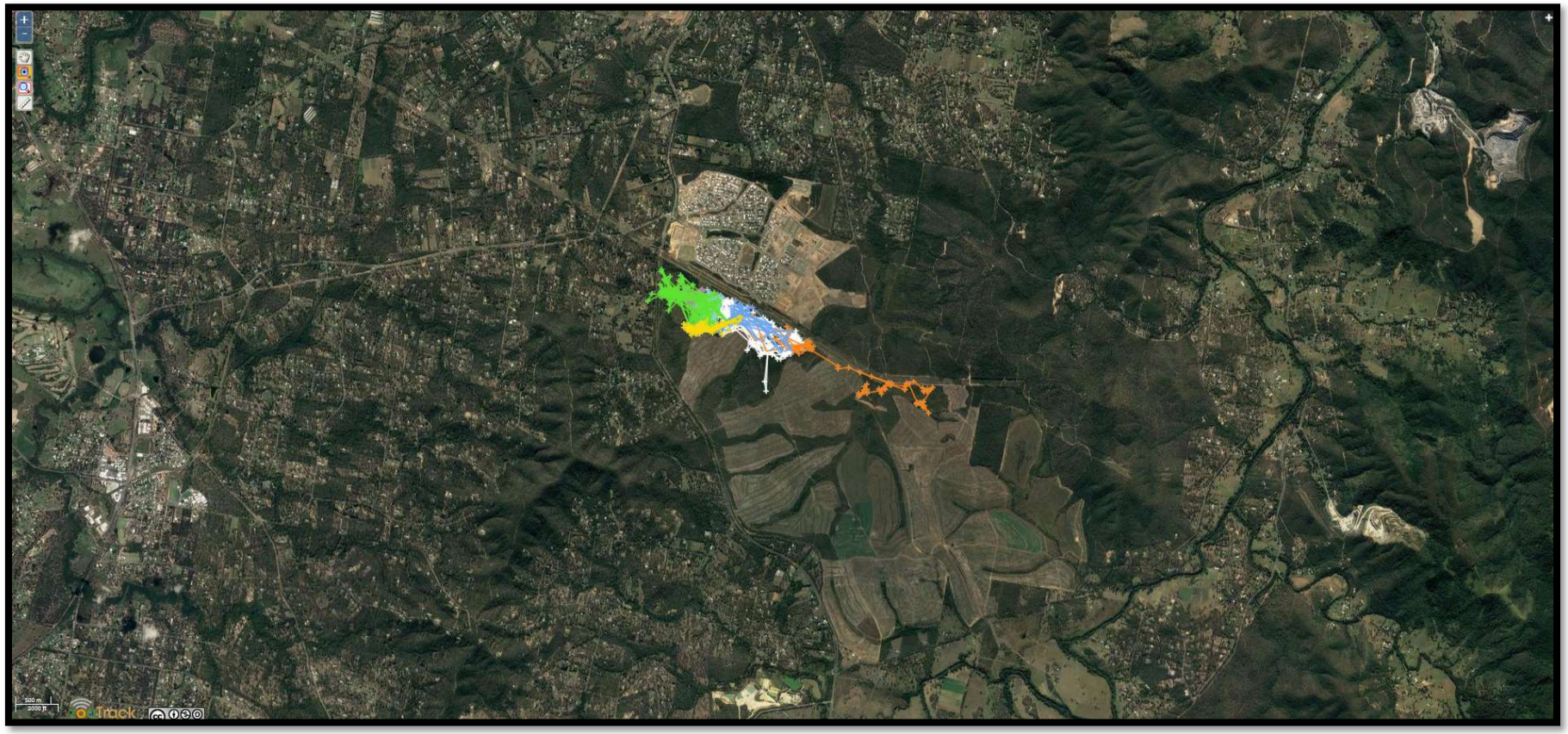
UQ #	Koala Name	Gender	No. fixes*	Maximum fixes / day	Average fixes / day	MCP 95% (ha)	KUD 50% (ha)	KUD 95% (ha)
13008	Bomber	M	105	2	0.4	33.3	12.0	64.7
13488	Cain	M	180	2	0.4	36.7	16.4	63.3
13486	Jean	F	562	2	1.2	47.5	18.0	77.2
13495	Kobe	F	149	2	1.1	94.8	63.2	302.5
13489	Scarlet	F	221	2	1.1	14.7	7.3	28.9
13490	Sue-Bob	F	524	2	1.1	8.1	2.2	11.0
13304	Zara	F	139	2	0.8	5.3	2.4	8.8
	Stationary tag (A4-069)		22	2	0.4	0.2	0.2	0.6
	Stationary tag (A4-134)		66	2	1.1	0.2	0.1	0.3

* After filtering of inaccurate locations
MCP = minimum convex polygon home range estimator
KUD = kernal utilisation distribution home range estimator

The key points in regard to demography and health are as follows:

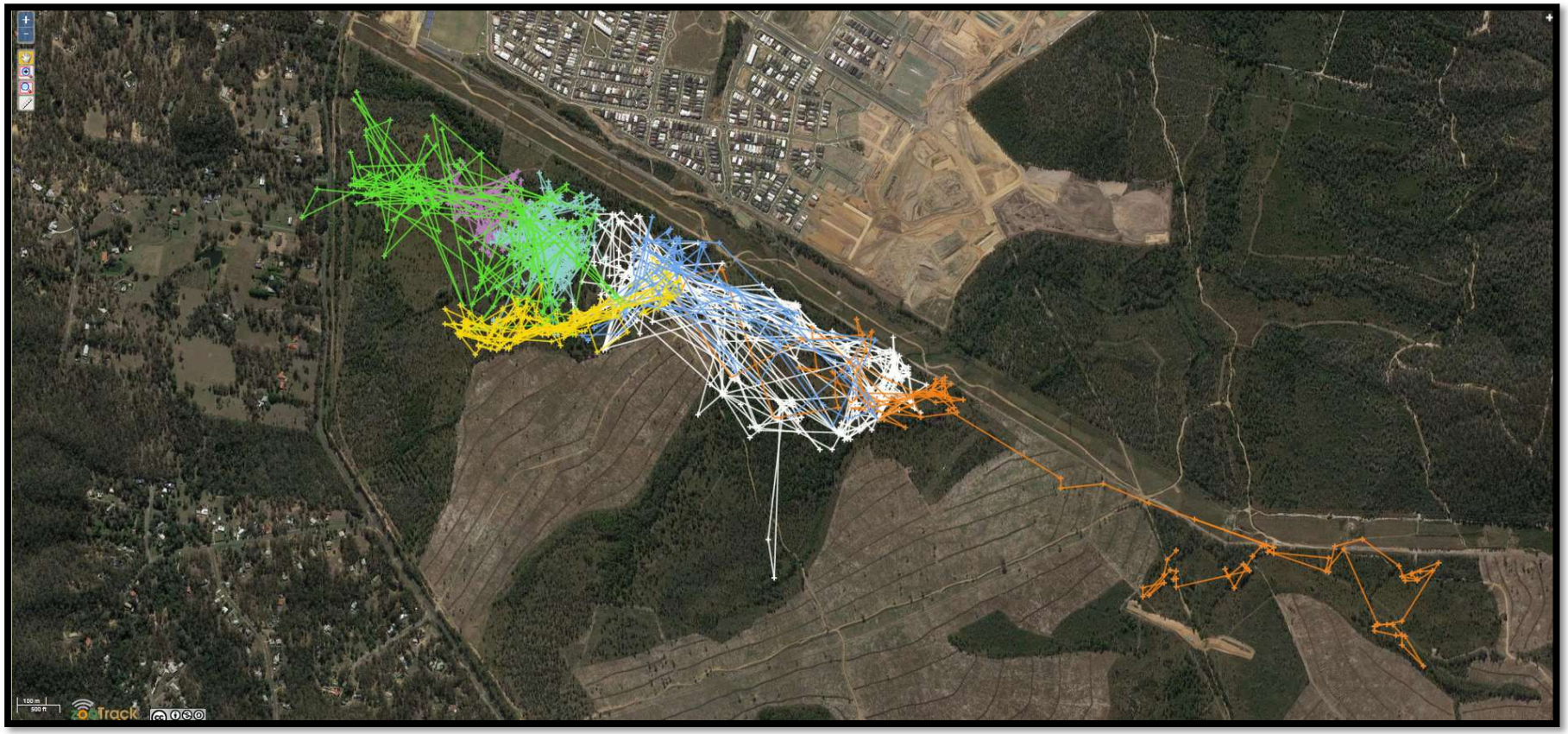
- Excellent movement datasets were obtained for all seven collared koalas, i.e. all >100 fixes; and an average of 0.4 - 1.2 fixes / day after filtering for accuracy.
- Movements plots show the collared individuals made extensive use of the site. Movements were concentrated on the creek lines and riparian vegetation, though also included frequent use of eucalypt regrowth areas (e.g. Sue-bob) and pine-dominated areas (e.g. Jean).
- 95% MCP home range estimates varied from 5.3 ha to 94.8 ha (Kobe). The 95% KUD estimates ranged from 8.8 ha to 302 ha (Kobe), though estimates for Kobe were likely inflated by her apparent home range shift during the collaring period (see **Figure 3-7**).
- Somewhat surprisingly, Jean occupied the second-largest range home range. This was likely partly attributable to the large sample size, being 562 fixes.
- The two males, Cain and Bomber, had the next largest home ranges (approximately equal). Their ranges had a high degree of overlap with collared females, but did not overlap with each other (see **Figure 3-13**).
- Despite the very large dataset for Sue-bob, this female had one of the smallest ranges. This may have been a reflection of her relatively poor health.
- The stationary tag tests highlighted that there can be apparent movement of koalas, even when they are sitting still (note: tests used only high accuracy fixes), however, these movements are relatively small if appropriate data filtering is conducted.

Figure 3-1 Plot of koala movements at landscape-scale



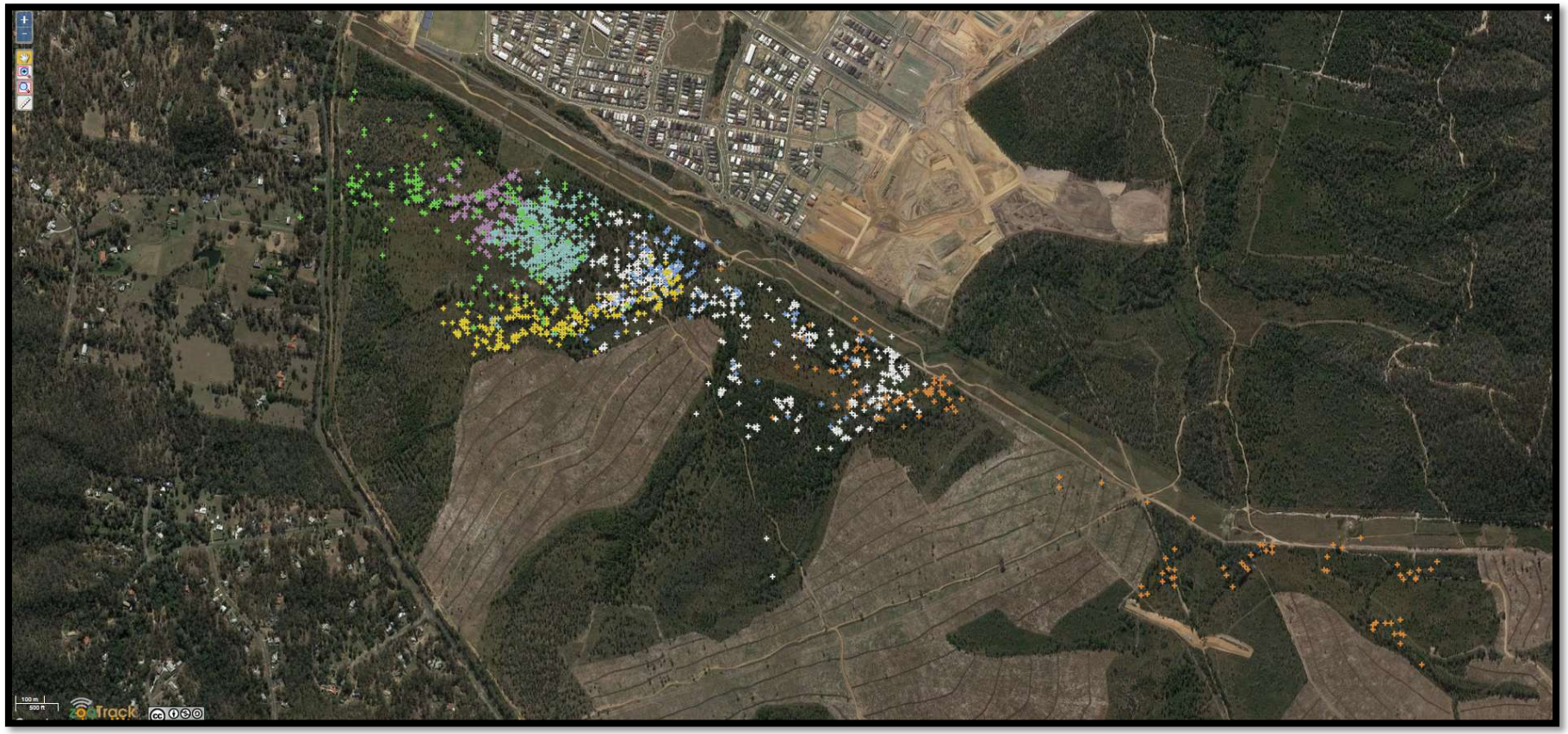
Note: Consecutive fixes are joined by lines.
Colour key: Bomber (blue), Cain (green), Jean (white), Kobe (orange), Scarlet (yellow), Sue-bob (aqua), Zara (purple).

Figure 3-2 Plot of koala movements at local-scale



Note: Consecutive fixes are joined by lines.
Colour key: Bomber (blue), Cain (green), Jean (white), Kobe (orange), Scarlet (yellow), Sue-bob (aqua), Zara (purple).

Figure 3-3 Plot of koala locations at local-scale without lines to show movement trajectories



Colour key: Bomber (blue), Cain (green), Jean (white), Kobe (orange), Scarlet (yellow), Sue-bob (aqua), Zara (purple).

Figure 3-4 Plot of movements for Bomber

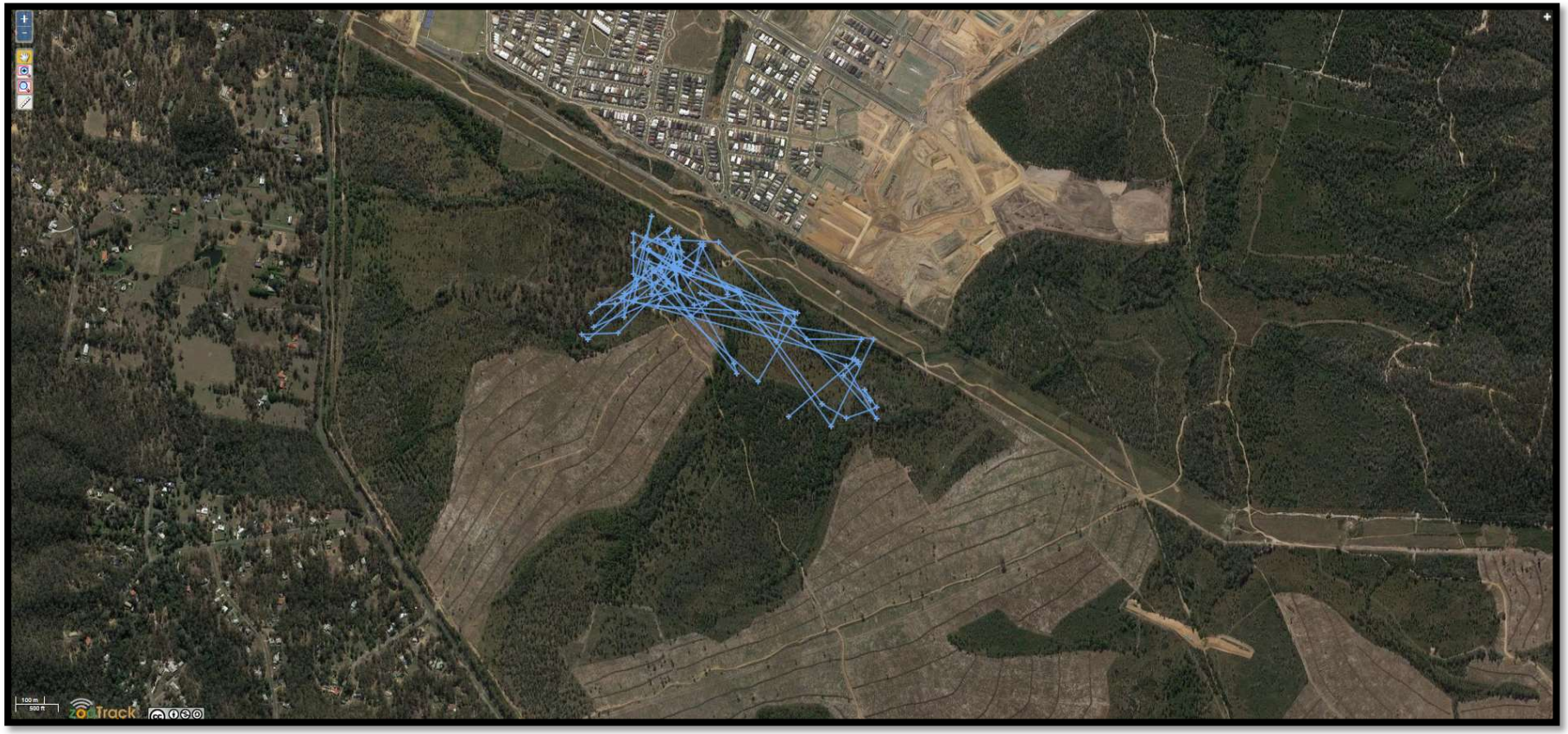


Figure 3-5 Plot of movements for Cain

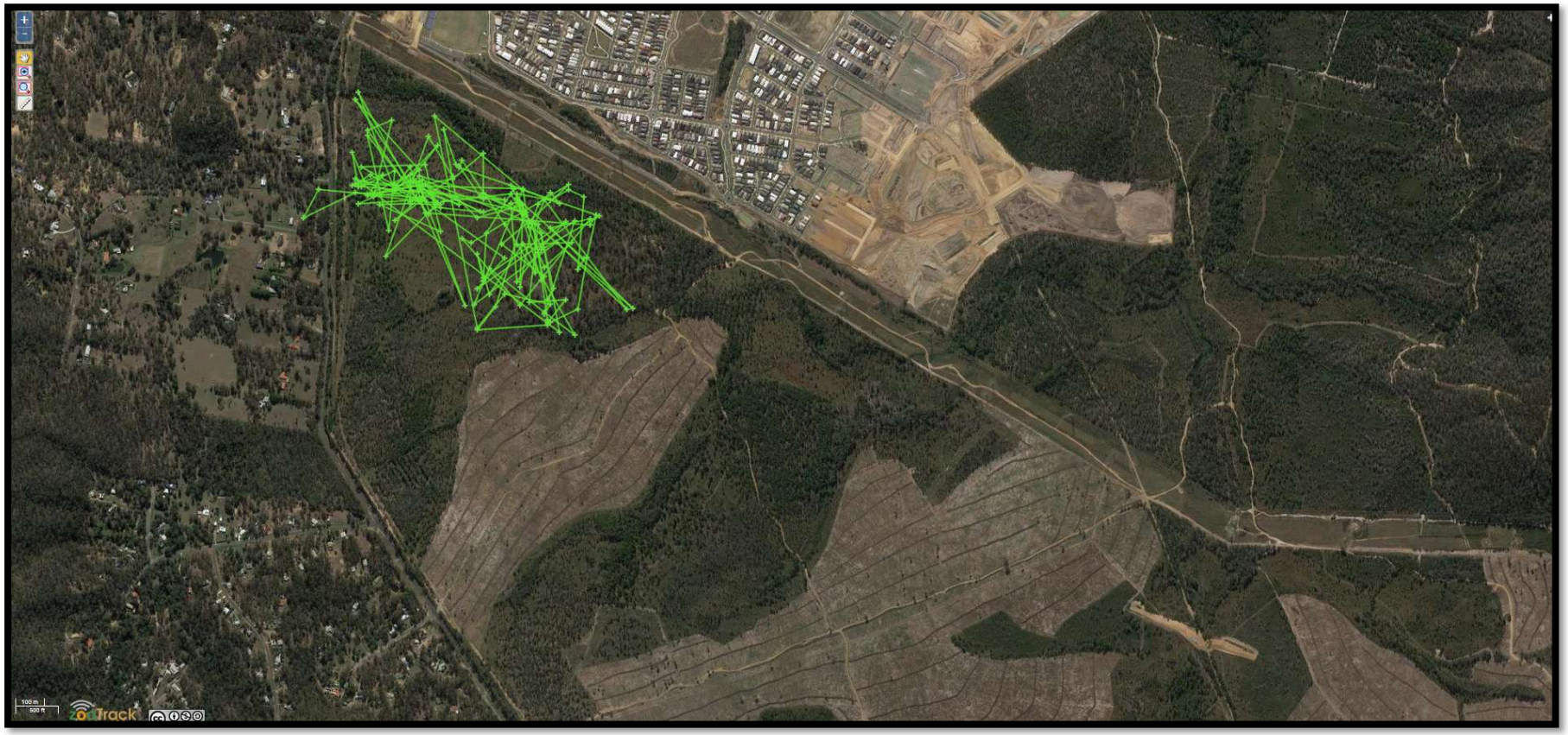


Figure 3-6 Plot of movements for Jean

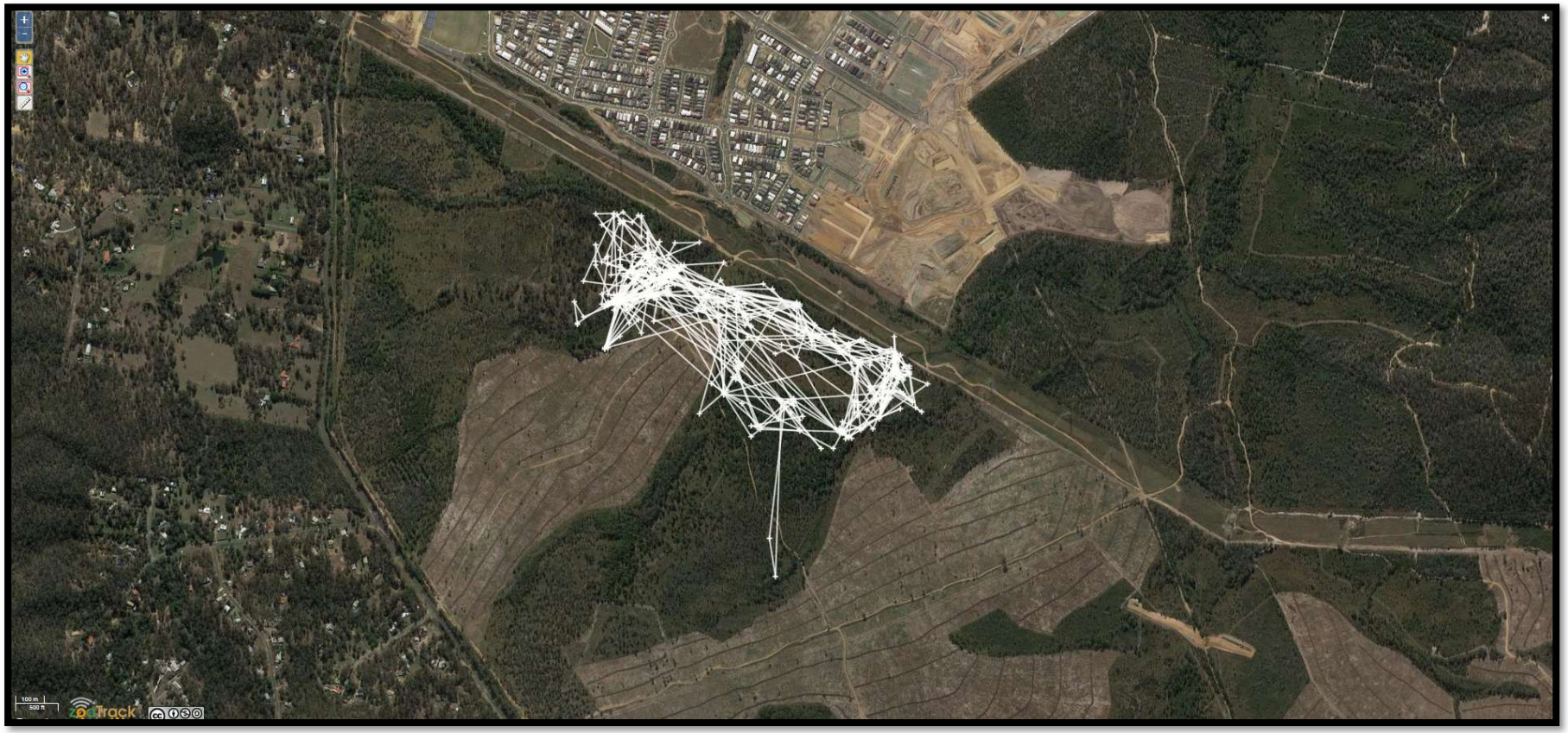


Figure 3-7 Plot of movements for Kobe

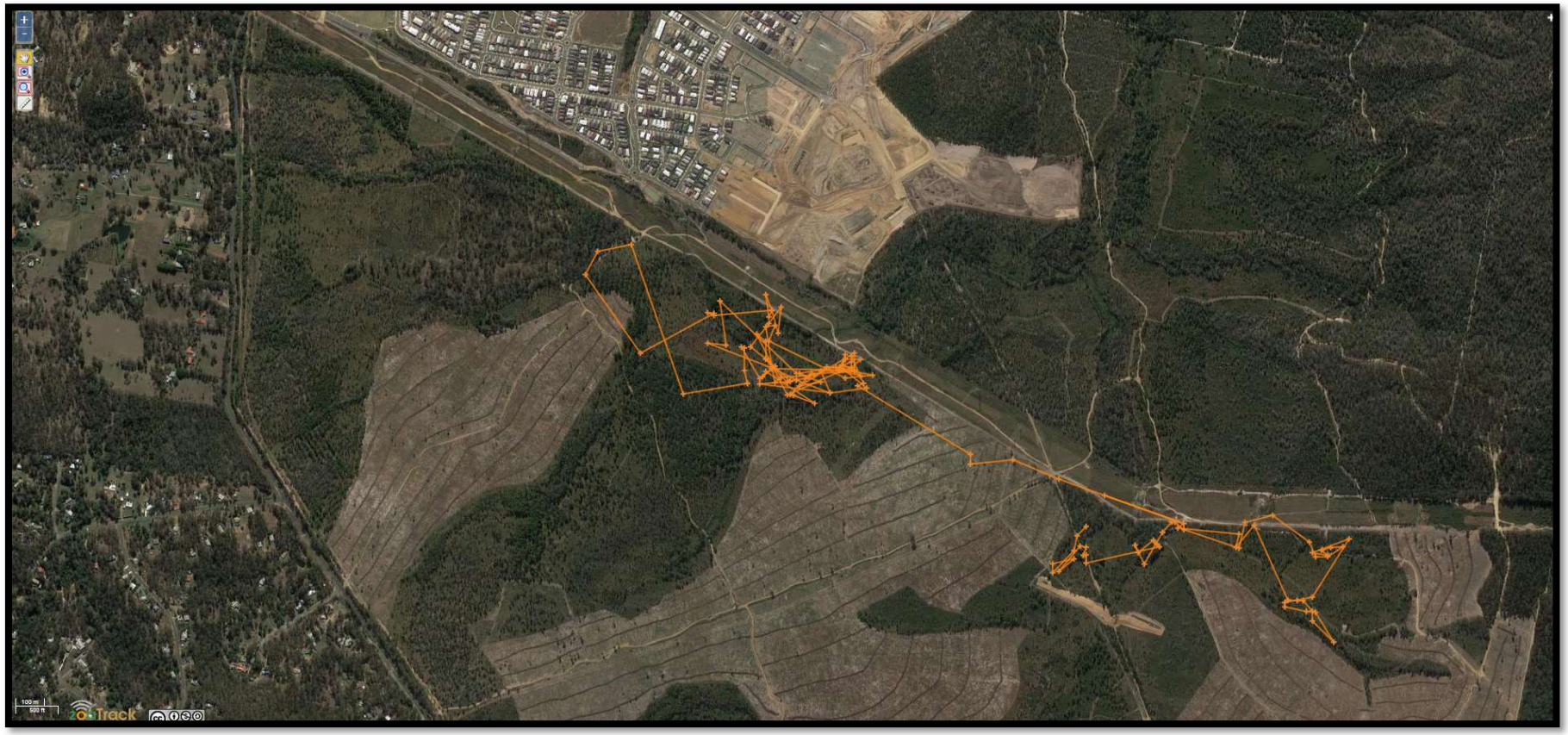


Figure 3-8 Plot of movements for Scarlet

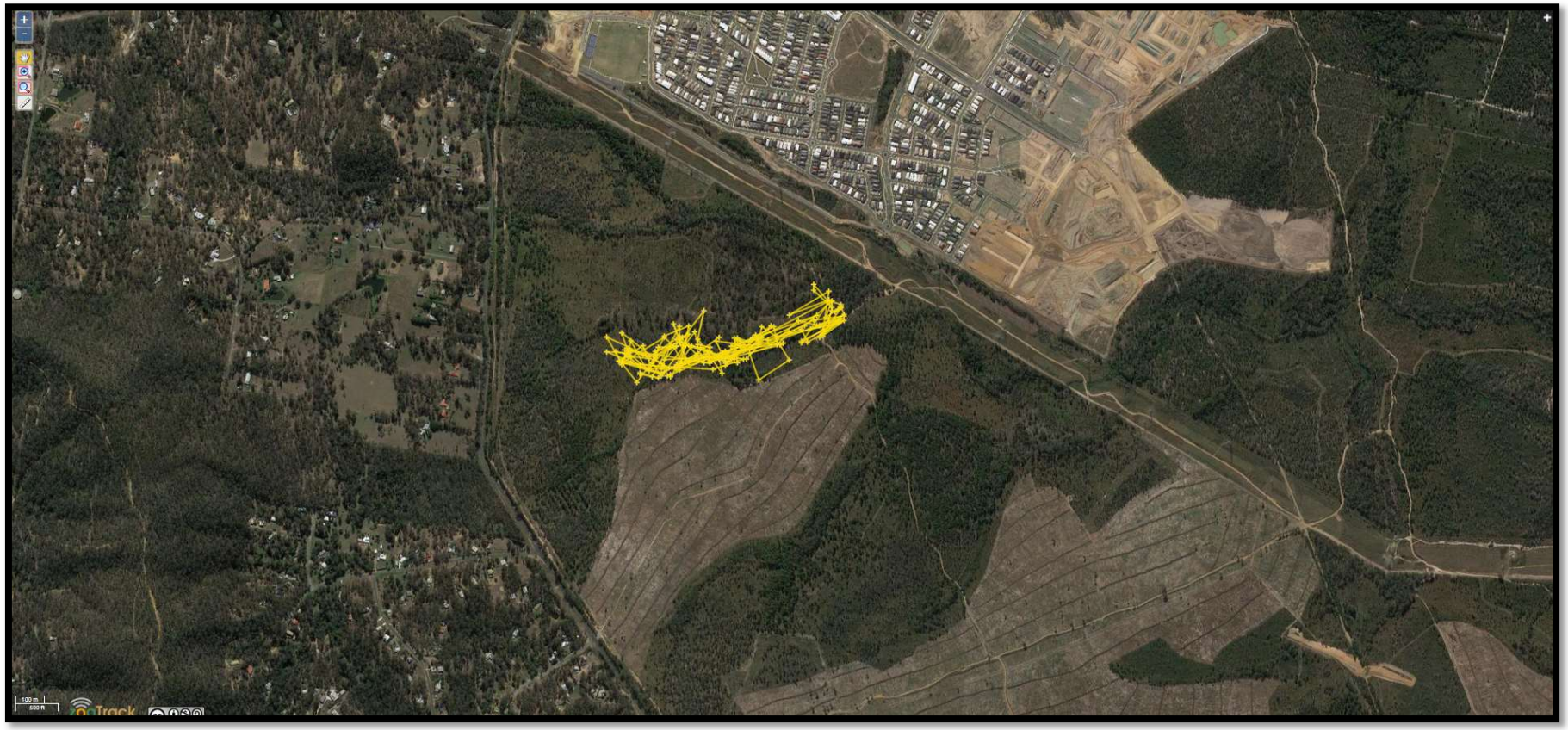


Figure 3-9 Plot of movements for Sue-bob

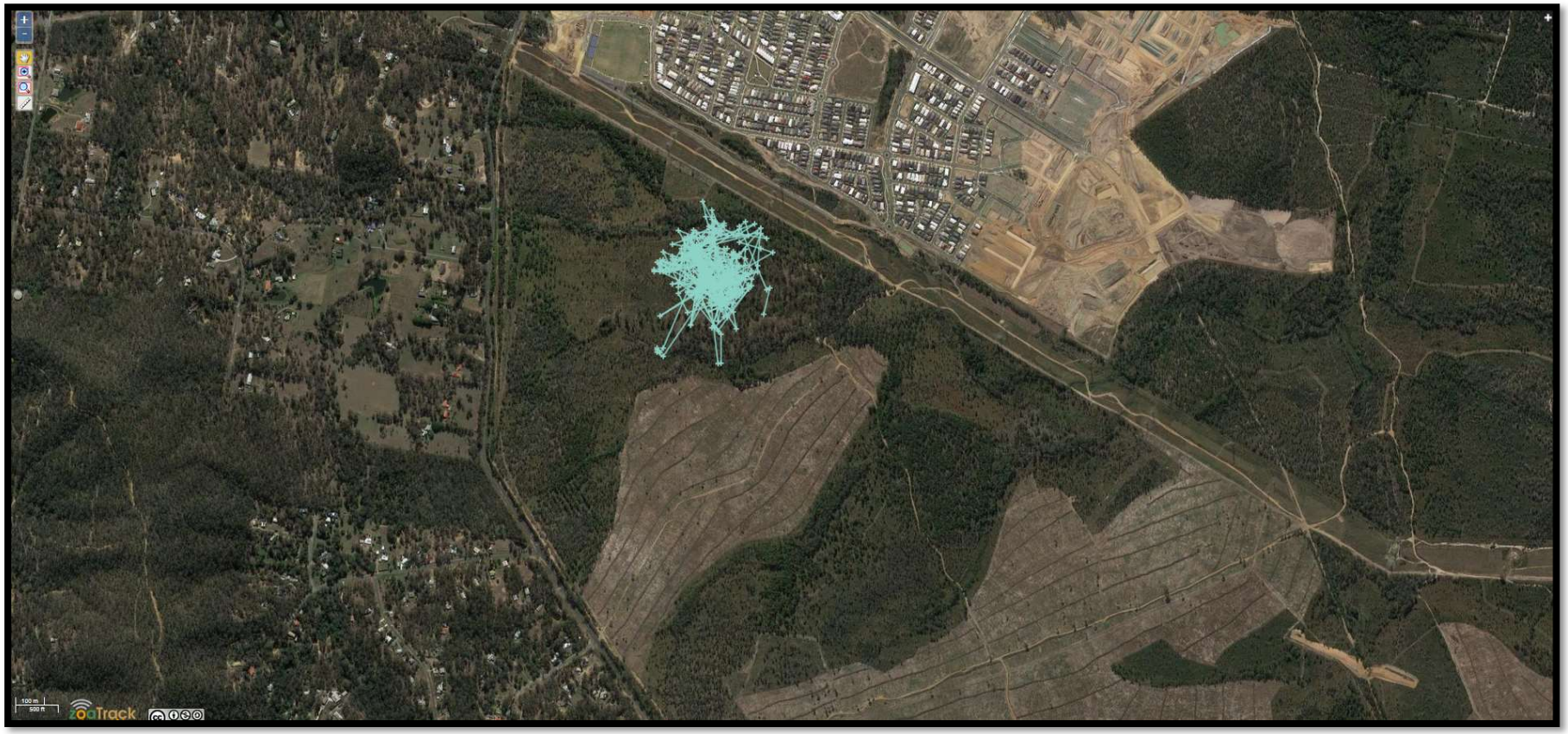


Figure 3-10 Plot of movements for Zara

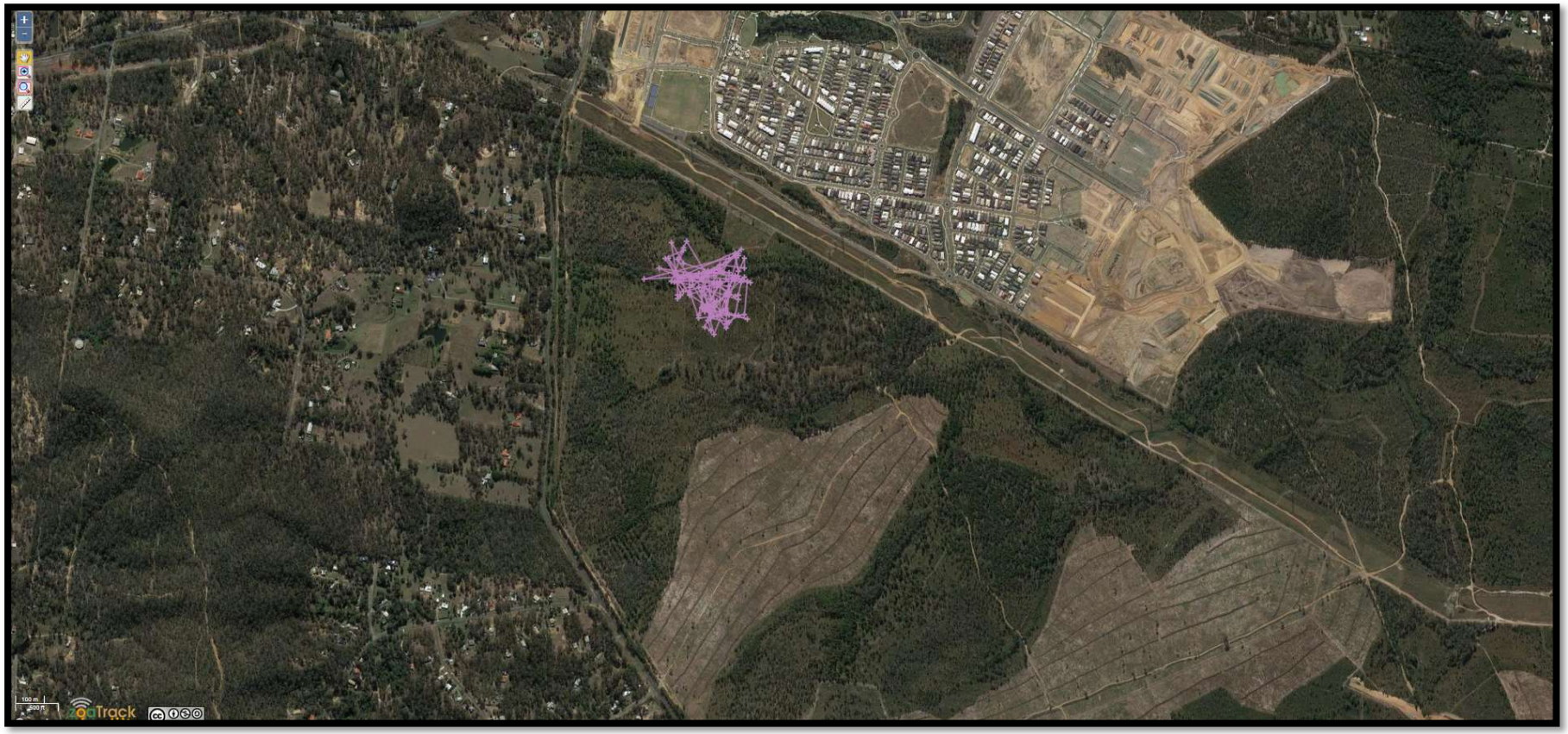
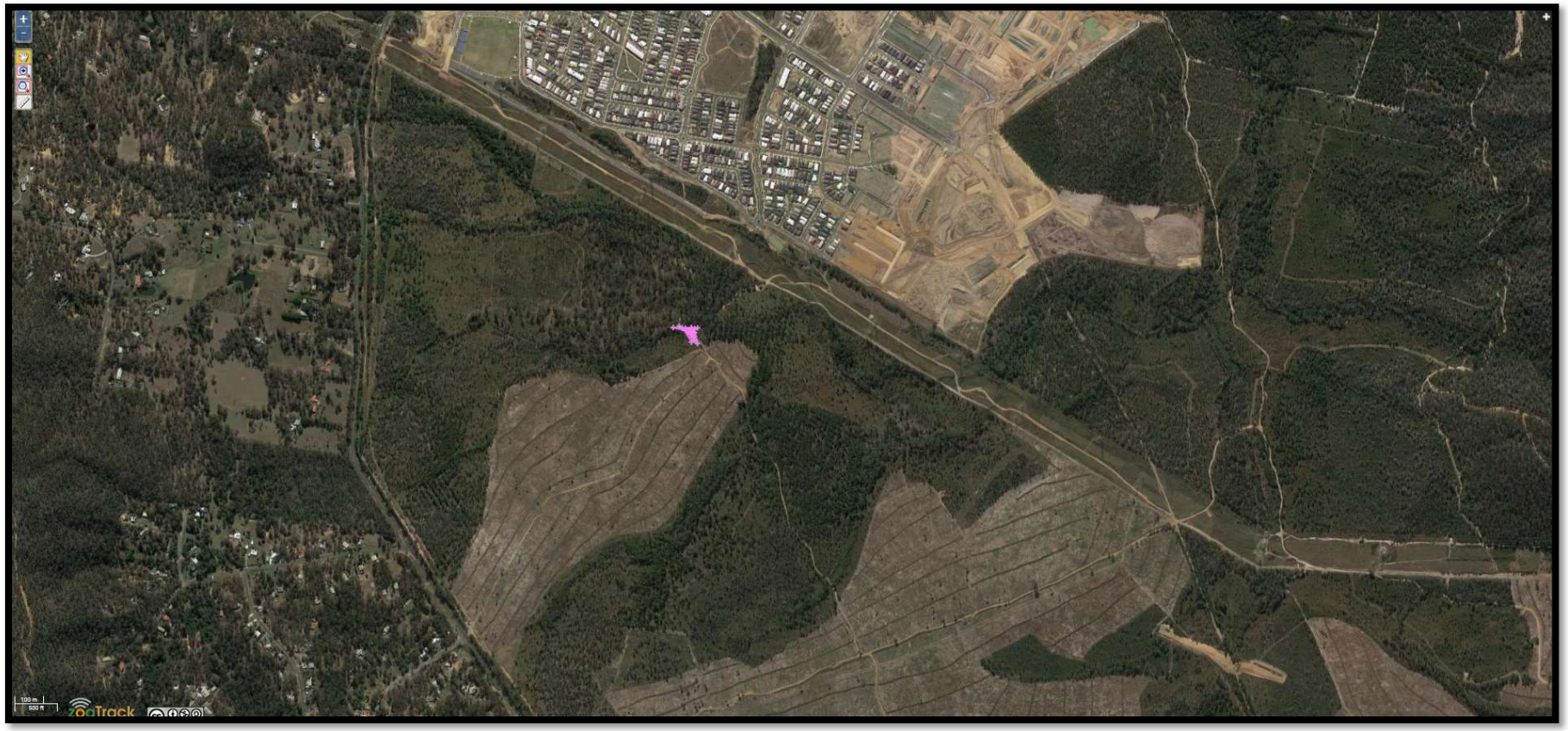
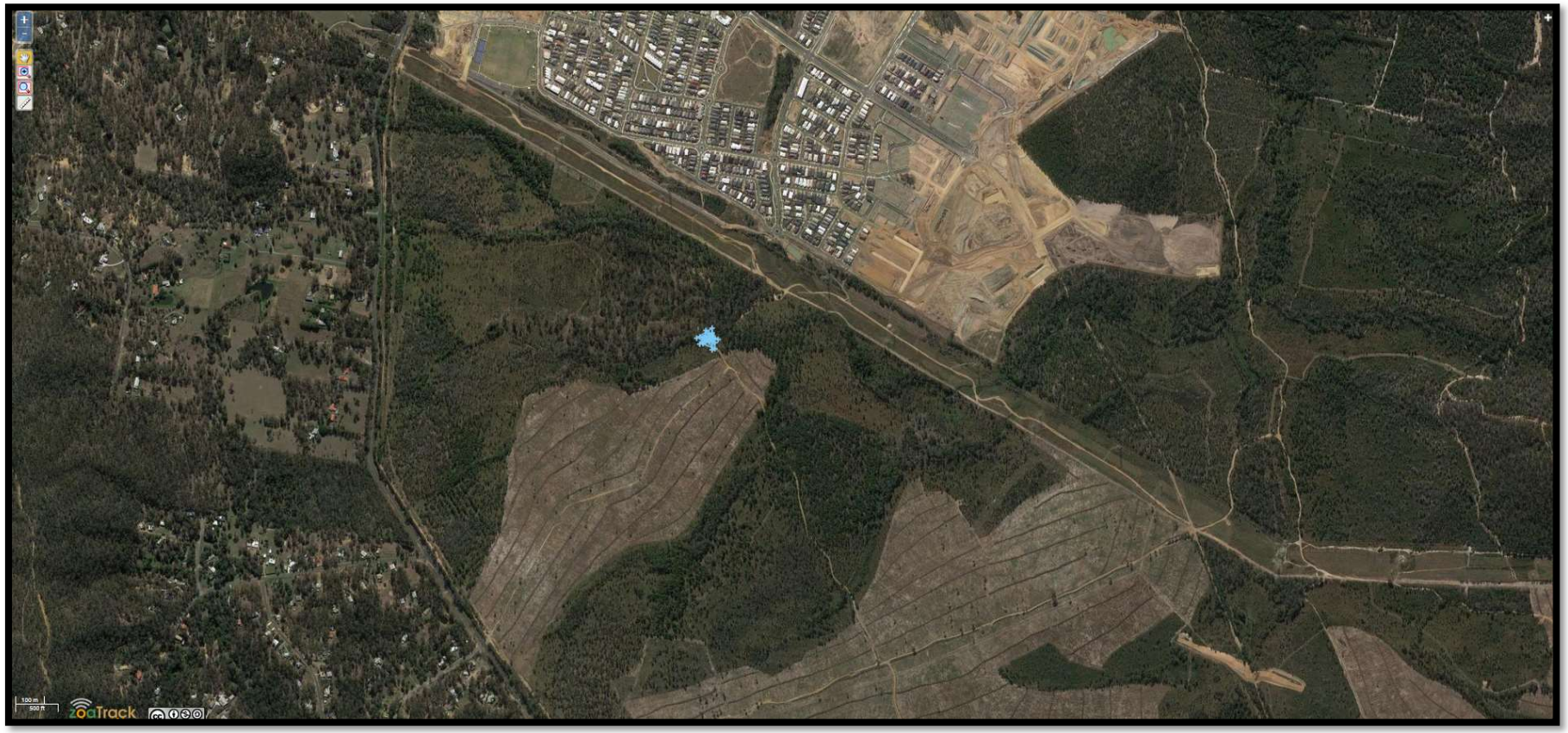


Figure 3-11 Plot of apparent movements for stationery tag A4-069



Note: Represents high accuracy fixes only.

Figure 3-12 Plot of apparent movements for stationery tag A4-134



Note: Represents high accuracy fixes only.

Figure 3-13 Plot of 95% MCP home range estimates

Colour key: Bomber (blue), Cain (green), Jean (white), Kobe (orange), Scarlet (yellow), Sue-bob (aqua), Zara (purple).

Figure 3-14 Plot of 95% MCP home range estimate for Bomber

Figure 3-15 Plot of 95% MCP home range estimate for Cain

Figure 3-16 Plot of 95% MCP home range estimate for Jean

Figure 3-17 Plot of 95% MCP home range estimate for Kobe

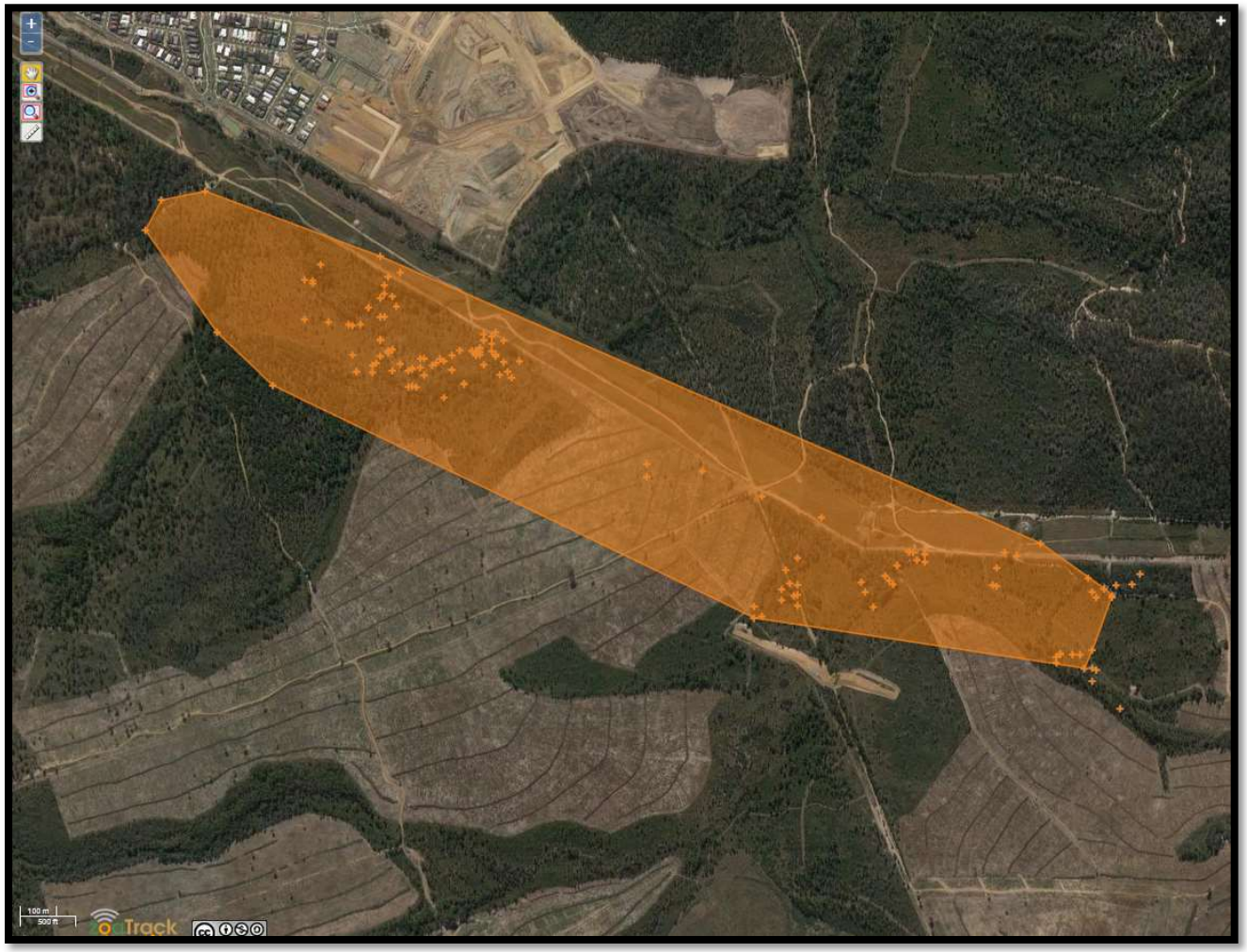


Figure 3-18 Plot of 95% MCP home range estimate for Scarlet

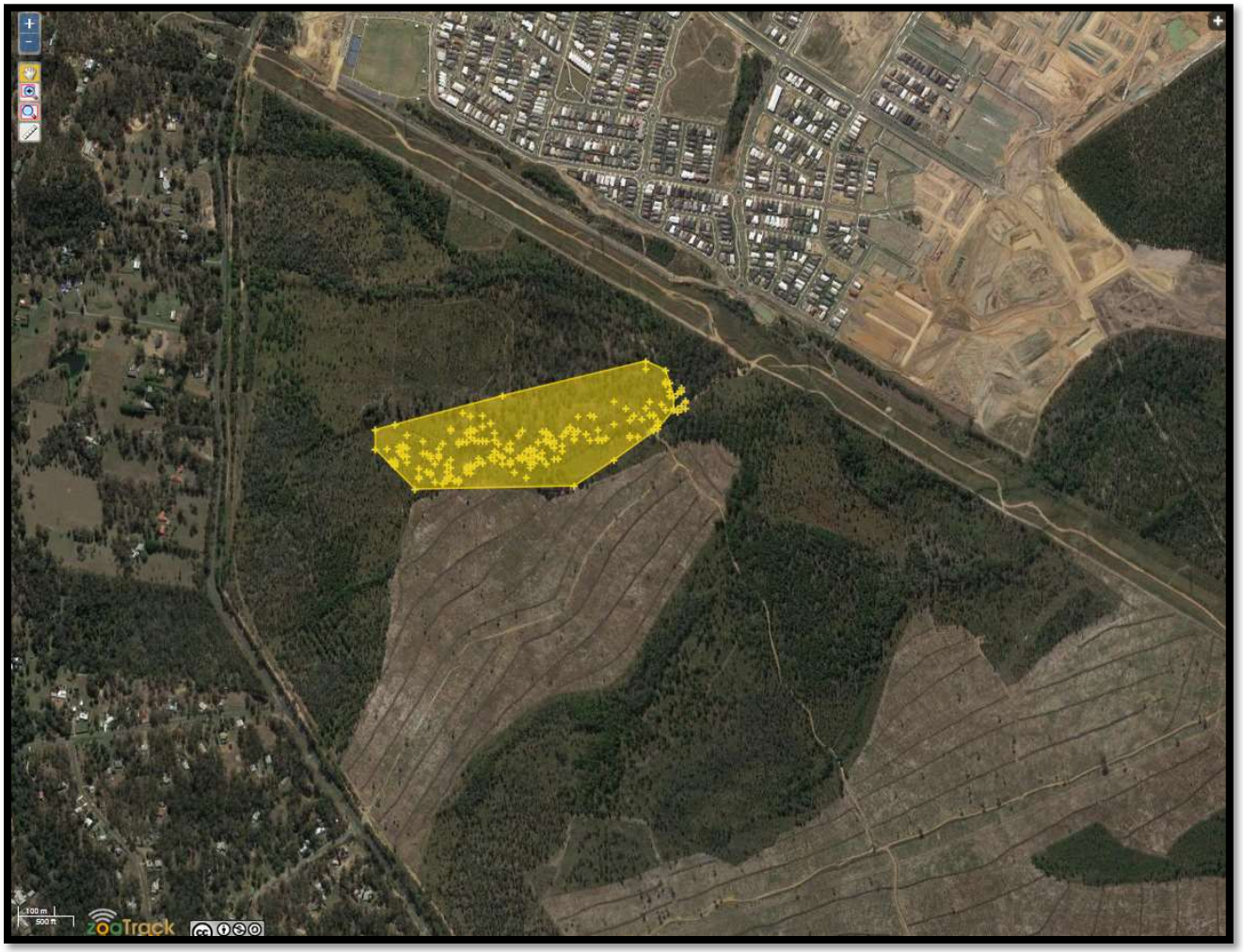
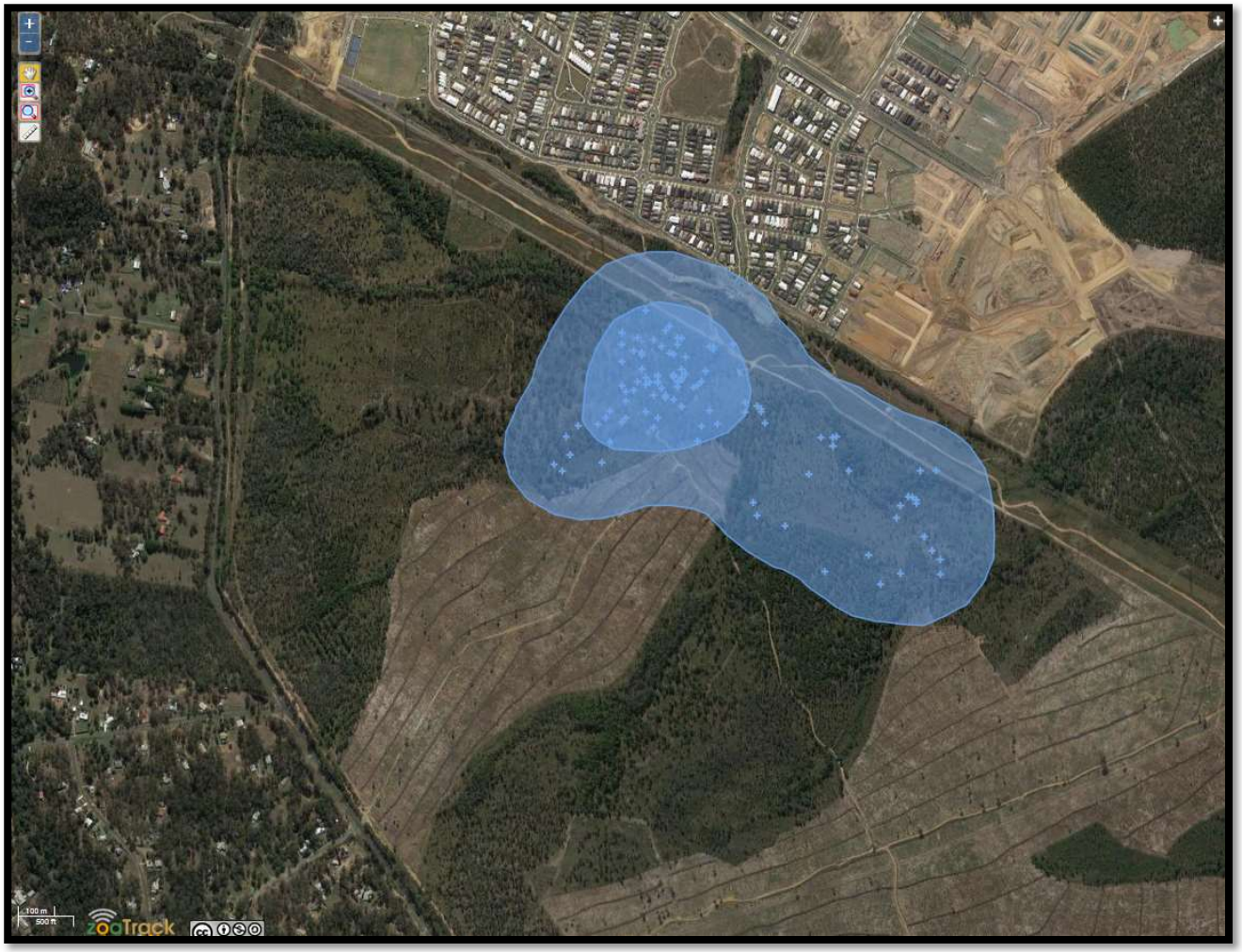


Figure 3-19 Plot of 95% MCP home range estimate for Sue-bob

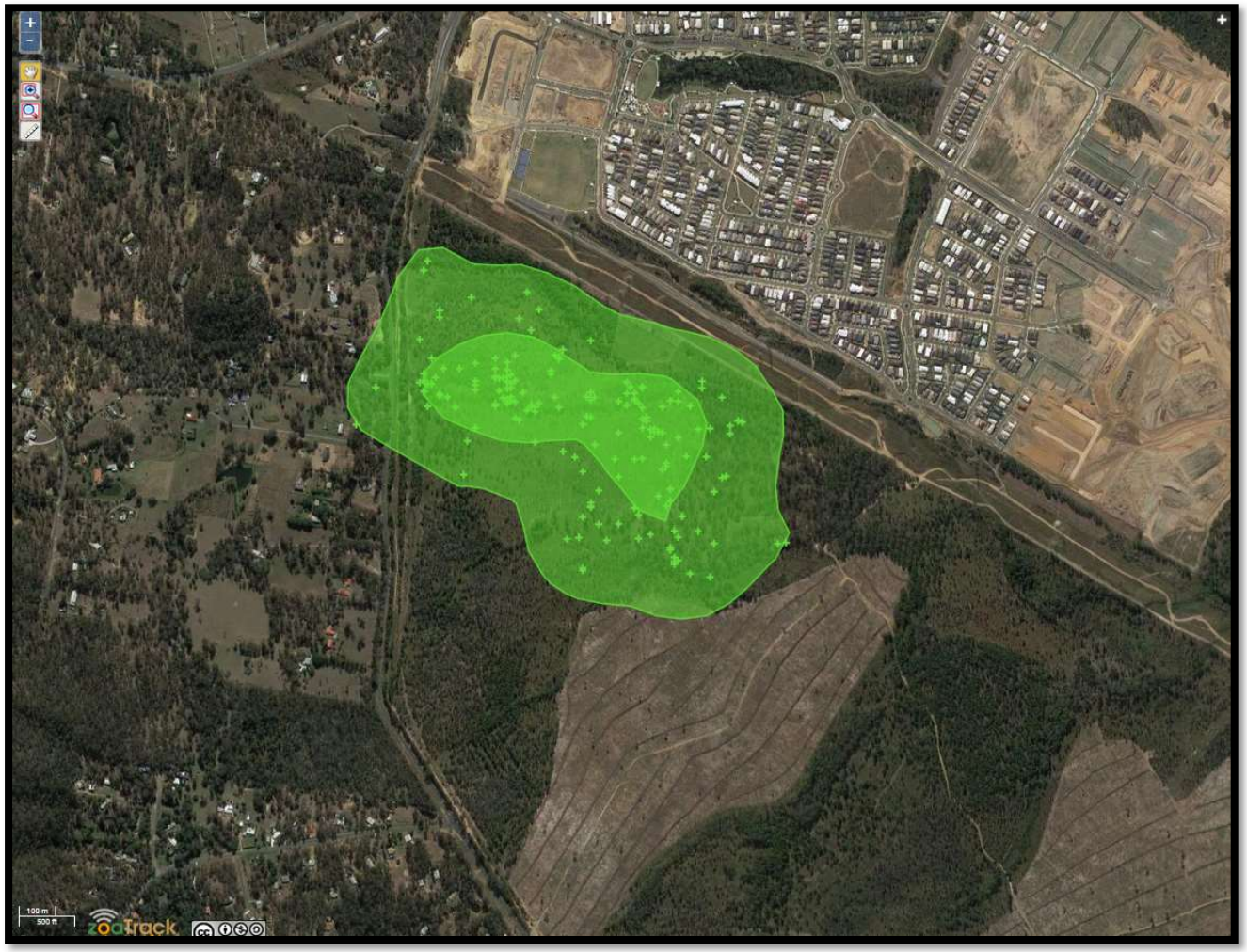
Figure 3-20 Plot of 95% MCP home range estimate for Zara

Figure 3-21 Plot of 50% and 95% KUD home range estimates for Bomber



Note: The 50% KUD is the smaller polygon within the larger 95% KUD polygon.

Figure 3-22 Plot of 50% and 95% KUD home range estimates for Cain

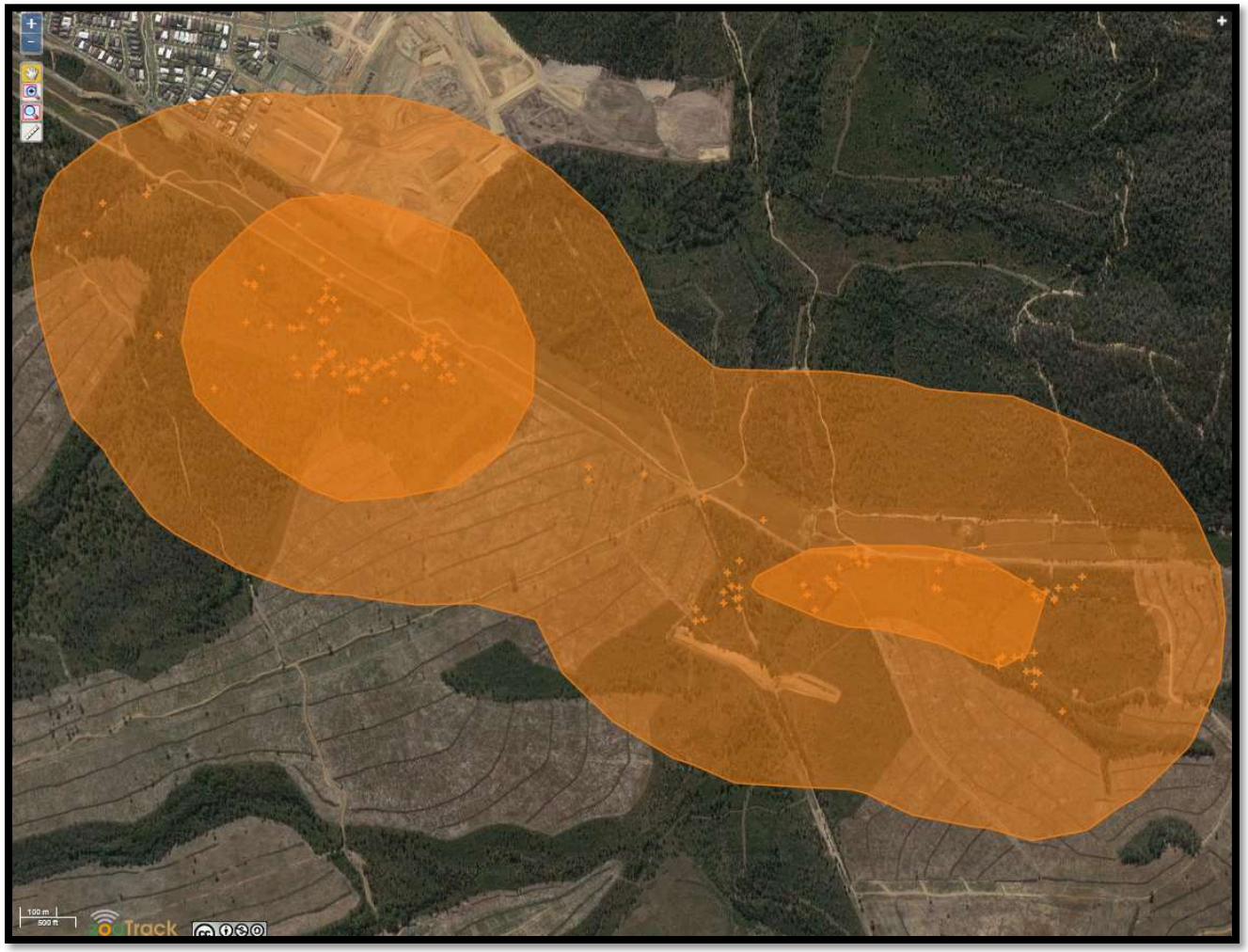


Note: The 50% KUD is the smaller polygon within the larger 95% KUD polygon.

Figure 3-23 Plot of 50% and 95% KUD home range estimates for Jean

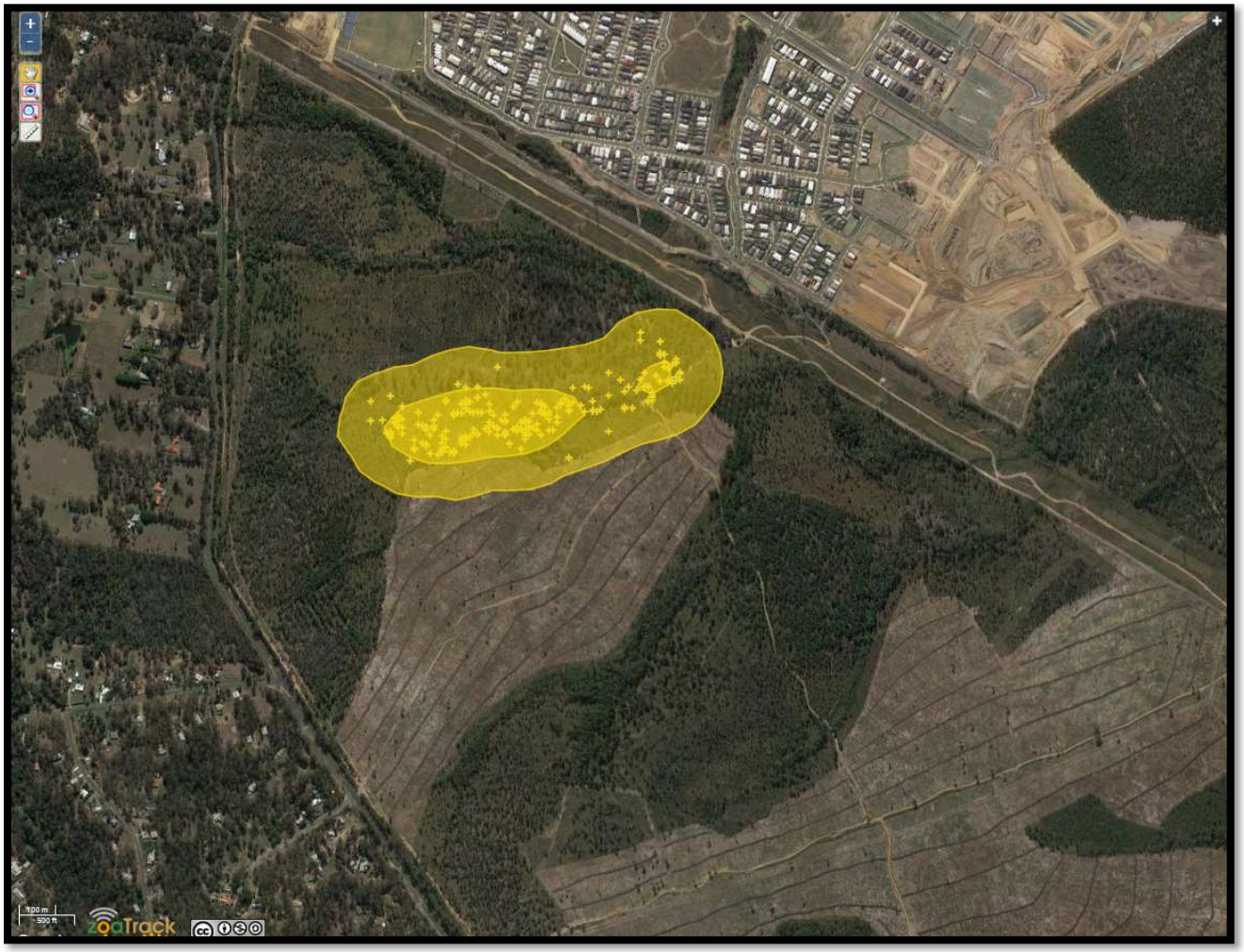
Note: The 50% KUDs are the two smaller polygons within the larger 95% KUD polygon.

Figure 3-24 Plot of 50% and 95% KUD home range estimates for Kobe



Note: The 50% KUDs are the two smaller polygons within the larger 95% KUD polygon.

Figure 3-25 Plot of 50% and 95% KUD home range estimates for Scarlet

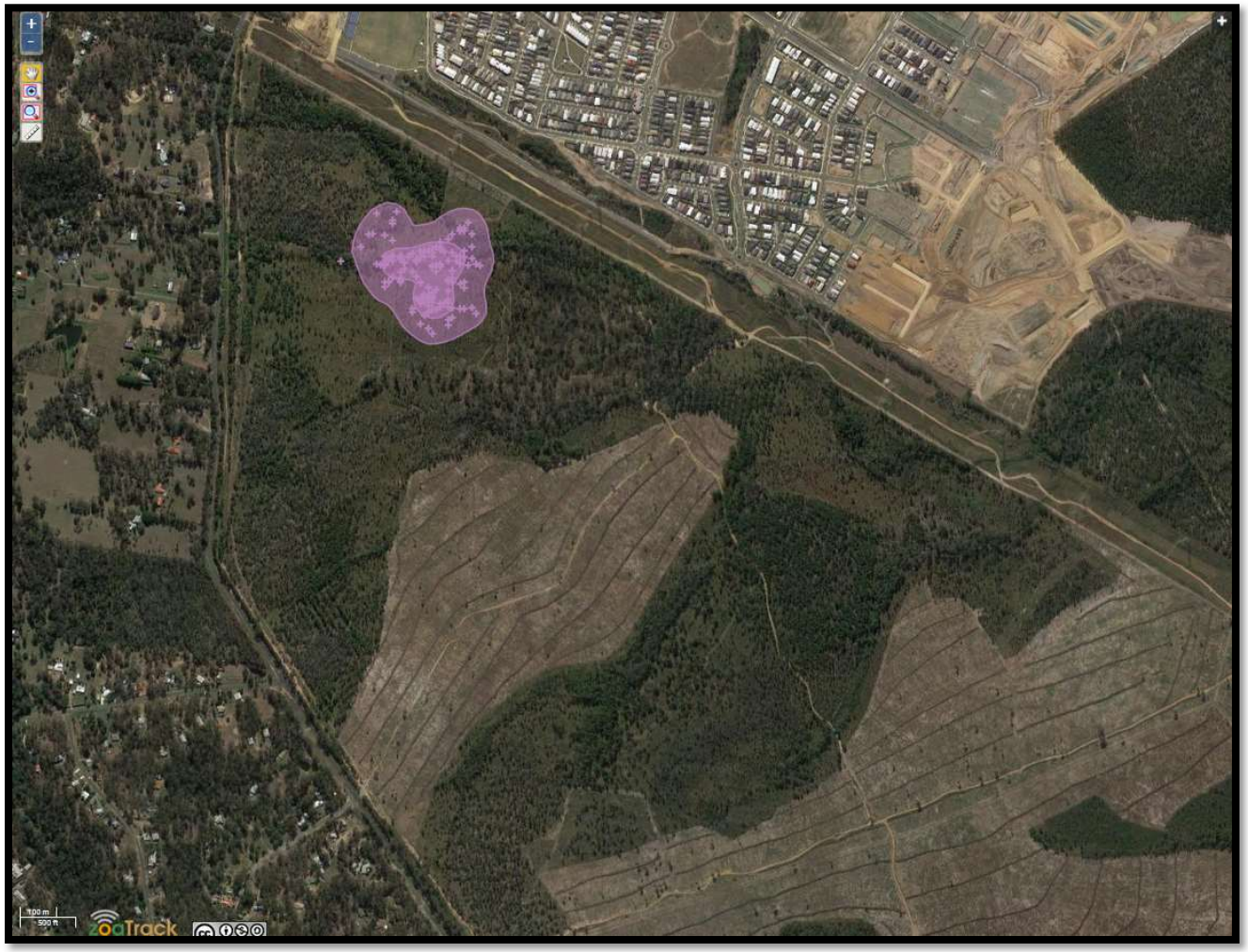


Note: The 50% KUDs are the two smaller polygons within the larger 95% KUD polygon.

Figure 3-26 Plot of 50% and 95% KUD home range estimates for Sue-bob

Note: The 50% KUD is the small polygon within the main 95% KUD polygon.

Figure 3-27 Plot of 50% and 95% KUD home range estimates for Zara



Note: The 50% KUD is the small polygon within the main 95% KUD polygon.