Ormiston Koala Population Monitoring and Community Engagement &
Genetic Koala Survey for Additional Koala Safe Neighbourhood Candidate Areas

2019-2020 Progress Report (Year 2)

Prepared for Redland City Council

By the University of the Sunshine Coast, Detection Dogs for Conservation

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Detection Dogs for Conservation

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Executive summary

Purpose

This report includes two different, but closely related, projects that were designed to feed into the Redland City Council's (RCC) Koala Safe Neighbourhoods (KSN) program, a major koala conservation initiative by RCC. Here we provide a progress report on the inaugural Koala Safe Neighbourhood project in Ormiston that is ongoing, and in addition report on the KSN expansion project, which involves the addition of new KSNs in select areas of Birkdale, Thornlands/Cleveland, and Mount Cotton.

The primary aim of the KSN is to generate a higher sense of custodianship from residents toward their local koalas by informing, supporting, and empowering them to actively conserve koalas within urbanised landscapes. Central to the management of koalas within a KSN is the ongoing monitoring of the local koala population. The monitoring has several applied purposes, including collecting data on disease incidence or frequency of exposure to threats (dogs, cars). KSN heavily relies on a citizen science component to enable the ongoing monitoring of the local koala population. Specific aims were to gain information on:

Monitoring technologies

In particular:

a) test technology that allows fine-scale tracking of koala movement,
b) deploy innovative koala research techniques,
c) investigate how monitoring can be transitioned into an ongoing citizen science program,

Koala habitat utilisation

In particular:

a) local movement and identification of areas that exacerbate/minimise threats to koalas,

b) home-ranges and core-ranges identification,

Health and genetics

In particular:

a) refinement of current genetic sampling for koalas within the KSN catchment,
b) survival, mortality and recruitment for the population,
c) health and disease assessment,

Community Engagement

In particular:

a) communicate a positive conservation message about koalas,
b) increasing the profile of koalas in Koala Safe Neighbourhoods, especially through recruitment of citizen scientists and social media.

Findings

> ***Note.*** Specific home- and core-range per koala are given in Appendix 1.

Monitoring

Since koala monitoring within the Ormiston KSN commenced in March 2019, and including the ongoing koala monitoring, genetics research and community engagement project for Phases 2/3, a total of 33 koalas have been monitored, including 13 that currently continue to be monitored in the project areas (Banjo, Bark, Benson, Blake, Bruce, Kimo, Lackey, Rainbow, Silkie, Summer, Slinky, Uka and Bob). A total of 64 captures and veterinary checks have been conducted, almost 30,000 GPS location fixes logged and, during radio-tracking for welfare checks, an additional 101 opportunistic sightings of uncollared koalas have been recorded.

Home-range and core-range

Home-range (95% of the estimated distribution) and core-range (50% of the estimated distribution) were estimated for each of the monitored koalas (Appendix 1). Home-range varies from 1 ha to 180 ha (mean (*M)* = 24 ha, standard deviation (*SD)* = 35), while core-range varies from 0.3 ha to 44 ha (*M* = 6 ha, *SD* = 10). Note that mean area and deviation might be overestimated for males because they include two koalas who dispersed to establish new home-ranges (Bark and Rubin). Excluding these two individuals, the mean home- and core-range are, respectively, 15 ha (*SD* = 17) and 3 ha (*SD* = *4*). Males presented larger home-range and core-range areas and a higher variation of home range size than females. These inferences will require further data before being confirmed, as they can be biased by individuals with longer monitoring periods.

Movement Patterns

During the study period in the Ormiston KSN, dispersal events have been recorded for at least two young male koalas (Bark and Rubin). In Birkdale and Thornlands, the monitoring period is still too short to establish accurate home-range estimates and movement patterns. So far, none of the monitored koalas has been involved in road accidents or attacked by dogs, but one koala (Lulu) and her dependent joey were killed by a train. Throughout all potential KSNs, monitored koalas were mostly located in protected habitat (especially Council reserves), however 52% of them crossed roads to move between geographic positions at least once and 74% were recorded in residential yards at least once.

Implications for Conservation. Home- and core-range were predominantly located in remnant vegetation and protected areas, however, occasionally, individuals crossed roads and were recorded in residential yards. Due to the priority of the project to only catch and collar koalas when safe to do so (and therefore away from most roadside areas), interaction with roads and residential yards (potentially housing domestic dogs) is likely underestimated.

Population health

Since the koala monitoring began in Ormiston in March 2019, 53 veterinary exams have been conducted across the KSNs by Endeavour Veterinary Ecology. This includes 43 in Ormiston, eight in Thornlands and two in Birkdale. In 28% of the cases, koalas were diagnosed as sick or injured, four individuals were euthanised. Chlamydia was the most common disease found in the koalas examined. During welfare checks, one monitored koala was found with disease symptoms (Banjo) and three deceased (Lucky, Poppy and Summer) from diseases. One female, Lulu, and her dependent joey were killed by a train in Ormiston.

Implications for Conservation. The level of chlamydia infection indicates vulnerability of the koala population in the Koala Safe Neighbourhood areas. In this scenario, ongoing monitoring becomes vital to identify and treat koalas before they die or become infertile. Additionally, monitoring can be important to detect "super spreader" koalas and decrease the rate of transmission.

The Redlands mainland has a relatively high density of urban koalas when compared to other areas in South East Queensland, therefore it is well placed to engage the community to promote guardianship over their local neighbourhood koalas.

Genetic analysis

We collected 116 samples across all Koala Safe Neighbourhoods using koala scat detection dogs. DNA has successfully been extracted from most of the scat samples and, after filtering and removing duplicates, 60 individual koalas were confidently identified. This includes 29 individuals from Ormiston, nine from Birkdale, 16 from Thornlands, and six from Mount Cotton. All genetic information will be added to samples collected across the Redlands mainland during the koala genetic survey 2020-2021, currently ongoing. Results will be presented in future reports.

Community engagement

Community engagement was severely impacted by regulations and restrictions, including gatherings and social distancing, linked to COVID-19. The current situation still does not encourage social interactions, so group engagement activities have been avoided.

Nonetheless, whenever safe and possible, the Detection Dogs for Conservation team engaged in conversations about koala conservation with members of the public. Brochures of the Redlands 24hr Wildlife Rescue Service were shared, and the Detection Dogs for Conservation team participated in four citizen scientist workshops (via Zoom and physically). The Detection Dogs for Conservation team created content (information, images and videos) and shared with the Redland City Council for social media engagement and Council newsletters.

1. Introduction

1.1 Scope of works

The Redland City Council (RCC) Koala Conservation Action Plan 2016-2021 supports an ongoing research project in collaboration with the University of the Sunshine Coast's Detection Dogs for Conservation (DDC) team. A key objective is to conduct koala monitoring and data collection within four designated Koala Safe Neighbourhoods. These actions provide information to better understand existing koala populations and inform management plans. Specifically, the project aimed to gain:

- Up-to-date information on koala presence and numbers in KSN,
- Assess health of KSN koala populations,
- Community engagement.

In particular, the following activities inform the scope of the project:

1. Establishment of a comprehensive phased monitoring project that seeks to encompass all koalas and can be transitioned into an ongoing citizen science program;
2. Use of monitoring technology that allows fine-scale tracking of koala movement;
3. Development or trial of innovative koala monitoring techniques;
4. Undertake best practice capture methods;
5. Undertake best practice management and handling of koalas;
6. Regular visual tracking of the collared koalas;
7. Provision of a technique to identify individual koalas;
8. Establishment of minimum population size;
9. Collection of koala scats/tissue for refinement of current genetic sampling for koalas within the KSN catchment;
10. Health and disease assessment;
11. Determine survival, mortality and recruitment for the population;
12. Determine local movement and identification of areas that exacerbate/minimise threats to koalas;
13. Identify and investigate core areas of koala habitat utilisation and connectivity;

14. Engage with the community and communicate a positive conservation message about koalas;
15. Liaise, and work in collaboration with, Redland City Council's Koala Project Officer, Koala Education Officer and Wildlife Extension Officers and the community as required.

1.2 Background

Australia has the highest mammal extinction rate of any country in the world (Woinarski et al. 2015), therefore effective conservation and monitoring are of urgent priority. For instance, Koalas (*Phascolarctos cinereus*) are, despite their iconic status and economic value (potentially $3.2 billion per annum (Conrad 2014)), experiencing an alarming sharp decline in the northern parts of their range (Queensland, New South Wales and the Australian Capital Territory). In Queensland, for example, land area occupied by koalas has contracted by an estimated 31% over the past century (Gordon et al. 2006) and the number of koalas has declined by approximately 43% (39-46% range) over a period of 20 years (McAlpine et al. 2015). In some areas of the state, documented declines have been even greater, including an 80% decline in the Mulga Lands bioregion over 14 years (Seabrook et al. 2011) and, within the South-East Queensland bioregion, declines of 80% and 54.% within the Koala Coast and Pine Rivers populations respectively (Rhodes et al. 2015), these results were also prior to the mega 2019-2020 bushfire, which further impacted koala populations (Phillips et al. 2021). Of even further concern is evidence that the rates of decline in these areas are worsening over time (Rhodes et al. 2015).

The reasons for the koala population decline are well known: 1) habitat loss and fragmentation (which also reduces genetic diversity and connectivity), 2) infectious disease caused by the bacterial pathogen, Chlamydia (which causes blindness, sterility and potential death), and 3) the risks associated with koala movements in human-altered landscapes (including dog attacks and car strikes) (Rhodes et al. 2011, Polkinghorne et al. 2013, Burton and Tribe 2016), but evidence about how these factors are impacting specific populations and how to mitigate them is often not available to decision-makers, and this holds true for both State and local government authorities. This report provides information to the Redland City

Council to help understand specifically the Redlands Coast koalas and the threats they face. This collaboration accomplishes several of their proposed management intents set out in their Koala Conservation Strategy 2016 to include a) decisions based on science; b) protect and improve koala habitat; c) reduce koala deaths, and; d) what is the community thinking.

Particularly in urban environments, actions in favour of biodiversity are extremely affected by socio-political factors, in addition to economic and ecological factors (Nilsson et al., 2019). For this reason, conservation efforts that include a wide range of actors can present powerful positive impacts. Community engagement is particularly important. Since the 18th- and 19th-century, citizen science has been provided by members of the public. It has changed over the years, but the main principle remains the same - non-professional scientists taking part in research (Tripp, 1943).

The Citizen Science Research Model is currently the most used approach around the world. Participants are encouraged to collect data about a specific topic, for example, sightings of koalas in the Redlands Coast. The data is publicly available, including to researchers who can analyse data and formulate predictions (Dickinson et al., 2010). This model also includes an important educational component. The knowledge and scientific practices are shared with the local communities which become empowered and can participate, with managers and researchers, in developing management strategy.

Here, we deployed proven and cost-effective methodologies with the intent to collect and analyse data on koala presence, genetics, movement, health and population dynamics. For example, conservation detection dogs were used to detect koalas and koala scats for genetic and population analyses, koala movements were tracked remotely using GPS, and koalas were thoroughly examined by veterinarians and radio-tracked in the field via VHF devices for health checks. Trials of a new technology (Bluetooth) and the potential for its integration to a community engagement program continued. Details are given below.

Innovative monitoring technologies

Since March 2019, we have consistently monitored a total of 33 koalas across the Redlands mainland using different types of tracking devices such as GPS, VHF and Bluetooth equipped ear-tags. We aimed to assess:

a) movement of the monitored koalas,
b) their health status,
c) the potential to develop a citizen science monitoring program,
d) pros and cons of different tracking techniques for ongoing koala monitoring within an urban setting.

Koala habitat utilisation

We estimated the extent of home range and core area of monitored koalas across the KSNs to assess:

a) habitat utilisation,
b) potential threats,
c) hotspots for further conservation initiatives (targeted education, dog control, tree plantings etc).

Koala population health assessment

We estimated a suite of demographic and health traits to assess the extent to which KSN's koalas are exposed to different threats. These included:

a) estimation of koala survival/mortality and reproduction rates based on the project sample size,
b) quantification of disease incidence for KSN koalas.

Community engagement

We engaged the local community with koala conservation through different approaches. These included:

a) participate in workshops promoted by the Redland City Council,
b) creation of content for the council to use in its communication with the general public,
c) developing close community relationships (texting, meeting, training, inviting to join koala releases etc) with specific groups of highly engaged and motivated citizen scientists,
d) engaging with interested citizens during fieldwork.

2. Methodology

2.1 Monitoring Technologies

2.1.1 Devices

All healthy captured adult koalas were fitted with the following technology before being released following their veterinary examination:

1. **Microchip** inserted subcutaneously into the inter-scapular area to enable identification of individual koalas at any facility with a microchip scanner (e.g. wildlife hospital).

2. **Solar-powered Bluetooth Low Energy (BLE)** ear tag (<5g) to enable identification of individual koalas from near the base of its tree using any smartphone.

3. Collar assembly incorporating a safety weak link (designed to break if koala becomes entangled).

4. Collar GPS. **GPS tracker** with up to 6 location fixes per day (4 pm, 8 pm, midnight, 4 am and 8 am), 6 to 8 months estimated battery duration with near-real-time location data. **GPS logger** with higher frequency but shorter battery life.

   The GPS tracker units were modified to decrease weight. This then enabled them to be positioned in the prime GPS collar position at the back of the neck, ensuring higher success and accuracy of 3 to 6 attempted location fixes per day. Estimated battery duration is now 4 to 6 months. Data from GPS loggers currently deployed (positioned under chin with VHF beacon) can only be accessed when collars are recovered.

5. Collar **VHF beacon** for periodic radio-tracking (welfare checks) and to enable locating dropped collars.
6. Collar **altimeter** system providing 4-second interval data logging for up to 42 days.

2.1.2 Radio-tracking and welfare checks

Radio-tracking has continuously been performed once to twice per month for welfare checks of all collared koalas. During this process, all opportunistic sightings of uncollared koalas have been recorded in the project database and the Queensland State Government's Wildnet database. Koalas have been observed with binoculars to try to ascertain: (1) sex, (2) external signs of chlamydial infection, often referred to as pink eyes (for ocular infection/conjunctivitis) and wet bottom (for urinary tract infection), and (3) presence of a joey. When a sick or injured koala was located during tracking events, it was immediately reported to Redlands Wildlife Rescue Service. Researchers also recorded location, time, position in the tree, tree species (when known) and koala behaviour.

2.2 Koala habitat utilisation

We have estimated home ranges for koalas fitted with GPS trackers, loggers and VHF devices. All location fixes with accuracy better than 30 m were retained.

The home-range of each collared koala was estimated using location data obtained to date. Home ranges were calculated as 95% and 50% (core-area) of the individual's estimated distribution based on fixed Kernel Density Estimators. To avoid bias caused by uneven sampling interval during the home range calculation, a maximum of one location fix per day was used (last record of the day). Bandwidth smoothing parameters were calculated individually according to the method proposed by Worton, B. (1995). Overlaps were calculated by overlaying individual home-ranges. All smoothing parameters, home ranges, overlaps and their sizes were calculated using adehabitatHR package in R statistical software, and were mapped using the software QGIS® version 3.10.2-A Coruña.

Limitations

Home ranges and areas presented in this report are a partial estimation only, calculated from data collected up to 31 October 2020. Therefore, they represent space used during the period each koala was wearing a collar (which differs between koalas) and likely not indicative of a koala's entire home range.

We decided to use a daily time series instead of all available location fixes. This may reduce the precision of home ranges but avoids biases and incorrect assumptions caused by the highly variable frequency at which GPS location points were logged. For example, some individuals had GPS units set to log one geographic position every 15 minutes (the loggers), while others every few hours (the trackers). The variation occurred due to different research objectives such as:

- "real-time" tracking (the trackers) for community engagement,
- fine-scale (but shorter life) GPS mapping (the loggers) to determine movements especially across roads,
- definition of home-ranges and individual space use.

Additionally, overlaps between home-ranges are given despite the temporal variation of the data collection, as an indication of areas of high used habitat for our ambassador koalas. Note that the data cannot be interpreted as favoured koala habitat in general (as we only have a small proportion of the koala population collared), nor to quantify koala interactions. Location fixes recorded by GPS devices and radio-tracking represent only the period for which a koala was monitored.

2.3 Health examination

All veterinary procedures were conducted by or under the direct supervision of an experienced wildlife veterinarian (Drs Jon Hanger, Amy Robbins or Pip McKay) with the assistance of an experienced wildlife veterinary nurse. Veterinary procedures were conducted at the Redland's Animal Shelter (Thornlands, QLD) and the Endeavour Veterinary Ecology clinic (Toorbul, QLD).

After induction of general anaesthesia, all captured koalas received a full veterinary physical and clinical examination and the findings were recorded.

The following standardised veterinary procedures and diagnostic tests were performed:

1) General physical exam: weight, body condition score, tooth wear (approximating koala age),
2) Ear punch for DNA analyses (and fitting of ear tag when needed).
3) Blood collection and processing for packed cell volume and total protein (PCV/TP) estimation and cytology.
4) Bone marrow collection and cytology to detect any abnormalities, such as leukemia.
5) Abdominal fluid collection and cytology.
6) Cystocentesis for urinalysis (Combur test, USG and urine sediment cytology).
7) Ultrasound of kidneys, reproductive tract and bladder
8) Swabs for the detection of Chlamydia from the following sites: conjunctiva, urogenital sinus (female koalas) or penile urethra (male koalas) and urine sediment.

While still under general anaesthesia, koalas were microchipped and fitted with a GPS/VHF collar with altimeter, and Bluetooth ear tag. Koalas were then transferred to a transport cage until fully recovered and ready for release. Sub-adults were microchipped, but a GPS collar was only fitted at the discretion of veterinary personnel, based on their experience.

If, in the judgement of the veterinary team, a koala was found with an illness that was unlikely to respond to treatment, the koala was euthanised before recovery from anaesthesia by intravenous injection of concentrated pentobarbitone sodium (Lethabarb). If in the judgement of the veterinary team, a koala's illness or injury warranted veterinary treatment or care, the koala was transferred to the Australia Zoo Wildlife Hospital. Unless veterinary treatment was required, captured koalas were released at the point of capture within 24 hours.

All collared koalas were visually observed with binoculars at least monthly by an experienced koala researcher (primarily Kye McDonald, secondarily Caio Santos Neto).

Koalas with collar requiring adjustment, or that presented confirmed signs of illness, injury or distress were re-captured as soon as possible. Koalas with illness or injury were taken to Australia Zoo Wildlife Hospital (AZWH) for veterinary assessment.

It should be reinforced that all koala collars feature a safety weak link that is designed to break if the koala becomes entangled. Indeed, no collar-related incidents have been recorded.

2.4 Genetics

Genotyping was conducted non-invasively from material contained in the surface of koala scats (both koala and bacterial DNA). This allows for large scale, relatively cheap, unbiased sampling of DNA compared to more widely used methods (catching, anaesthetising and collecting biopsy/swab, or relying on hospital samples). However, compared to high-quality samples (biopsies/swabs), scat DNA is degraded and presents multiple extraction difficulties (due to inhibitors present from the koala dietary component of the scat).

Fresh scats (mainly still covered in mucus or shiny and smelly – for more information refer to Redlands Coast Koala Population Assessment Project – Final Report, 2018, p. 33) found during the KSN surveys were collected for genetic analysis. Scats were collected in a sterile tube without direct skin contact to avoid potential contamination and loss of koala DNA. Tubes were kept on ice until they were stored in a -20 degrees Celsius freezer. DNA was extracted using the method described in Schultz et al. (2018b). DNA extractions were genotyped using a next-generation sequencing protocol for detecting Single Nucleotide Polymorphism or SNP (Kilian et al. 2012) using specific probes designed for this project to increase the percentage of SNPs replicated across most samples, and therefore enhance all downstream genetic analyses.

The genetic sampling in this study was constrained by administrative boundaries, rather than ecological or genetic boundaries - i.e. koalas in Redlands Coast with part of Brisbane and Logan Councils, form a population known as the "Koala Coast" (Lee et al. 2010). Therefore, all samples collected in 2019/2020 were incorporated into the Redlands Genetic Dataset to be further analysed with samples to be collected during the 2020/2021 citywide genetic survey. Results will be reported in June 2021 – Phase 3 – Final Report

2.5 Community engagement

A primary focus of the current project's citizen science engagement was the development and trial of solar-powered Bluetooth ear tag monitoring technology, which can then be integrated with a user-friendly smartphone App for use by local residents and tourists alike, who are interested in spotting and recording wild koalas.

Bluetooth ear tag performance was recorded during the course of each deployment period/per individual koala. Once a device was detected using the mobile platform application via a smartphone in the field, the distance between the base of the tree and the smartphone was calculated. The use of the Bluetooth device has shown positive results and the future progress to a more robust and user-friendly platform will depend on the ability to secure funding for mass production and development of a public smartphone App. Development of the Bluetooth device itself is continuing, with the device being at its 4th iteration.

Over the course of the koala monitoring projects, the Detection Dogs for Conservation team has attended events and workshops promoted by the Redland City Council (RCC), actively endorsed koala conservation messages, and engaged and empowered the community when in the field. The team were active in providing RCC with social media content when recruiting and promoting the collared koala ambassadors within each KSN. In addition, the Detection Dogs for Conservation team were approached to promote koala conservation and engagement at the Redlands College, and invited Griffith University's Social Marketing and Behaviour Change research group to participate in delivering a scientifically accurate conservation message through an entertaining media: a virtual character.

Limitations

Most of the planned community engagement activities could not be delivered due to COVID-19 restrictions. For example, BBQ and training of more citizen scientists on the Bluetooth could not happen due to directives from the Government. We look forward to carrying out these activities in the future if COVID-19 restrictions allow.

3. Results

Note. This main body of the report focuses on giving general trends and analyses, and to preserve the flow, specific maps per koala are not included here but given in Appendix 1.

3.1 Koala Safe Neighbourhoods

3.1.1 Koala captures

Since the beginning of the koala monitoring by the Detection Dogs for Conservation group in March 2019, to the time of writing this report (February 2020), and including the ongoing and expanded Koala Safe Neighbourhoods project, out of 42 captured koalas 33 were monitored, including 13 still currently monitored in the project areas (Banjo, Bark, Benson, Blake, Bruce, Kimo, Lackey, Rainbow, Silkie, Summer, Slinky, Uka and Bob). A total of 64 captures, re-captures, and releases were conducted (Table 1). During tracking, 101 opportunistic sightings of uncollared koalas were also recorded in the project database.

To include the three additional Koala Safe Neighbourhoods (Birkdale, Thornlands/Cleveland, and Mount Cotton) into the koala ambassador and monitoring program, specific regions were surveyed with drone acquired thermal imagery, visual spotting, and detection dogs to identify targets for capture (Figure 1). A total of 15 days between August and December 2020 were allocated to locate and capture an additional six koalas for the KSN ambassador koala program. These activities will be fully reported in the "*Koala Safe Neighbourhoods: Koala monitoring, genetics research and community engagement project. Phase 3 - Year 3 Progress Report (2020-2021)*".

Figure 1. Drone surveys and koala detections.

Figure 2. Opportunistic koala sightings during welfare monitoring.

Table 1. Summary of koala captures, re-captures, and releases.

Koala Name	Sex	Ear tag	Capture date	Suburb	Release date	Outcome
Kimo	Female	206	17/04/2019	Wellington Point	17/04/2019	collared
Cuddles	Female	201	01/05/2019	Ormiston	01/05/2019	collared
Gumnut	Female	208	24/04/2019	Wellington Point	24/04/2019	collared
Lucky	Male	207	17/04/2019	Ormiston	17/04/2019	collared
Banjo	Male	211	24/04/2019	Ormiston	24/04/2019	collared
Bruce	Male	212	01/05/2019	Ormiston	01/05/2019	collared
Lulu	Female	213	24/04/2019	Ormiston	24/04/2019	collared
Ted	Male	223	01/05/2019	Ormiston	01/05/2019	collared
Monty	Male	203	01/05/2019	Ormiston	01/05/2019	collared
Brian	Male	202	17/04/2019	Ormiston	17/04/2019	collared
Saxon	Male		01/05/2019	Ormiston	NA	AZWH – unresponsive to treatment, euthanasia
Rubin	Male	3398	01/05/2019	Ormiston	02/07/2019	treated and collared
Unnamed female	Female		01/05/2019	Ormiston	NA	euthanised
Leaf	Female	205	21/08/2019	Ormiston	21/08/2019	released
Ted	Male	223	21/08/2019	Ormiston	16/10/2019	treated and collared
Bruce	Male	212	21/08/2019	Ormiston	21/08/2019	collared
Chips	Male	236	21/08/2019	Wellington Point	21/08/2019	collared
Poppy	Female	234	21/08/2019	Ormiston	21/08/2019	collared
Wonky	Male	250	18/09/2019	Ormiston	18/09/2019	collared
Bilbo	Male	248	18/09/2019	Wellington Point	18/09/2019	collared
Brian	Male	202	18/09/2019	Ormiston	18/09/2019	collared
Ember	Female	215	18/09/2019	Ormiston	13/11/2019	treated and collared
Silkie	Female	229	25/09/2019	Ormiston	25/09/2019	collared
Pebble	Female		25/09/2019	Ormiston	NA	AZWH - euthanasia

Koala Name	Sex	Ear tag	Capture date	Suburb	Release date	Outcome
Kimo	Female	206	25/09/2019	Wellington Point	25/09/2019	collared
Wonky	Male	250	16/10/2019	Wellington Point	16/10/2019	collared
Chips	Male	226	16/10/2019	Wellington Point	16/10/2019	collared
Banjo	Male	211	23/10/2019	Ormiston	30/10/2019	treated and collared
Bruce	Male	240	30/10/2019	Ormiston	30/10/2019	collared
Banjo	Male	211	30/10/2019	Ormiston	30/10/2019	collared
Milo	Male	235	30/10/2019	Ormiston	30/10/2019	collared
Tally	Female	249	30/10/2019	Ormiston	30/10/2019	collared
Bluey	Male	239	30/10/2019	Ormiston	30/10/2019	collared
Olive	Female		30/10/2019	Ormiston	NA	AZWH - euthanasia
Ember	Female	215	Came from AZWH	Ormiston	13/11/2019	collared
Kimo	Female	206	10/12/2019	Wellington Point	10/12/2019	collared
Bark	Male	220	Came from AZWH	Ormiston	16/06/2020	collared
River	Female		Pebble's joey	Ormiston	28/03/2020	Bluetooth only
Uka	Female	408	25/08/2020	Birkdale	25/08/2020	collared
Rainbow	Female	406	25/08/2020	Birkdale	25/08/2020	collared
Banjora	Female		02/09/2020	Thornlands	NA	AZWH - euthanasia
Lackey	Male	M291	02/09/2020	Thornlands	05/11/2020	treated and collared
Kimo	Female	401	03/09/2020	Ormiston	03/09/2020	collared
Nibble	Female		03/09/2020	Ormiston	03/09/2020	joey – not collared
Silkie	Female	405	03/09/2020	Ormiston	03/09/2020	collared
Cariad	Female		03/09/2020	Ormiston	NA	AZWH - euthanasia
Blake	Male	229	10/09/2020	Thornlands	11/09/2020	collared
Daisy	Female		13/09/2020	Thornlands	NA	EVE - euthanasia
Summer	Female	407	17/09/2020	Thornlands	18/09/2020	collared
Slinky	Male	410	27/10/2019	Myora Springs, NSI	11/10/2020	treated and collared
Bob	Male		10/12/2020	Mount Cotton	05/2/2021	treated and collared
Lackey	Male	240	10/12/2020	Thornlands	10/12/2020	replaced collar

Koala Name	Sex	Ear tag	Capture date	Suburb	Release date	Outcome
Summer	Female	407	10/12/2020	Thornlands	NA	AZWH - euthanasia
Benson	Male	409	10/11/2020	Cleveland	17/12/2020	collared
Liptus	Male	206	28/11/2020	Birkdale	22/01/2021	collared
Sir Derek	Male	402	13/09/2020	Thornlands	15/01/2021	collared

3.1.2 Koala monitoring

A total of 33 koalas have been monitored (including koala monitoring Phase 3, from April 2019 to Dec 2020) (Table 2). Slinky, Bark and Benson were not captured by the Detection Dogs for Conservation team. The AZWH notified DDC about their planned releases and we were able to fit GPS collars on these three koalas to join the project. Currently, seven koalas (Bark, Benson, Kimo, Lackey, Rainbow, Silkie and Slinky) are GPS monitored, eight are Bluetooth equipped (Bark, Benson, Blake, Kimo, Lackey, Rainbow, Silkie and Slinky) and two are VHF monitored (Banjo and Bruce) in the project areas. Unfortunately, 15 have dropped their collar and are no longer being monitored, four koalas died (two were found dead while radio-tracking, likely from natural causes).

Table 2. Name, monitoring duration and current status of each koala that has been monitored in the Koala Safe Neighbourhoods project area.

Name	Period	Status	Suburb
Banjo	Apr 2019 – Current	Monitored	Ormiston
Bark	Jul 2020 – Current	Monitored	Ormiston/Wellington Point
Benson	Dec 2020 – Current	Monitored	Thornlands/Cleveland
Bilbo	Sep 2019 - Jul 2020	Dropped collar	Wellington Pt
Blake	Oct 2020 – Current	Monitored	Thornlands/Cleveland
Bluey	Oct 2019 - Dec 2019	Dropped collar	Ormiston
Bob	Feb 2021 - Current	Monitored	Mount Cotton
Brian	Apr 2019 - Dec 2019	Dropped collar	Ormiston
Bruce	May 2019 – Current	Monitored	Ormiston
Chips	Aug 2019 - Feb 2020	Dropped collar	Wellington Point
Cuddles	May 2019 - Oct 2019	Dropped collar	Ormiston
Ember	Nov 2019 - Jan 2020	Dropped collar	Ormiston
Gumnut	Apr 2019 - Jan 2020	Dropped collar	Wellington Point
Kimo	Apr 2019 – Current	Monitored	Wellington Point
Lackey	Nov 2020 – Current	Monitored	Thornlands/Cleveland
Leaf	Aug 2019 - Sep 2019	Dropped collar	Ormiston

Name	Period	Status	Suburb
Liptus	Jan 2021 - Current	Monitored	Birkdale
Lucky	Apr 2019 - Apr 2019	Deceased	Ormiston
Lulu	Apr 2019 - Jul 2019	Deceased	Ormiston
Milo	Oct 2019 – Jan 2020	Dropped collar	Ormiston
Monty	May 2019 - Jan 2020	Dropped collar	Ormiston
Poppy	Aug 2019 - Jan 2020	Deceased	Ormiston
Rainbow	Sept 2020 – Current	Monitored	Birkdale
River	Joey raised and released	Bluetooth only	Ormiston
Rubin	Jul 2019 - Sep 2019	Dropped collar	Ormiston
Silkie	Sep 2019 - Current	Monitored	Ormiston
Sir Derek	Jan 2021 – Feb 2021	Dropped Collar	Thornlands
Slinky	Oct 2020 - Current	Monitored	Ormiston
Summer	Sept 2020 – Dec 2020	Deceased	Thornlands/Cleveland
Tally	Oct 2019 - Apr 2020	Dropped collar	Ormiston
Ted	May 2019 - Nov 2019	Dropped collar	Ormiston
Uka	Sept 2020 - Current	Monitored	Birkdale
Wonky	Sep 2019 - Apr 2020	Dropped collar	Wellington Point
Total	33 koalas (one Bluetooth only)	13 currently monitored	

3.1.3 GPS and VHF monitoring

All location fixes recorded by GPS and radio-tracking were filtered for high accuracy and cleaned from GPS errors (see Section 2.2). The final dataset comprises 29,988 geographic positions recorded from 17/04/2019 to 31/10/2020 (Table 3). The number of geographic points and period of data collection vary between individuals because it is intrinsically dependent on environmental conditions (i.e. rainy conditions can inhibit GPS signal), koala position (i.e. a tree trunk can inhibit GPS signal), collar type and logging interval, and duration of time during which a koala wore the GPS or VHF collar / ear tag. Note that the duration does not necessarily match the date difference between the last and first day of collar deployment because, in some cases, there is a gap between the moment a collar ceased operating to the day that a replacement was fitted.

Table 3. Name, period duration and number of fixes for each monitored koala during the project. The duration period represents the number of days a koala was actively monitored.

Koala name	Monitoring device	Period	Duration (days)*	Number of location fixes
Banjo	GPS logger	24/04/2019 - 21/06/2019	58	2068
Banjo	GPS tracker	24/04/2019 - 25/06/2019	62	98
Banjo	GPS tracker	31/10/2019 - 06/01/2020	27	82
Banjo	VHF tracker	24/04/2019 - 31/10/2020	556	24
Bark	GPS tracker	02/06/2020 - 31/10/2020	151	166
Bark	GPS logger	16/06/2020 - 03/07/2020	17	106
Bark	VHF tracker	16/06/2020 - 30/10/2020	136	12
Bilbo	GPS tracker	19/09/2019 - 31/12/2019	103	276
Bilbo	VHF tracker	18/09/2019 - 28/07/2020	314	16
Blake	GPS logger	11/09/2020 - 11/10/2020	30	290
Blake	VHF tracker	11/09/2020 - 26/10/2020	45	4
Blake	GPS tracker	10/09/2020 - 19/10/2020	39	701
Bluey	GPS logger	30/10/2019 - 11/12/2019	42	382
Bluey	VHF tracker	30/10/2019 - 25/02/2020	118	6
Bluey	GPS tracker	31/10/2019 - 30/12/2019	60	96
Bluey	GPS tracker	31/10/2019 - 30/12/2019	60	136
Brian	GPS tracker	18/04/2019 - 31/12/2019	257	389
Brian	VHF tracker	17/04/2019 - 30/11/2019	227	17
Brian	GPS logger	30/10/2019 - 11/12/2019	42	1377

Bruce	VHF tracker	01/05/2019 - 26/10/2020	544	46
Bruce	GPS logger	01/05/2019 - 22/11/2019	205	2220
Bruce	GPS tracker	01/05/2019 - 24/09/2019	146	240
Chips	GPS logger	21/08/2019 - 08/11/2019	79	607
Chips	GPS tracker	17/10/2019 - 30/12/2019	74	99
Chips	GPS tracker	21/08/2019 - 27/01/2020	159	155
Chips	VHF tracker	21/08/2019 - 25/02/2020	188	15
Cuddles	VHF tracker	01/05/2019 - 02/10/2019	154	19
Cuddles	GPS logger	01/05/2019 - 22/06/2019	52	1869
Ember	GPS logger	13/11/2019 - 24/12/2019	41	343
Ember	GPS tracker	13/11/2019 - 31/12/2019	48	170
Ember	GPS tracker	13/11/2019 - 31/12/2020	48	141
Ember	VHF tracker	13/11/2019 - 22/01/2020	70	6
Gumnut	GPS logger	24/04/2019 - 10/07/2019	77	2863
Gumnut	VHF tracker	24/04/2019 - 22/01/2020	273	36
Kimo	GPS tracker	25/09/2019 - 31/10/2020	402	395
Kimo	VHF tracker	17/04/2019 - 26/10/2020	558	53
Kimo	GPS tracker	17/04/2019 - 28/10/2019	194	398
Kimo	GPS logger	17/04/2019 - 18/12/2019	245	1254
Leaf	VHF tracker	21/08/2019 - 25/09/2019	35	6
Leaf	GPS logger	21/08/2019 - 05/09/2019	15	295
Leaf	GPS tracker	21/08/2019 - 09/09/2018	19	80
Leaf	GPS tracker	21/08/2019 - 09/09/2019	19	80
Lucky	VHF tracker	17/04/2019 - 05/05/2019	18	4

Lucky	GPS tracker	17/04/2019 - 30/04/2019	13	13
Lucky	GPS logger	17/04/2019 - 04/05/2019	17	455
Lulu	VHF tracker	24/04/2019 - 05/07/2019	72	13
Lulu	GPS logger	24/04/2019 - 21/06/2019	58	2258
Milo	VHF tracker	30/10/2019 - 07/01/2020	69	4
Milo	GPS tracker	30/10/2019 - 03/03/2020	125	101
Milo	GPS logger	30/10/2019 - 16/11/2019	17	87
Monty	GPS tracker	01/05/2019 - 13/07/2019	73	115
Monty	VHF tracker	01/05/2019 - 12/07/2019	72	11
Monty	GPS logger	01/05/2019 - 08/05/2019	7	290
Poppy	GPS logger	21/08/2019 - 03/09/2019	13	227
Poppy	GPS tracker	21/08/2019 - 04/09/2019	14	42
Poppy	VHF tracker	21/08/2019 - 07/01/2020	139	17
Poppy	GPS tracker	21/08/2019 - 04/09/2019	14	40
Rainbow	VHF tracker	28/08/2020 - 26/10/2020	59	5
Rainbow	GPS tracker	26/08/2020 - 28/10/2020	63	165
Rainbow	VHF tracker	26/08/2020 - 31/10/2020	66	174
Rubin	GPS logger	02/07/2019 - 23/09/2019	83	3475
Rubin	VHF tracker	02/07/2019 - 10/09/2019	70	13
Rubin	GPS tracker	05/07/2019 - 24/09/2019	81	129
Silkie	GPS tracker	27/09/2019 - 28/10/2020	397	376
Silkie	GPS logger	25/09/2019 - 29/10/2019	34	276
Silkie	VHF tracker	02/10/2019 - 26/10/2020	390	23
Slinky	VHF tracker	11/10/2020 - 26/10/2020	15	2

Slinky	GPS logger	11/10/2020 - 27/10/2020	16	41
Slinky	GPS tracker	11/10/2020 - 10/11/2020	30	77
Summer	GPS logger	18/09/2020 - 28/10/2020	40	109
Summer	VHF tracker	15/10/2020 - 26/10/2020	58	2
Summer	GPS tracker	18/09/2020 - 31/10/2020	62	114
Tally	GPS logger	30/10/2019 - 26/11/2019	27	217
Tally	GPS tracker	31/10/2019 - 31/12/2019	556	98
Tally	VHF tracker	23/10/2019 - 20/04/2020	151	9
Tally	GPS tracker	31/10/2019 - 16/02/2020	108	177
Ted	GPS logger	01/05/2019 - 06/11/2019	136	1023
Ted	VHF tracker	01/05/2019 - 20/11/2019	103	18
Ted	GPS tracker	01/05/2019 - 17/05/2019	314	33
Ted	GPS tracker	16/10/2019 - 19/10/2019	30	12
Uka	VHF tracker	28/08/2020 - 26/10/2020	45	5
Uka	GPS logger	25/08/2020 - 28/10/2020	39	169
Uka	GPS tracker	25/08/2020 -31/10/2020	42	173
Wonky	GPS logger	18/09/2019 - 02/12/2019	118	1449
Wonky	VHF tracker	18/09/2019 - 11/03/2020	60	14
Wonky	GPS tracker	16/10/2019 - 27/11/2019	60	115
Wonky	GPS tracker	17/09/2019 - 27/11/2019	71	136

* Note that the duration is not continuous, some koalas have dropped collars and were recollared.

3.1.4 Bluetooth devices

The Bluetooth ear tag has been continuously improved through the project based on ongoing field testing (Table 4). Initially, the mean detection range was 5 m (*SD* = 13 m) measured from the device receiving the signal to the base of the tree where the monitored koala was located. Since the 25 August 2020, all captured koalas have received the new Bluetooth device and the results increased to 31 ± 13 m detection range. Currently 10 koalas have active Bluetooth ear tags. These results are promising for the development of a reliable system that will allow citizens to monitor koalas in urban areas. The next version of the Bluetooth ear tag, with improved durability, is in the pipeline.

Table 4: Bluetooth ear tag evolution through the project

Version	Number of field deployment	Issues	Tested in the field
V1 = unmodified circuit board chip antenna; glued to ear tag	18	● insufficient transmission range ● detaching from ear tag	deployed from 17/04/2019
V2 = white (insulated copper wire) external whip antenna; slide-lock moulded and glued to ear tag	9	● excellent transmission range ● remaining attached ● antenna breakage (resulting in no/limited transmission range)	deployed from 25/9/2019
V3 = black (plastic coated braided stainless steel) external whip antenna; slide-lock moulded and glued to ear tag	17	● improved transmission range ● remaining attached ● better durability but still some antenna breakage (resulting in no/limited transmission range)	deployed from 25/08/2020
V4 = internal antenna			to be deployed

3.2 Koala habitat utilisation

3.2.1 Home-range and core-range

Home-range (95% of the estimated distribution) and core-range (50% of the estimated distribution) were estimated for each of the GPS/VHF monitored koalas (Table 5). Home-range varies from 1 ha to 180 ha (M = 24 ha, SD = 35) while core-range varies from 0.3 ha to 44 ha (M = 6, SD = 10 ha). Note that mean area and deviation might be overestimated for males because they include koalas who dispersed (Bark and Rubin). Excluding these two individuals, the mean home-range and core-range are, respectively, 15 ha (SD = 17) and 3 (SD = 4) ha.

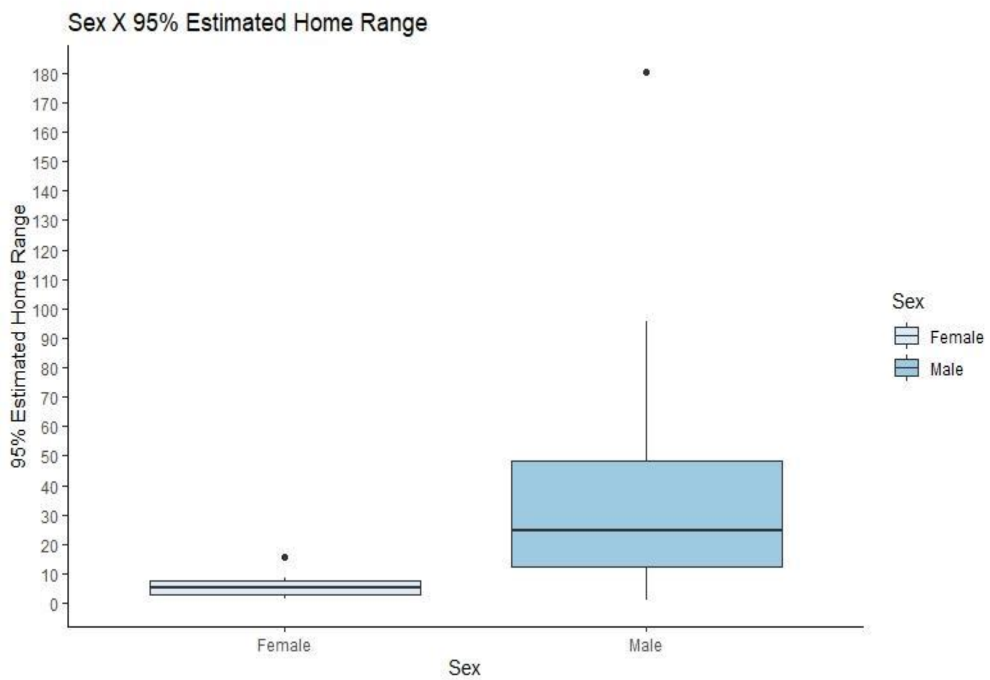
Table 5. Summary of home-range, core-range, and smoothing factor for all koalas monitored in 2019 and 2020.

Name	Sex	Duration (days)	Smoothing factor (m)	Core-range (ha)	Home-range (ha)
Kimo	Female	292	25	2	7
Bruce	Male	163	51	5	25
Brian	Male	160	98	15	68
Silkie	Female	138	32	2	8
Bark	Male	135	140	35	96
Chips	Male	129	40	2	11
Banjo	Male	128	68	7	30
Bilbo	Male	107	53	5	24
Tally	Female	103	20	0	3
Gumnut	Female	101	20	1	3
Rubin	Male	85	191	44	180
Wonky	Male	84	47	4	14
Bluey	Male	80	74	7	37
Uka	Female	66	24	1	4
Cuddles	Female	64	16	0	2
Rainbow	Female	64	55	3	16
Ember	Female	62	21	1	2
Lulu	Female	62	32	2	7
Monty	Male	61	103	16	60
Milo	Male	58	51	4	20
Ted	Male	56	33	2	7
Summer	Female	42	42	1	9
Blake	Male	33	70	5	26

Name	Sex	Duration (days)	Smoothing factor (m)	Core-range (ha)	Home-range (ha)
Slinky	Male	30	13	0	1
Poppy	Female	28	35	1	7
Leaf	Female	23	21	1	2
Lucky	Male	18	25	1	3
Mean		**88**	**52**	**6**	**25**
SD		**58**	**41**	**10**	**39**
Note: Any range data calculated on less than 90 days are given for reference but cannot be assumed to represent koala range across seasons. Benson and Lackey are not included here due to low number of points.					

From all monitored koalas (N = 33), 17 were males (56 %) and 13 females (44%), in addition during the monitoring we observed 15 joeys with the females (some female koalas had more than one joey over the period of monitoring). Males had a mean home-range size of 40 ha (*SD* = 46) and core-range size of 10 ha (*SD* = 12). Females, on the other hand, had smaller and less variable ranges; mean home-range size of 5 ha (*SD* = 4) and core-range of 1 ha (*SD* = 0.8) (Figure 3).

A



B

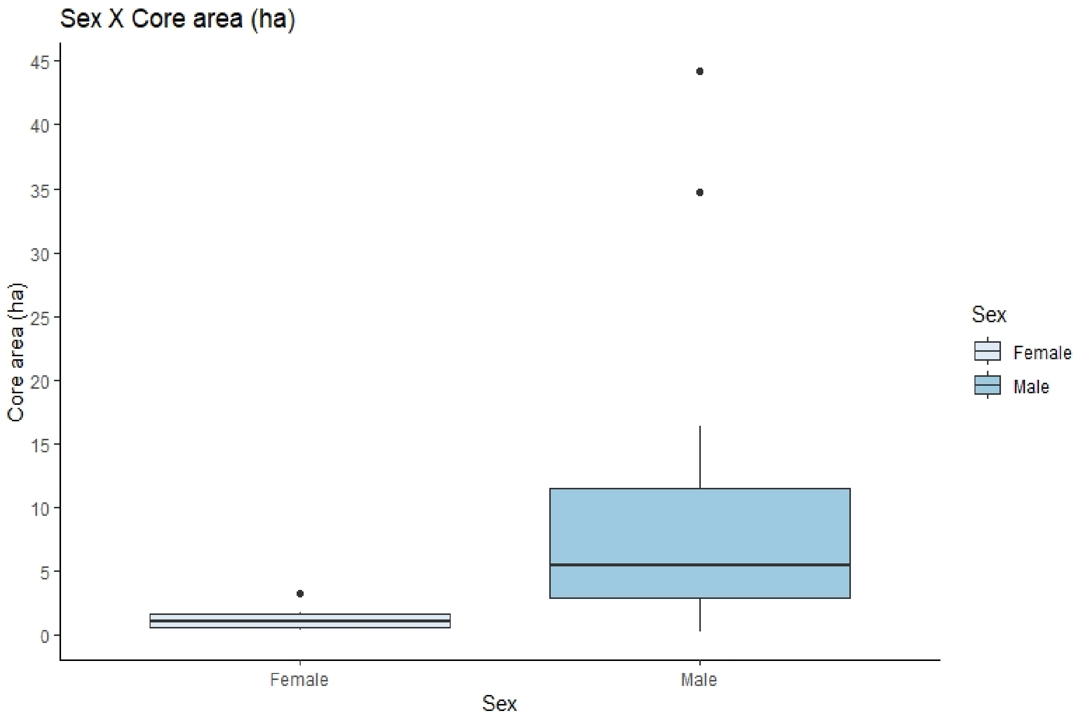


Figure 3. (A) Home-range and (B) core-range area per sex.

3.2.2 Overlaps between home- and core-range of different koalas

The majority of monitored koalas in Ormiston are spatially distributed into three areas: 1) Bligh Street, Wellington Point; 2) Stevens Place, Ormiston; and 3) Montgomery Park, Ormiston. Overlaps between home-ranges occur in 77% (N = 21) of cases, while core-ranges only overlap in 51% (N = 14) of cases (Figures 4 - 6).

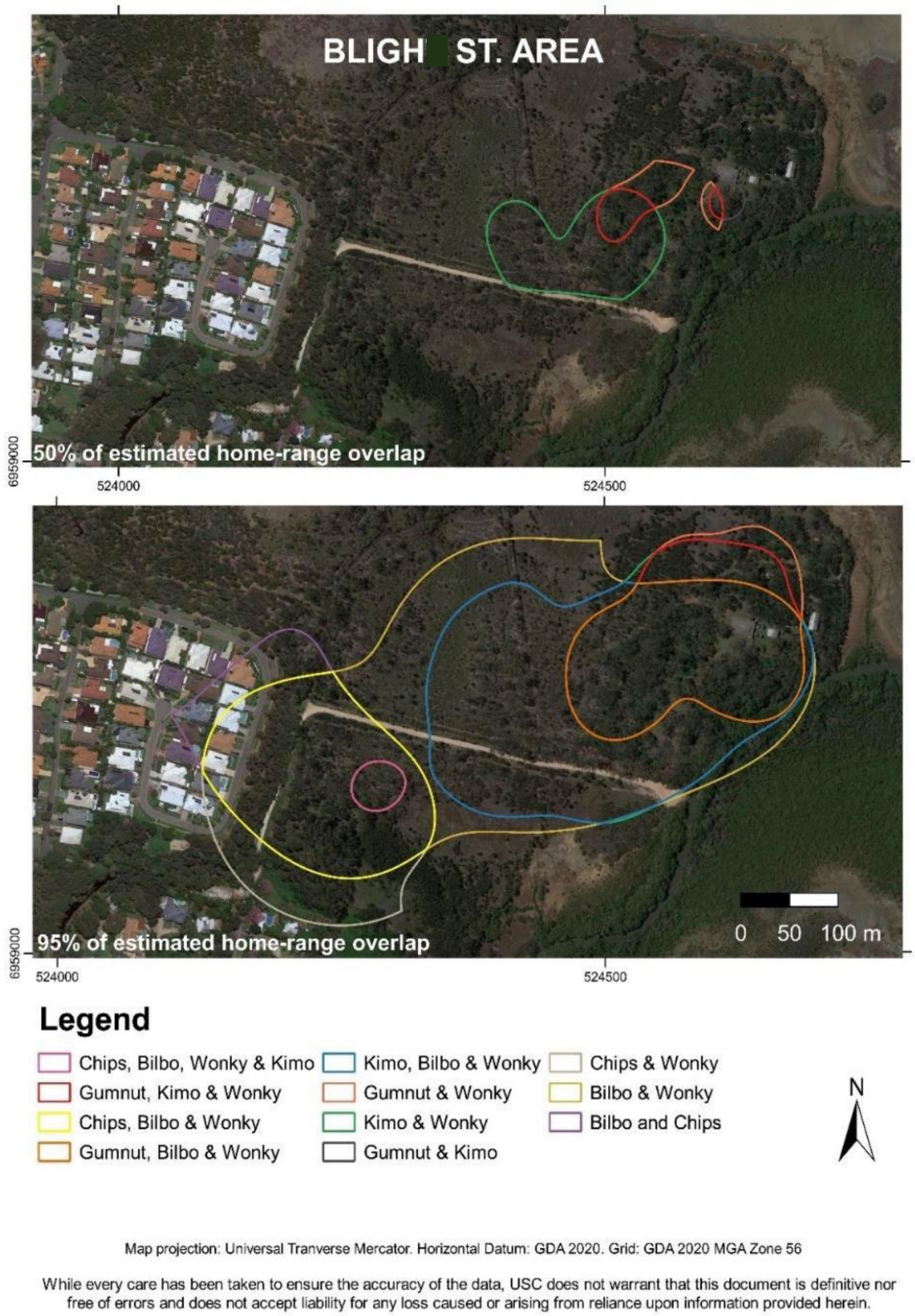


Figure 4. Overlap between individual home-range and core-range in (95% and 50% of estimated spatial range, respectively) in the Bligh Street area, Wellington Point.

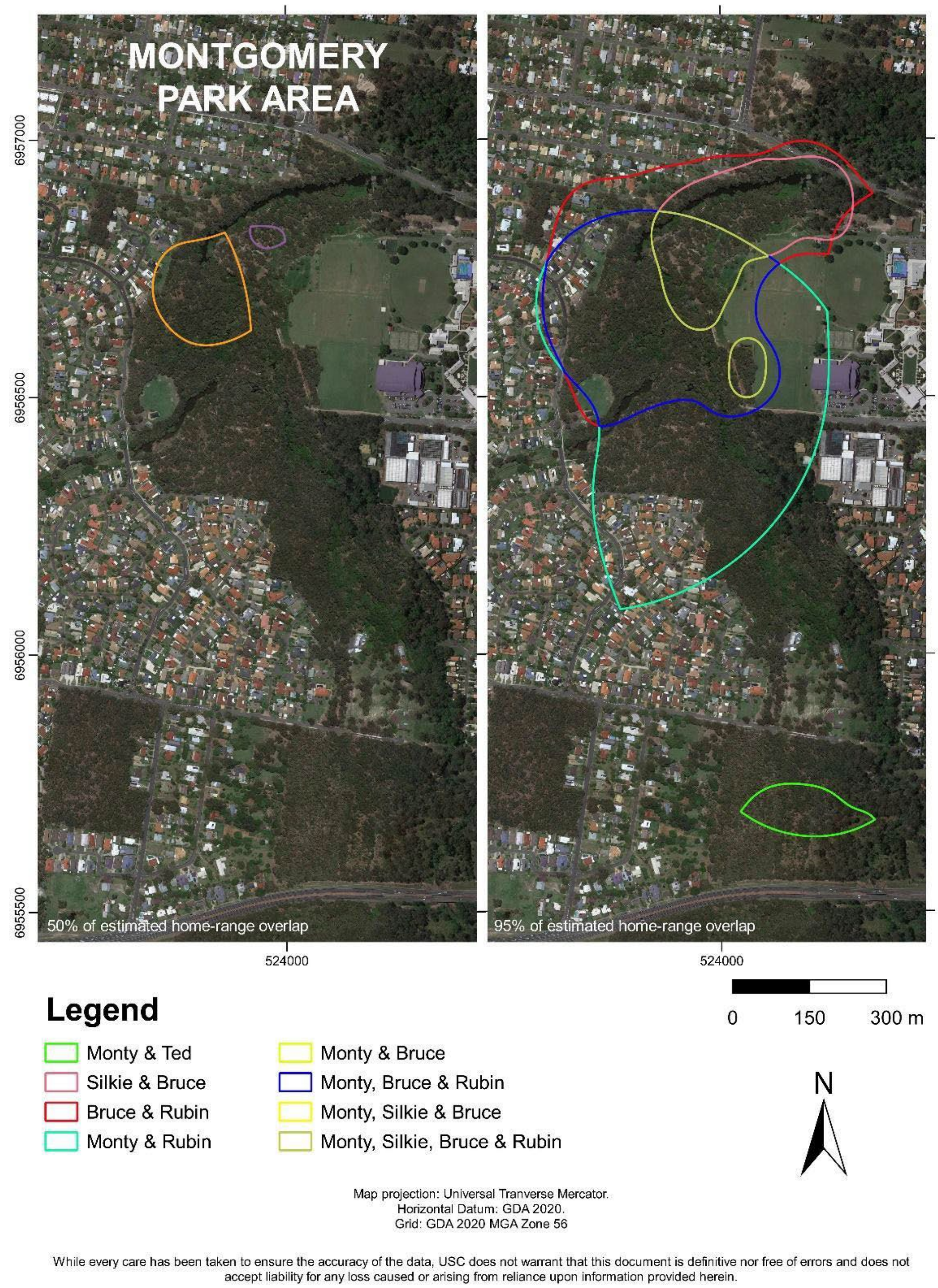


Figure 5. Overlap between individual home- and core-range (95% and 50% of estimated spatial range, respectively) in Montgomery Park area, Ormiston.

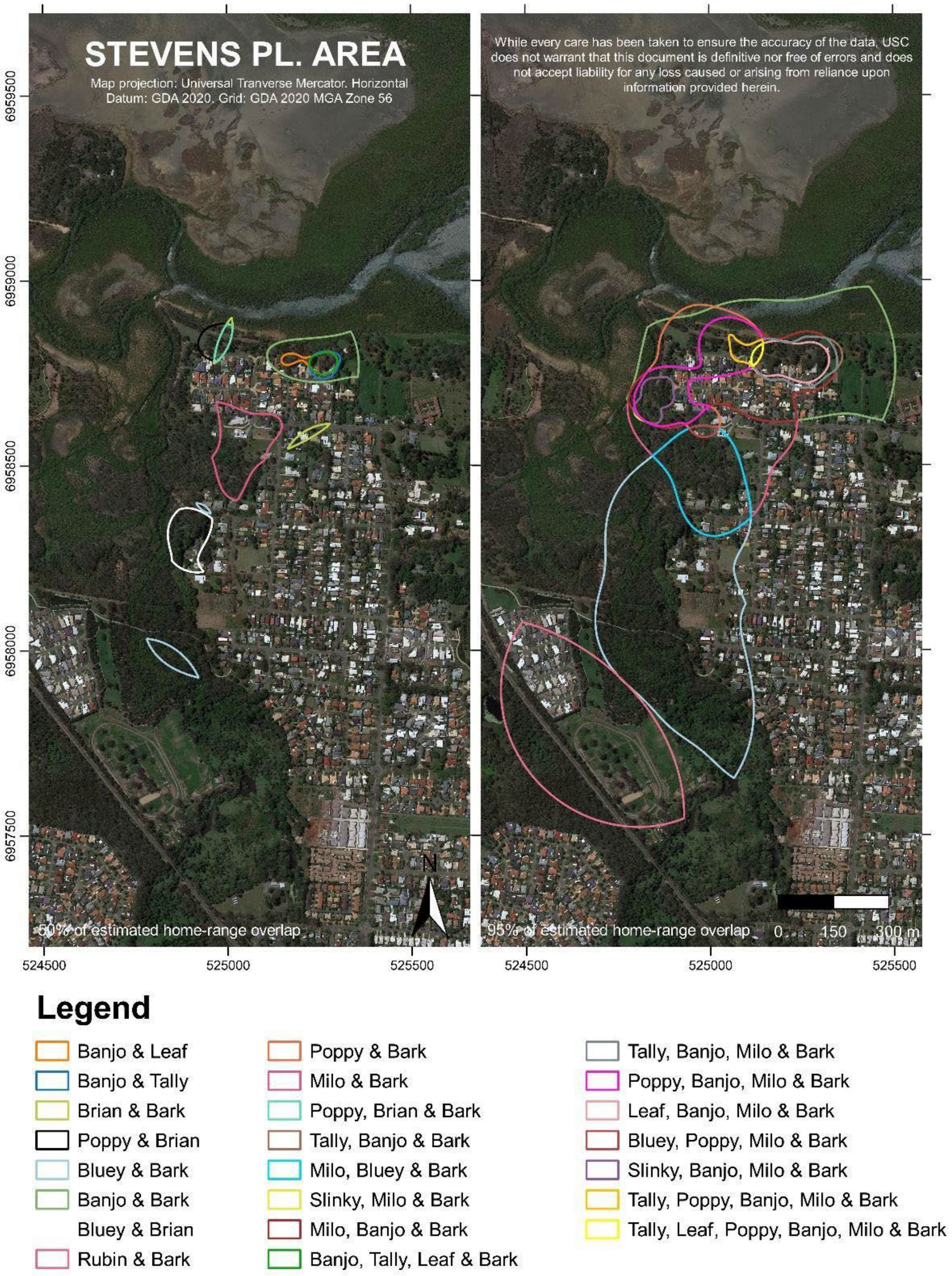


Figure 6. Overlap between individual home- and core-range (95% and 50% of estimated spatial range, respectively) in Stevens Place area, Ormiston.

3.2.3 Movement patterns and landscape protection to minimise threats

Of the koalas included in Table 5 (N = 27), none were involved in road accidents or attacked by dogs. It has to be noted though that we only attempt to recruit koalas into the program when safe to do so, which excludes almost all koalas along roadsides. This introduces a bias against koalas living in close proximity to roads and therefore would decrease our ability to detect road crossing. One female, Lulu, was killed by a train. Monitored koalas displayed a preference for conserved habitat (Figure 7), however 52% (N = 14) of the monitored koalas crossed roads to move between locations at least once (Figure 8) and 74% (N = 20) were recorded in residential yards at least once (after correcting for GPS error).

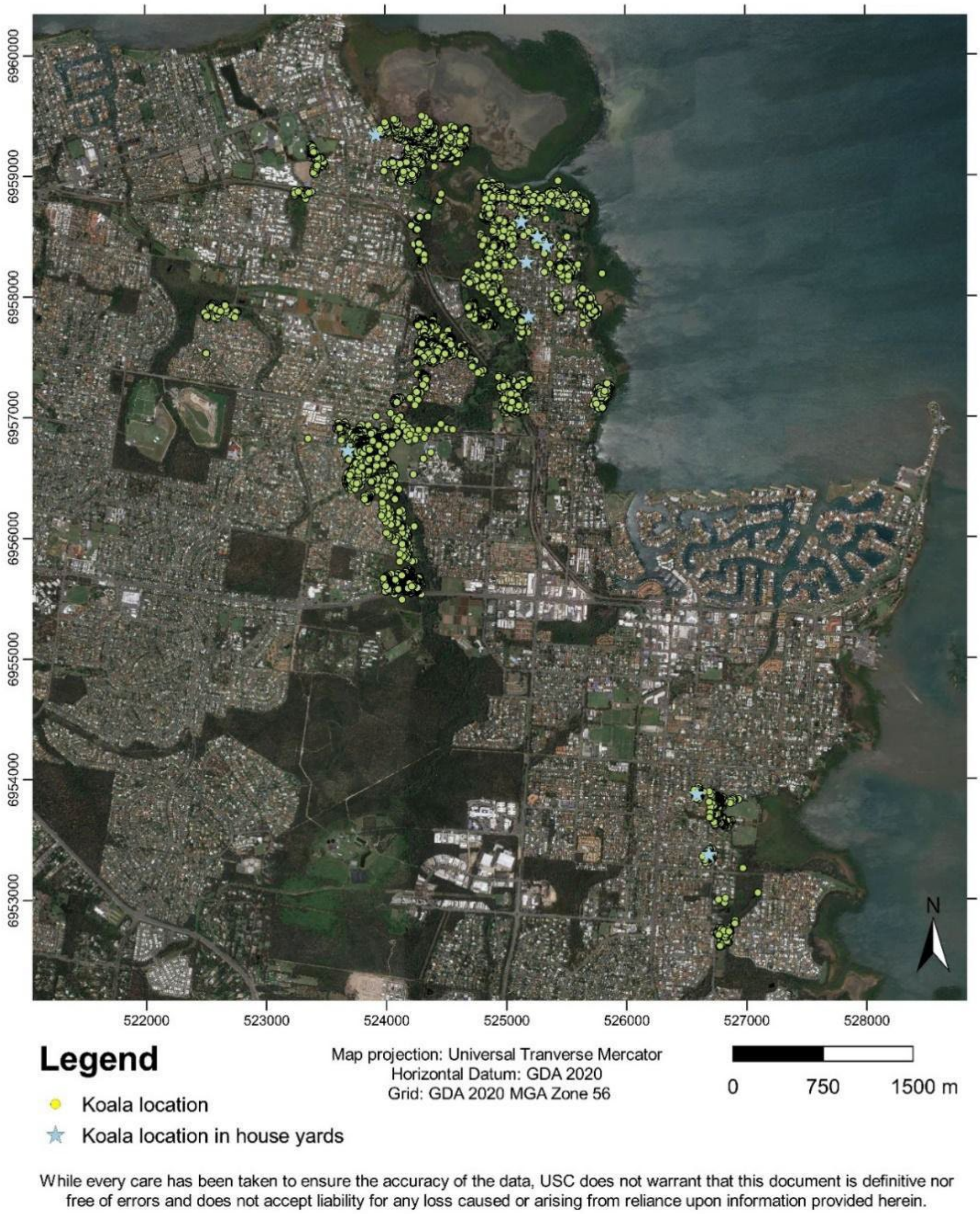


Figure 7. Spatial distribution of all koalas. The star symbol indicates examples of koala location in residential yard.

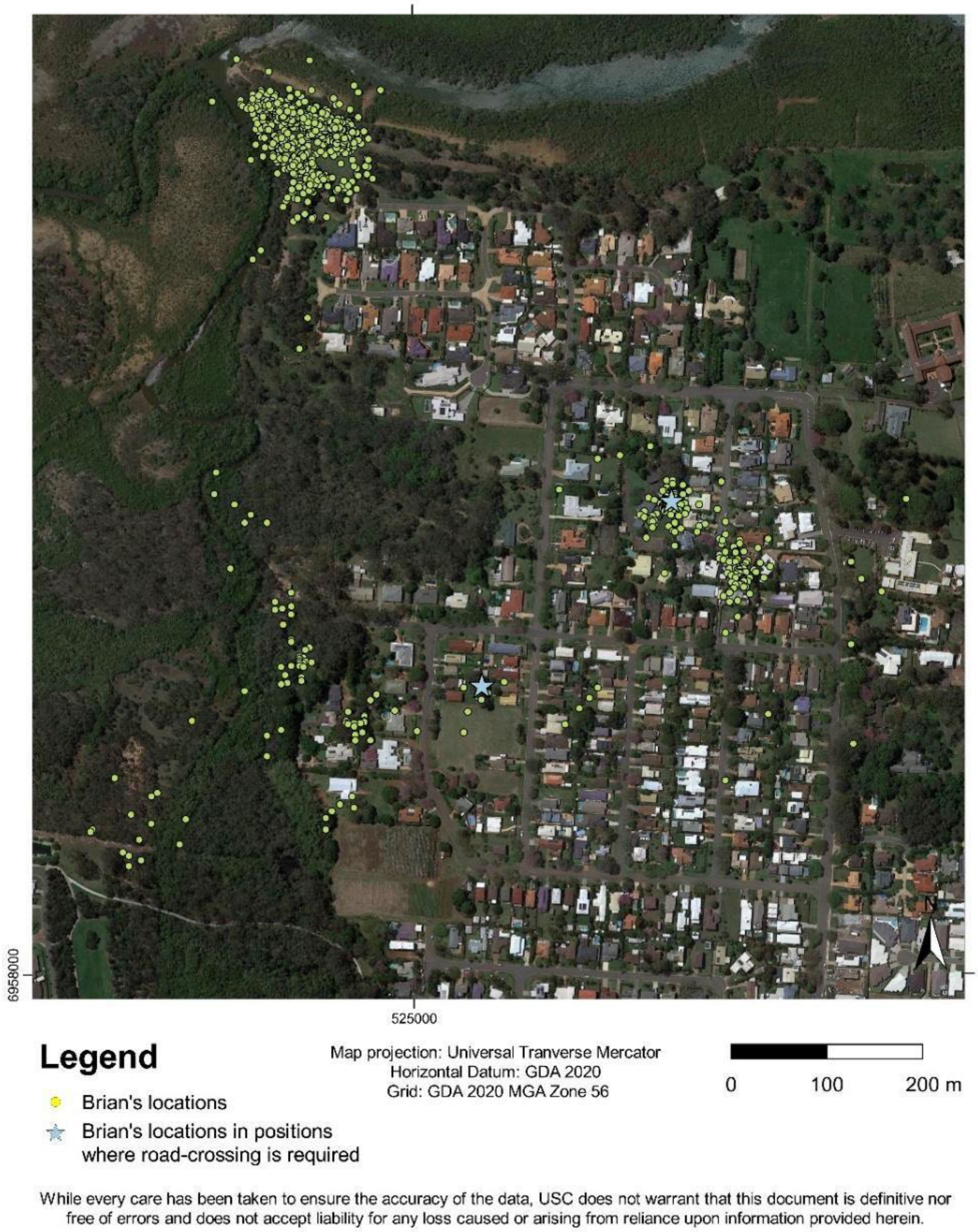


Figure 8. Example of koala locations in places where road-crossing was required.

3.3 Population health and koala veterinary exams

3.3.1 Veterinary exams

Since March 2019, a total of 42 koalas were captured within the KSN project area (some had multiple capture events). Each capture event was followed by a thorough veterinary examination by Endeavour Veterinary Ecology (EVE) or, if the koala was overtly sick at time of capture, it was transferred to Australia Zoo Wildlife Hospital (AZWH) for examination and treatment. Of the 53 veterinary examinations conducted by EVE until October 2020 (Appendix 2), 38 (72%) koalas were classed as “healthy” and 15 (28%) as sick or wounded. At initial capture, 24% required treatment and 24% were euthanised. Out of 33 koalas monitored, three died during monitoring period (mortality rate =9%). [Note: the number of koalas captured differs from the veterinary examinations due to some koalas having multiple examinations, and it also differs from the number of koalas monitored, which is the number of koalas released with some monitoring technology.]

Since June 2019, four individuals (Ted, Ember, Lackey and Bob) were transferred to Australia Zoo Wildlife Hospital (AZWH) for successful treatment of cystitis and successfully released back into the wild at their point of capture. Ember was accompanied by a healthy “back-rider” joey. Banjo was successfully treated by AZWH for nasal trauma, potentially sustained from a fight with another male koala.

Six captured koalas required euthanasia. A female, Pebbles, presented with a large mass in her forearm. The AZWH diagnosed this as severe lymphoedema and attempted surgery, however the tumour grew back aggressively and she was euthanised. Her joey, River, was placed into care and released in March 2020 (River was not fitted with a collar, just a Bluetooth ear tag). Another female, Olive, presented with weeping and cloudy eyes. She was diagnosed by AZWH as blind, with reproductive disease, unable to be released back into the wild and was euthanised. Daisy was diagnosed by EVE as having leukemia and, considering her poor welfare prognosis, she was euthanised. Daisy’s joey, Sir Derek, was placed into care and is now in the plantation at AZWH practicing climbing prior to release back in the wild. Cariad, Summer and Banjora were transferred to AZWH with bilateral reproductive disease, bursal cysts and poor body condition and were also humanely euthanised.

Three monitored koalas were found dead in the wild. A 6.5 years old male, Lucky, was found dead during scheduled radio-tracking on the 5 May 2019. A necropsy by EVE determined the cause of death as disease, with a possible contribution of poor weather and partial entrapment in natural structures (misadventure) (EVE Necropsy Report, page 3). A 2.5 years old female koala, Lulu, who was healthy (as per her body condition and weight post-mortem measurements), with normal behaviour observed two days prior to her death, was reported hit and killed by a train by Queensland Rail staff on the night of Sunday 7 July 2019. Her body (and that of her 6-7-month-old dependent joey) were recovered by a wildlife rescuer that evening. We collected Lulu's corpse and collar on 9 July. The koala's body condition score was rated as 6 (fair), same as her initial veterinary examination, and body weight was 5.7 kg (apparent weight gain since capture). She was considered to be in good health immediately prior to being killed by a train while crossing the tracks. A 4 years old female, Poppy, was found dead on the 22 January 2020, also during scheduled radio-tracking. The corpse had already decomposed so a necropsy was not possible.

3.3.2 Welfare checks

Radio-tracking has continuously been performed at least once or twice monthly for welfare checks of all collared koalas. Currently, 13 koalas are monitored. A total of 445 records have been collected and reported in Appendix 3. Disease symptoms were noticed during radio-tracking for Poppy, Banjo, Tally and Summer (percent of sick koalas out of radiotracked koalas = 12%). A total of 15 joeys were recorded (one from Daisy, one from Ember, one from Leaf – who is currently carrying a new joey –, one from Lulu, three from Kimo, one from Pebbles, one from Poppy, one from Rainbow, two from Silkie, one from Summer, one from Tally, and one from Uka). Two koalas were found dead during routine welfare checks.

3.1 Genetic Analysis

3.1.1 Scat survey results

From detection dog surveys conducted in Ormiston between 20 March - 1 of May 2019, the Detection Dogs for Conservation team collected 68 samples (Figure 11). DNA was successfully extracted in-house from a total of 66 fresh koala scat samples – including collared koalas. DNA samples were filtered to remove duplicates, confidently identifying 29 individuals. From these individuals, we identified 15 males and 14 females (Figure 9). We also detected seven cases of Chlamydia in scats versus 22 cases where no Chlamydia was detected (Figure 10). All samples collected in 2019 were incorporated into the Redlands Genetic Dataset from 2018 and will be compared with samples collected during 2020/2021.

Figure 9. Stars indicate individual koalas identified by genetic analyses from scats found with detection dogs during surveys for Ormiston from March 2019 – May 2019

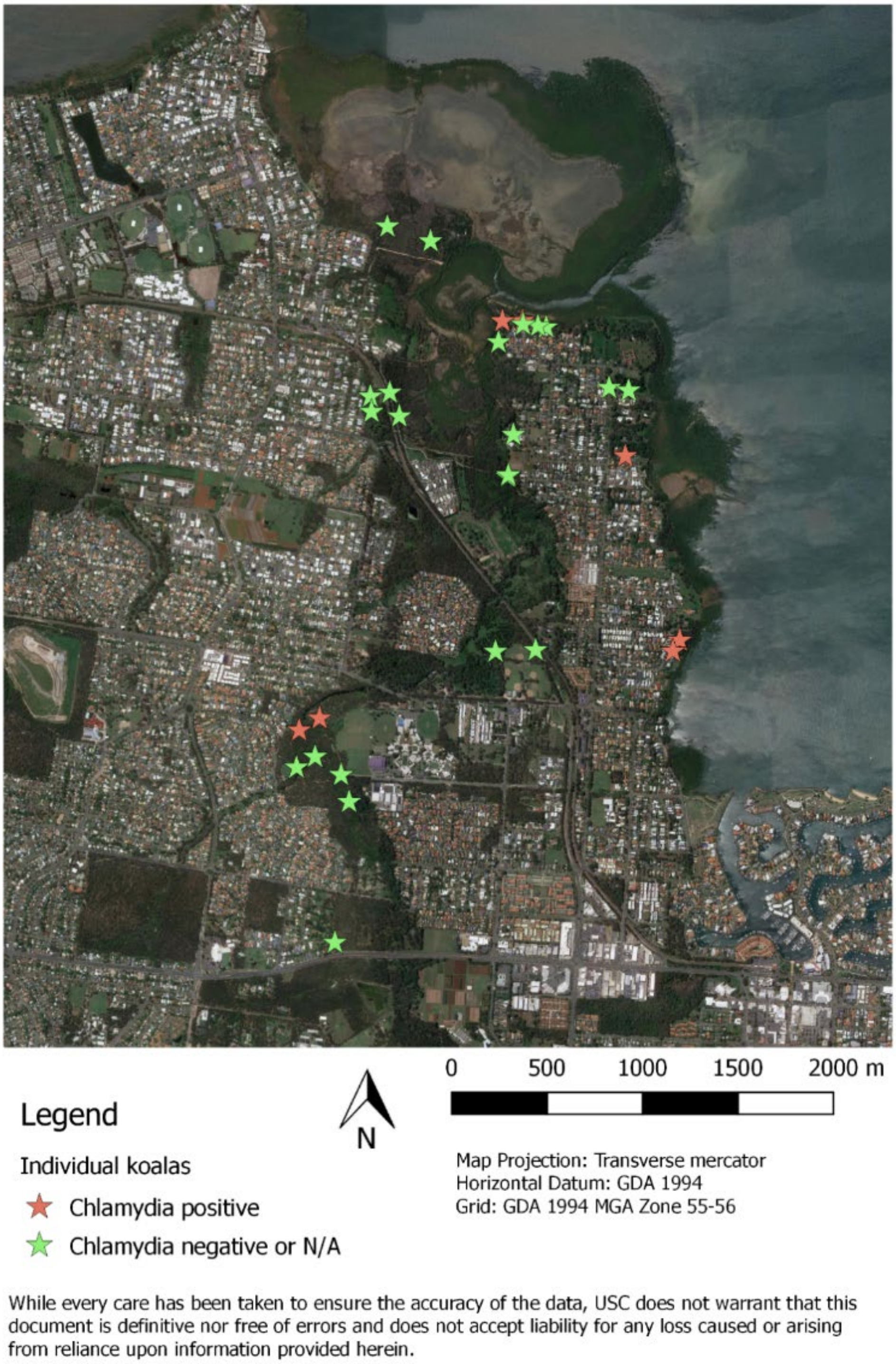


Figure 10. Presence of chlamydia tested in scats found during detection dog surveys in Ormiston from March 2019 to May 2019

From the 34 detection dog surveys conducted in Birkdale, Thornlands and Mount Cotton between the 18 December 2019 and 20 March 2020 (Figure 11), we collected 48 genetic samples (Figure 12) - 16 samples in Birkdale, 23 samples in Thornlands and nine samples in Mount Cotton (Figure 13-15). There were also three incidental koala sightings (Figure 16).

All genetic samples were subsequently filtered to remove duplicates, confidently identifying 31 individuals. Of those individuals, nine were identified in Birkdale, 16 individuals in Thornlands and six individuals in Mount Cotton (individuals are colour coded in Figure 13 - 15).

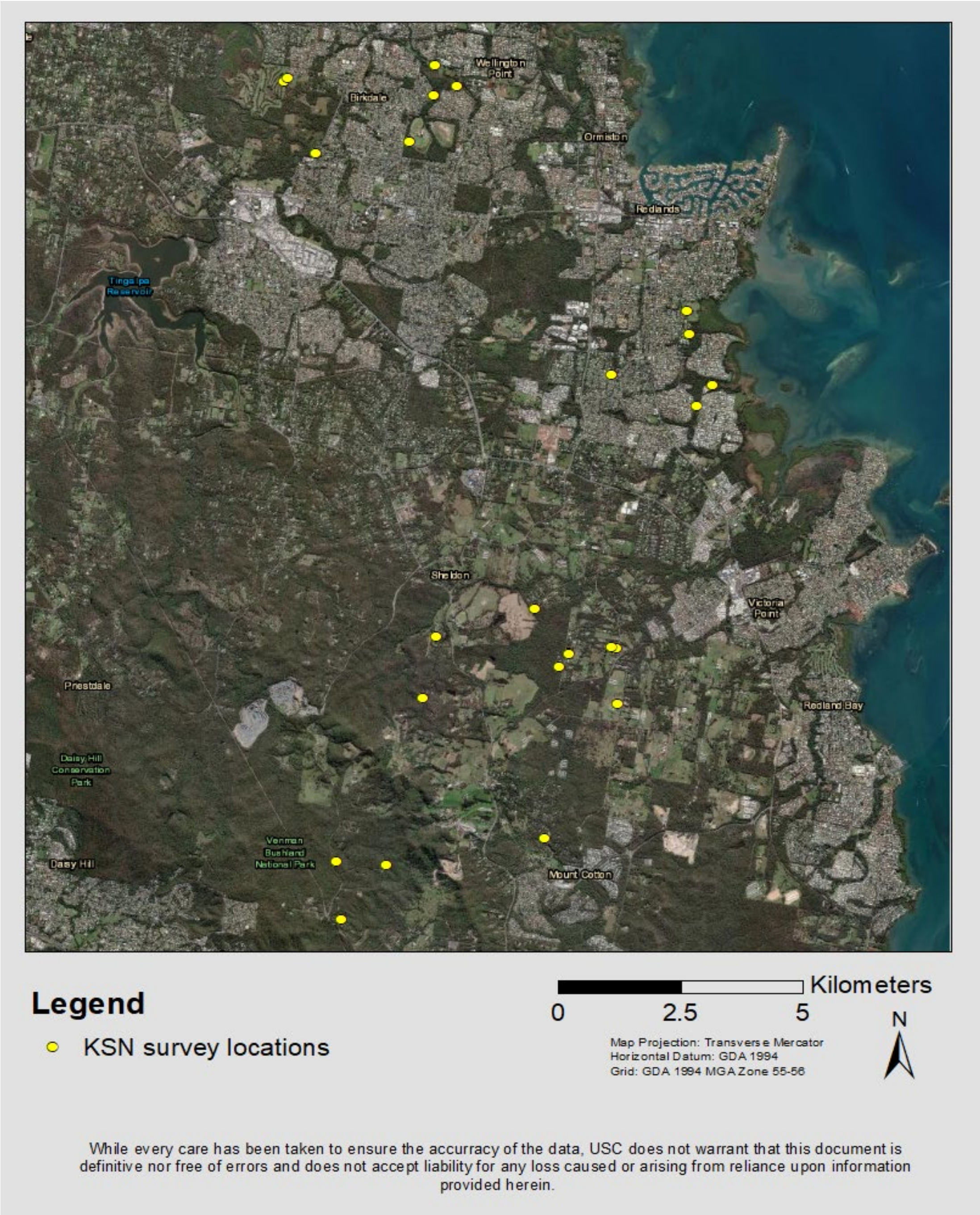


Figure 11. Survey start locations conducted with DDC fresh scat detection dogs in Birkdale, Thornlands and Mount Cotton between 18 December 2019 and 20 March 2020.

Figure 12. Location of fresh scat samples found using fresh scat detection dogs for genetic analyses across candidate KSNs.

Figure 13. Each colour represents individual koalas identified from genotyping fresh scats in Birkdale.

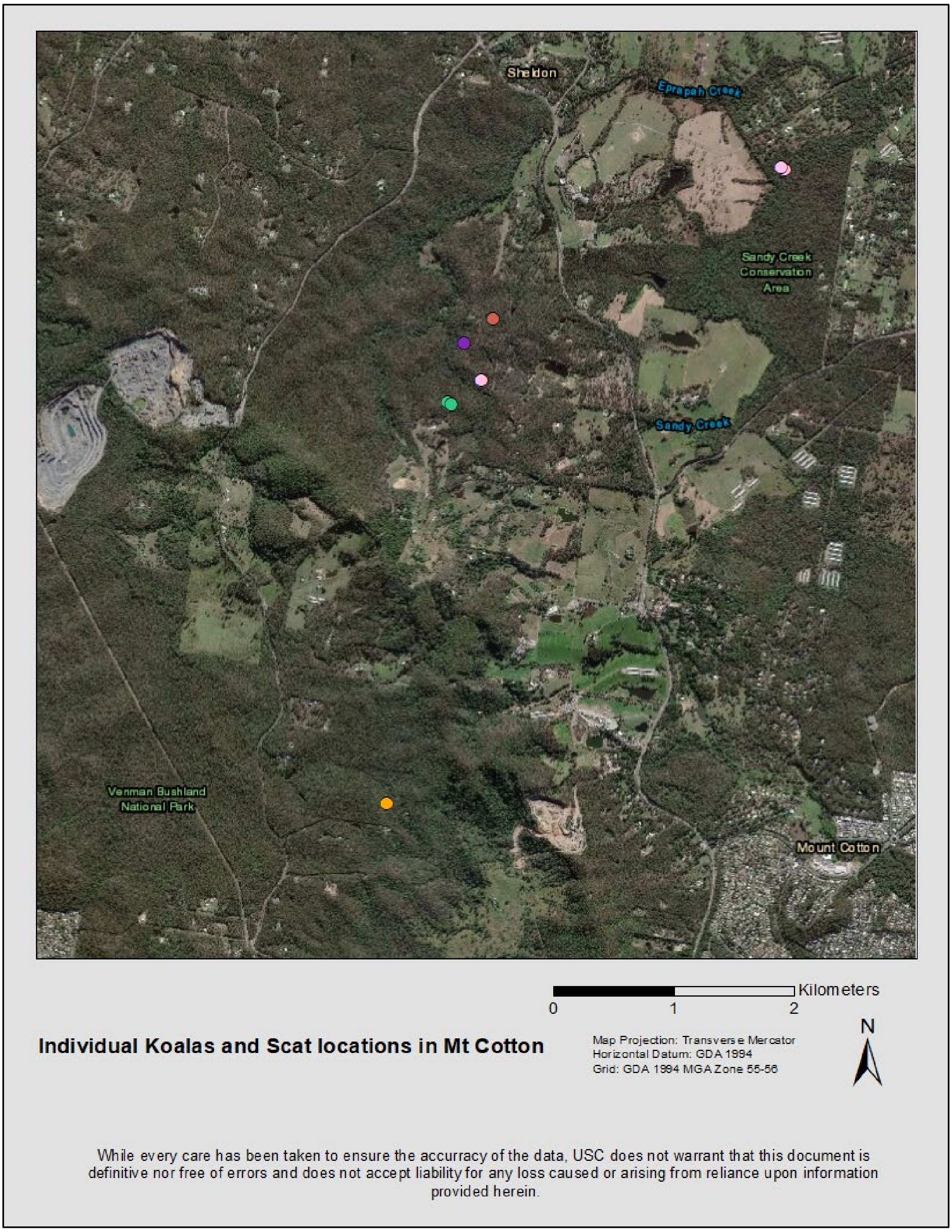


Figure 14. Each colour represents individual koalas identified from genotyping fresh scats in Mount Cotton.

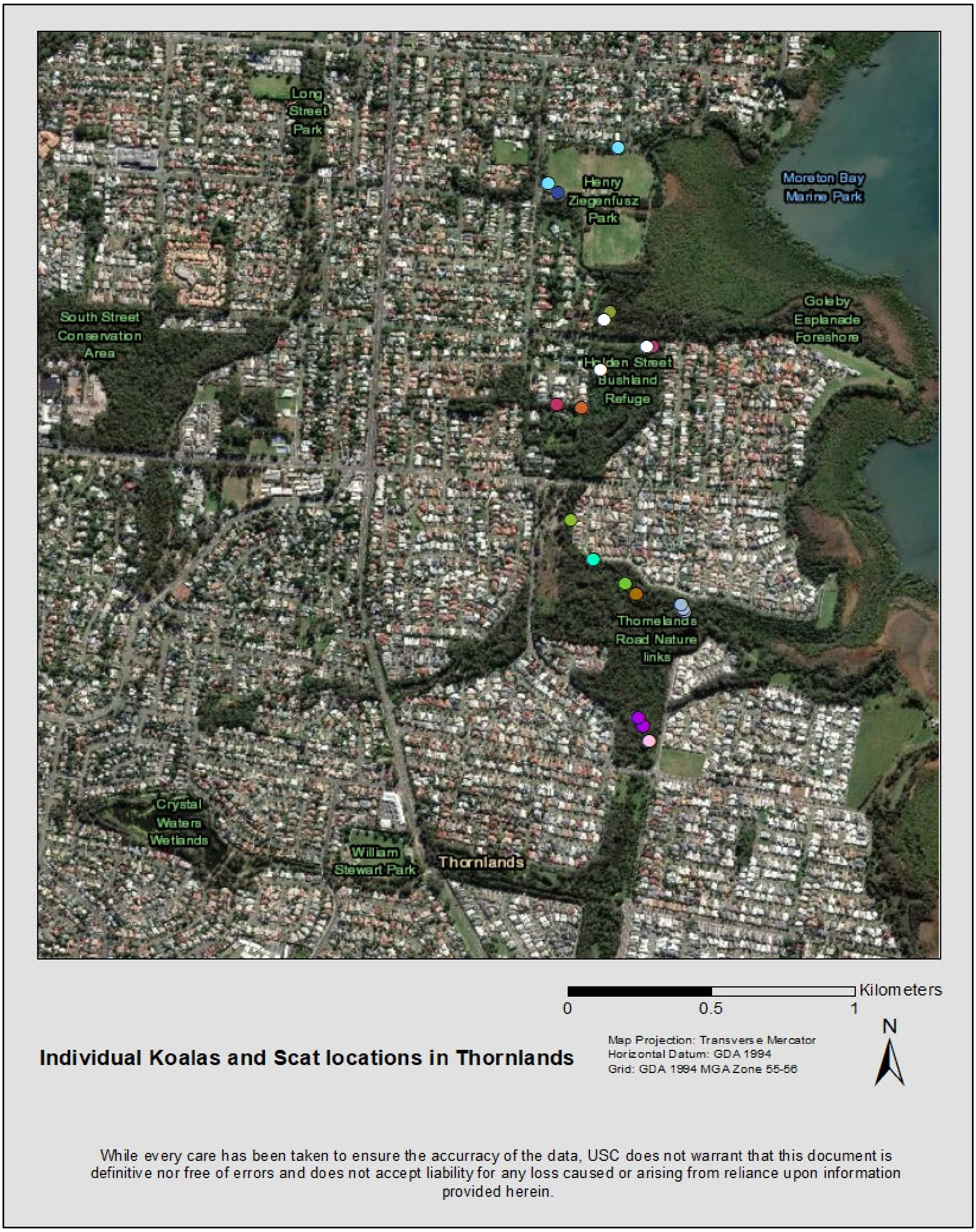


Figure 15. Each colour represents individual koalas identified from genotyping fresh scats in Thornlands.

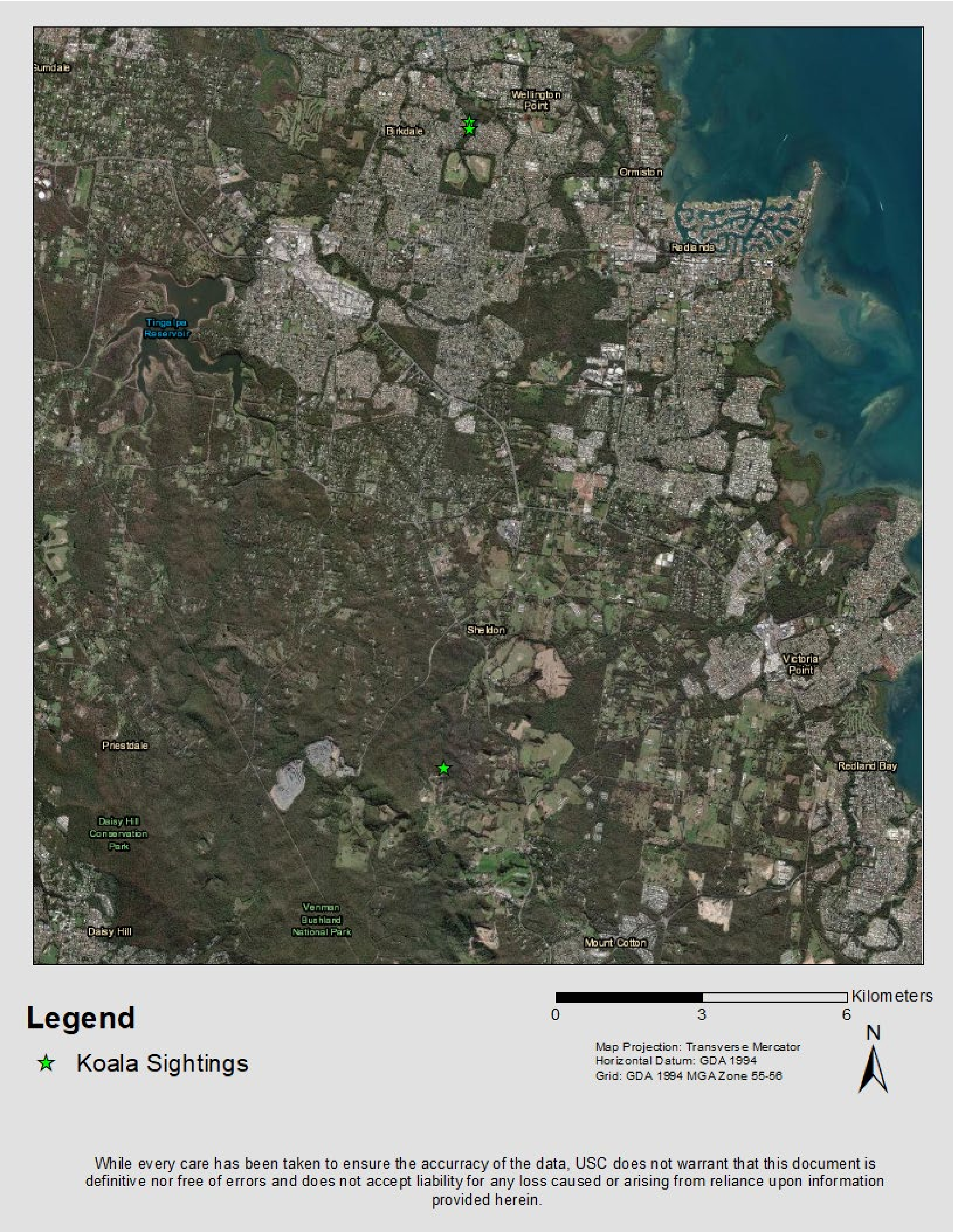


Figure 16. Koalas sighted during koala scat surveys.

3.2 Community Engagement

Community engagement was severely impacted by regulations and restrictions, including gatherings and social distancing, linked to COVID-19. The current situation still does not encourage social interactions, so engagement activities have been avoided.

However, whenever safe and possible, the Detection Dogs for Conservation team engaged in conversation about koala conservation with members of the public. Brochures of the Redlands 24hr Wildlife Rescue Service were shared, and three workshops were attended. We have provided the Redland City Council with information, images and videos that were posted in social media (Figure 17).

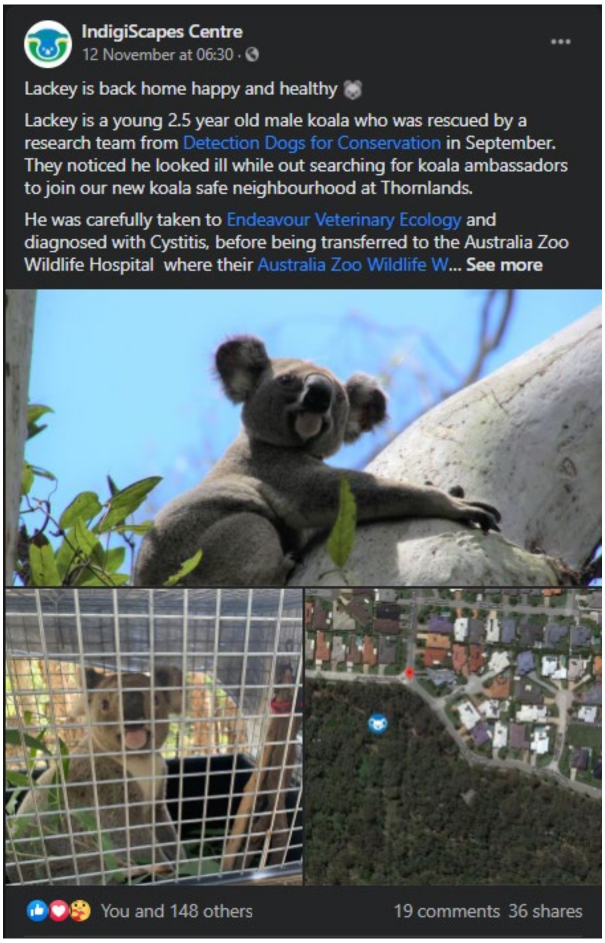


Figure 17. Social media post including information provided by the Detection Dogs for Conservation team (https://www.facebook.com/IndigiScapes on the 12 November of 2020).

Bluetooth ear tag details were shared with trusted members of the public (five local koala enthusiasts in Ormiston). These are strong supporters of the projects who frequently observe koalas during their walks or in their own backyard.

The Detection Dogs for Conservation team was approached to deliver a presentation at the Redlands College. The Detection Dogs for Conservation team provided koala info and a conservation message while Griffith University created an animation to speak to the message.

4. Project Progress Discussion

Koala monitoring

The duration of monitoring and data sampling interval of each koala is variable due to the trade-off between duration and sampling intensity of the different technology fitted to the koala collars. Additionally, all GPS collars are fitted with a safety weak link that breaks in case of entanglement or as a result of rough interactions (e.g. male koalas fighting). This results in shorter collared monitoring periods than intended for some koalas, as does any technical faults with individual collar devices. Although this poses some difficulty in comparative data analyses and places additional pressure on the project budget (additional search and capture required), it has successfully achieved its primary goal of ensuring zero collar-related incidents amongst all monitored koalas.

Eight different technologies – including the use of three different GPS devices, solar-powered Bluetooth ear tag, VHF beacon, drone acquired thermal imagery, visual spotting, detection dogs and genetic analyses - have been deployed to meet project deliverables. The use of multiple methodologies has increased DCC's efficiencies in locating and tracking koalas, the collection of scats for genetic analyses, monitoring koala welfare and ensuring appropriate veterinary examination and treatment as required.

From all technology deployed, the solar-powered Bluetooth ear tag will be the most important for transitioning to a citizen science program. The technology is highly accessible, providing a potential means for any community member with a smartphone to identify tagged koalas sighted in the wild, gain access to the koala's background information, be presented with locally relevant conservation messages, educated on danger signs indicative of possible injury or sickness and provide local wildlife rescue contact details, and, with the simple press of a button, be able to upload scientifically valuable data related to their sighting to all relevant databases. Given this, we highly recommend that the next steps moving forward are to complete final field testing of a robust weather-proof and koala-proof design, develop a custom smartphone app and linked database to interact with the Bluetooth ear tags and investigate commercial mass production of the Bluetooth ear tag to minimise cost per unit and maximise deployments in urbanised koala habitat via wildlife hospitals and koala carers.

Koala habitat utilisation

This project has followed the movement of 33 koalas in Birkdale, Ormiston, Thornlands/Cleveland, and Wellington Point over almost 15 months. This has enabled us to document dispersal events of young male koalas as well as other movement behaviours.

Males were found to have a mean home-range area 6 times larger than females and a core-range 8 times larger than females (but note that each individual was tracked for a different amount of times). These findings are congruent to population structure and social behaviour of koalas. Adult females tend to be more sedentary and occupy areas smaller than males (Thompson, 2006; Gonzalez-Astudillo, 2018). This behaviour also decreases seasonal variations of females' spatial distribution. The mean female home-range recorded in this study (5 ± 4 ha) fits the expected range for female koalas in South East Queensland, from 5 to 9 ha (Thompson, 2006). Adult males also tend to be relatively sedentary, but juveniles usually disperse before their first breeding season (Dique et al., 2003c; Thompson, 2006). The observed male home-range areas are larger than past reports of urban koala populations in New South Wales using 95% Fixed Kernel distribution (Goldingay & Dobner, 2014), but congruent to results found by Oliveira et al. (2014) in Ormiston, Redland City. Home-ranges in this study mainly encompassed remnant vegetation and relatively well conserved habitat. Only Brian and Milo have part of their core-range in urban areas not contiguous to remnant vegetation. This pattern is similar to what was observed by White (1999) and Oliveira et al. (2014).

Home-range overlaps were identified in this study (Figure 4 - 6). Between two and five koalas partially shared the same habitat. Core-range areas also overlap, but in fewer cases, potentially due to food resource limitation and dominance behaviours. In higher density areas, overlaps are more likely to occur (Mitchell, 1989), mainly between males and females. For example, at least five koalas were recorded using the parkland at Stevens Place, Ormiston, as part of their core-range. The area is characterised by the presence of good quality food resources, such as mature blue gum trees (*Eucalyptus tereticornis*) and tallowwoods (*E. microcorys*), enhanced by additional tree-plantings. Similar results were found in the Toondah Harbour area – a fragmented area encompassing single food trees, streets, residential properties, council parks, exotic vegetation, and diverse urban infrastructure – where at least 10 resident koalas partially shared the same habitat (de Villiers et al., 2019). Both studies underline the existence of areas of high use where the continued presence of even single food trees seems critical to sustaining a local koala population.

Another aspect of koala ecology witnessed in this project is dispersal. A 15 month-old male koala, Bark, was released to Stevens Place, Ormiston, in July 2020 after being in care. The area is known habitat for numerous other koalas (see Appendix 1). After release, Bark remained in Stevens Place for almost one month until Banjo, a 6 year-old male, challenged his continued presence. They were recorded in the same tree twice and locals living in the area reported fighting during the night. On the night of the 16 August 2020, Bark moved to an area near Rose Street, approximately 900 m from Stevens Place, where he resided for another month and was sighted, not exclusively, in house yards with medium size dogs ranging freely. On the 13 September, he dispersed to Gloucester Street, and then on to Bibury Street Park, a distance of 1.7 km from his release location, where he has currently settled (Figure 18). On the 26 October, Bark was sighted in the same tree as a female koala, potentially looking for a mate during the breeding season. This sequence of events highlights important issues for koala conservation: the dominance of some males (Ellis et al., 2002a); dispersal of young koalas (Dique et al., 2003; Ramsay, 2017); importance of habitat connectivity allowing dispersal and therefore gene flow (Fowler et al., 2000; Lee et al., 2010); temporal variance of home-ranges (Rus, 2020); threats that urban areas pose to koala survival (Dexter et al., 2017; Whisson et al., 2020); and the importance of community engagement so that threats can be mitigated.

Even though none of the koalas monitored in this study have been involved in vehicle or dog incidents, more than 70% were recorded in house yards at least once and more than half crossed roads at least once. Dexter et al. (2017), in a study with 51 koalas, observed that 35% crossed roads. Both studies indicate that koalas move through non-suitable parts of the landscape (e.g. yards with dogs, roads). These movement patterns and habitat choices pose a threat to koala survival in urban environments (Dique et al. 2003; Dexter et al., 2017). Young males are the most vulnerable group due to their dispersal behaviour (Dexter et al., 2017; Gonzalez-Astudillo, 2018). According to the Koala Hospital Data Form provided by the Queensland Government (https://www.data.qld.gov.au/dataset/koala-hospital-data, accessed in 23/09/2020), in Ormiston, between 1997 – 2015, 81 cases of dog attack were recorded and 41 were fatal (50%). Vehicle strikes also represent a deadly hazard to koalas. Based on the same dataset, in Ormiston, between 1997 – 2016, 432 accidents were recorded and 226 were fatal (52%). It is clear that koala conservation programs within urbanised habitats will only achieve successful outcomes if they factor in fine-scale koala movement behaviour and provide a means to mitigate urban threats.

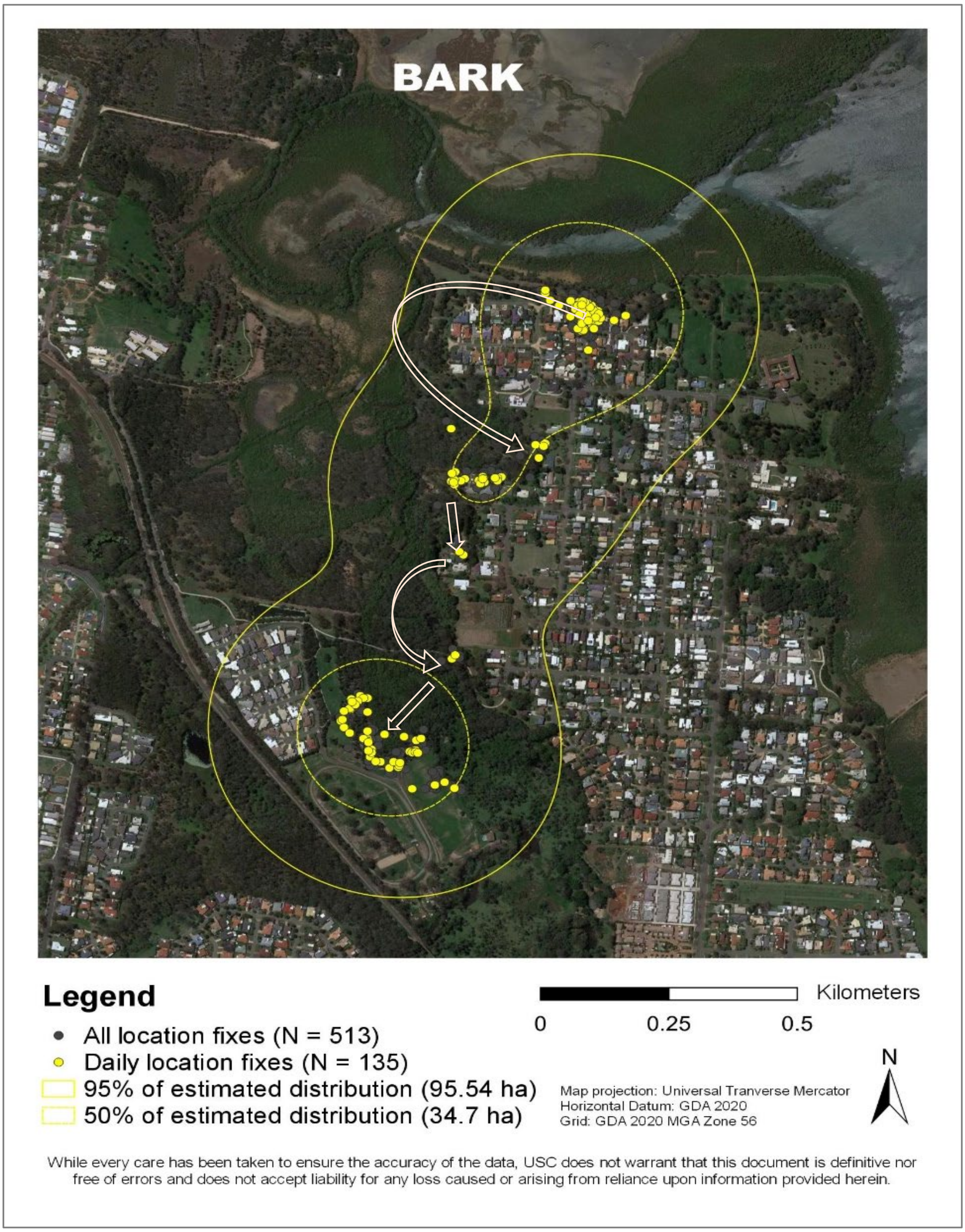


Figure 18. Home- and core-range of Bark, a young male koala released in Ormiston. The arrows indicate a possible pathway that of Bark dispersal.

Health assessment

Of the 53 veterinary examinations conducted until October 2020, the most common detected disease was Chlamydiosis. Approximately a third of the exams diagnosed the koala as sick or injured (28%). Four individuals were euthanised (chlamydia and cancer). Two koalas were found deceased during the welfare checks, one koala and joey were killed by train.

A genetic study conducted by DDC in (2018), concluded that 28% of the sampled koalas in the Redlands mainland tested positive for Chlamydia. This result is similar to what has been observed in the current projects. However, this correlation must be carefully interpreted because the numbers observed in 2019 and 2020 are not restricted to chlamydiosis and include injuries. Nonetheless, both findings reinforce the need to understand and develop ways to protect koala populations from diseases, especially by early identification of symptoms.

Usually, chlamydiosis is treated with antibiotics and potential vaccines are also being trialled (Philips, et al., 2019). Vaccines have shown positive effects in mild ocular Chlamydia disease and are not affected by antibiotics if applied during urogenital disease treatment (Philips et al., 2020). Several research programs and organisations, including the Currumbin Wildlife Hospital and the Endeavour Veterinary Ecology clinic, are trialling anti-chlamydia vaccines, therefore more results on vaccine efficacy will be available in the future.

Genetic Analysis

Detection dogs were used to collect 116 koala scat samples across the four the Koala Safe Neighbourhoods between March 2019 and November 2020. DNA has successfully been extracted from most of the samples and, after filtering and removing duplicates, 60 individuals were confidently identified. However, the number of individuals is not enough to deliver a robust genetic analysis for each KSN at this time (most software would require > 20 samples per KSN). Thus, all genetic information acquired during the development of the Koala Safe

Neighbourhoods projects will be pooled together with samples collected across the Redlands mainland from the 2018 and 2020 targeted genetic surveys. The continued sampling across the city over the past two years has allowed for greater certainty of the genetic characteristics of the Redland's koala population.

Future steps and management considerations

All recommendations in the Redlands Coast Koala Population and Genetic Assessment report (2018) are still valid.

In addition, we believe that the Redland City Council could:

- Assure the protection of koala food trees, especially where koala presence is known. We strongly advise planting additional locally native trees in urban regions to increase the availability and variability of habitat.
- Increase the number of Koala Safe Neighbourhoods in the next years to achieve the involvement of citizens across more neighbourhoods, with the aim to increase the general awareness and support for koala conservation across RCC.
- Continue to use and develop different technologies to improve koala monitoring. The solar-powered Bluetooth ear tag is proving successful at engaging locals in the ongoing monitoring of specific koalas. Ongoing development and funding avenues should be explored.
- Enhance ecological corridors and protect koala habitat from further fragmentation to minimise threats, especially from road-crossings and dog attacks.

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6. Appendices

Appendix 1: Individual home- and core-range of the monitored koalas

Banjo

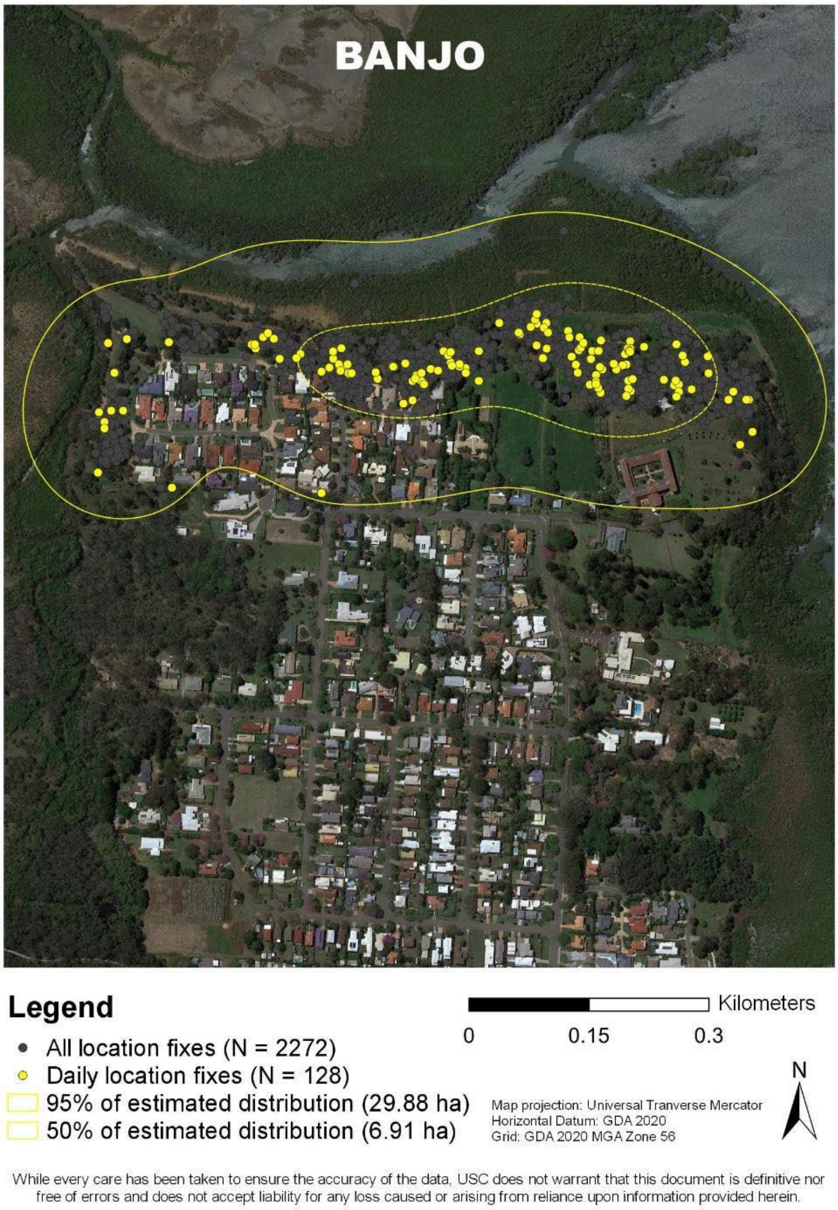

Figure 19. Home-range (95%) and core-range (50%) of the koala named "Banjo". Suburb: Ormiston.

Bark

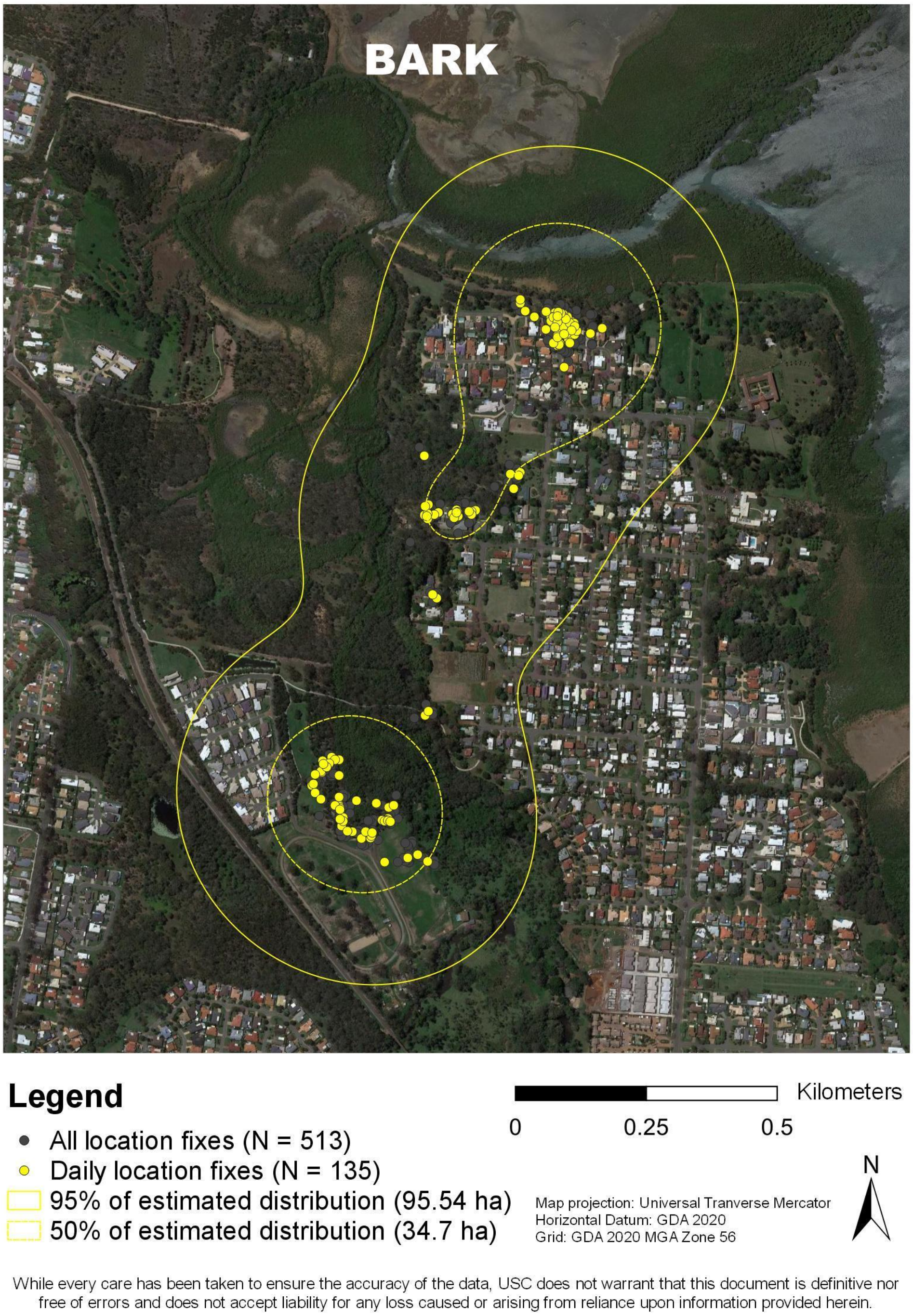

Figure 20. Home-range (95%) and core-range (50%) of the koala named "Bark". Suburb: Ormiston / Wellington Point

Bilbo

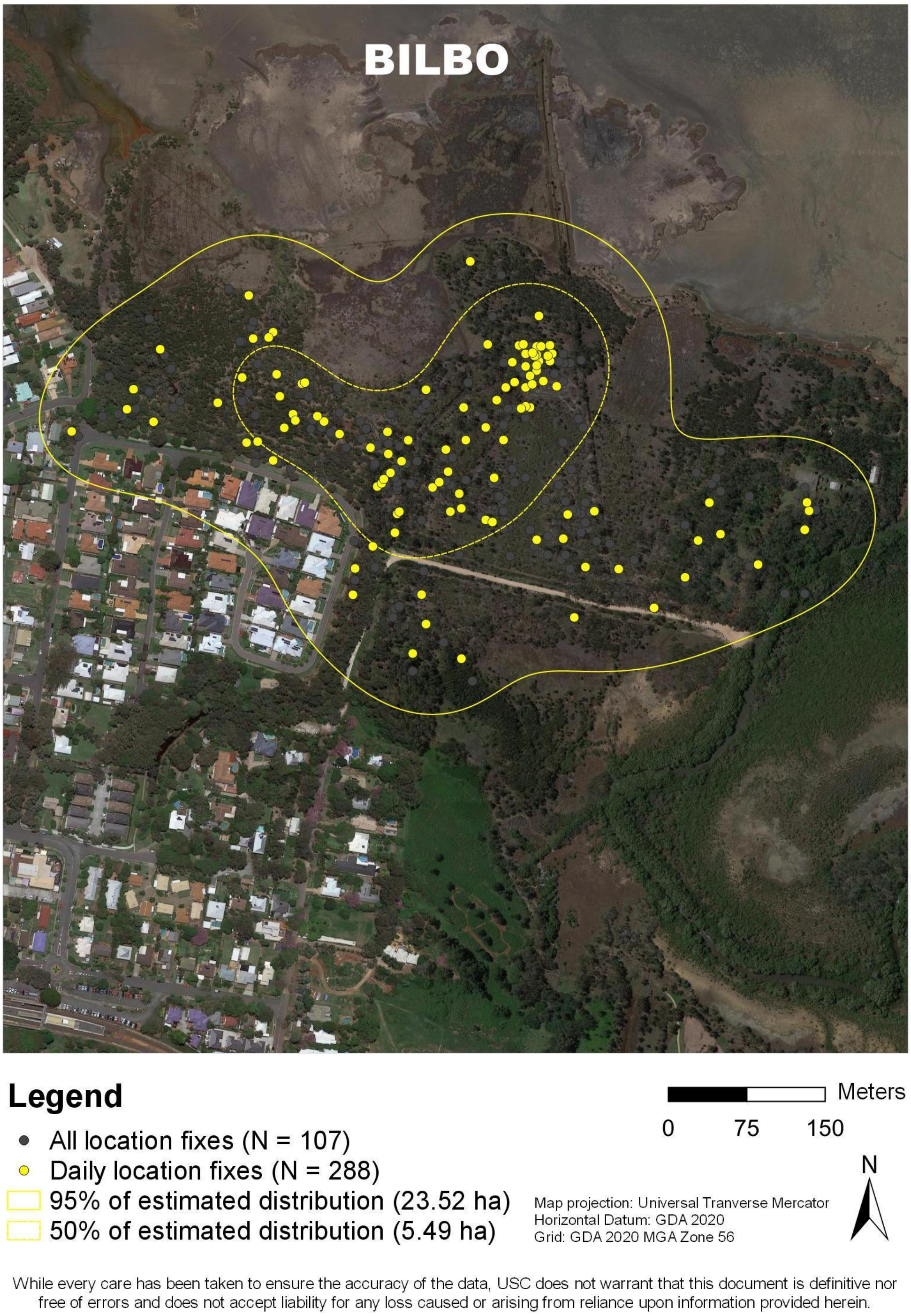

Figure 21. Home-range (95%) and core-range (50%) of the koala named "Bilbo". Suburb: Wellington Point

Blake

Figure 22. Home-range (95%) and core-range (50%) of the koala named "Blake". Suburb: Thornlands.

Bluey

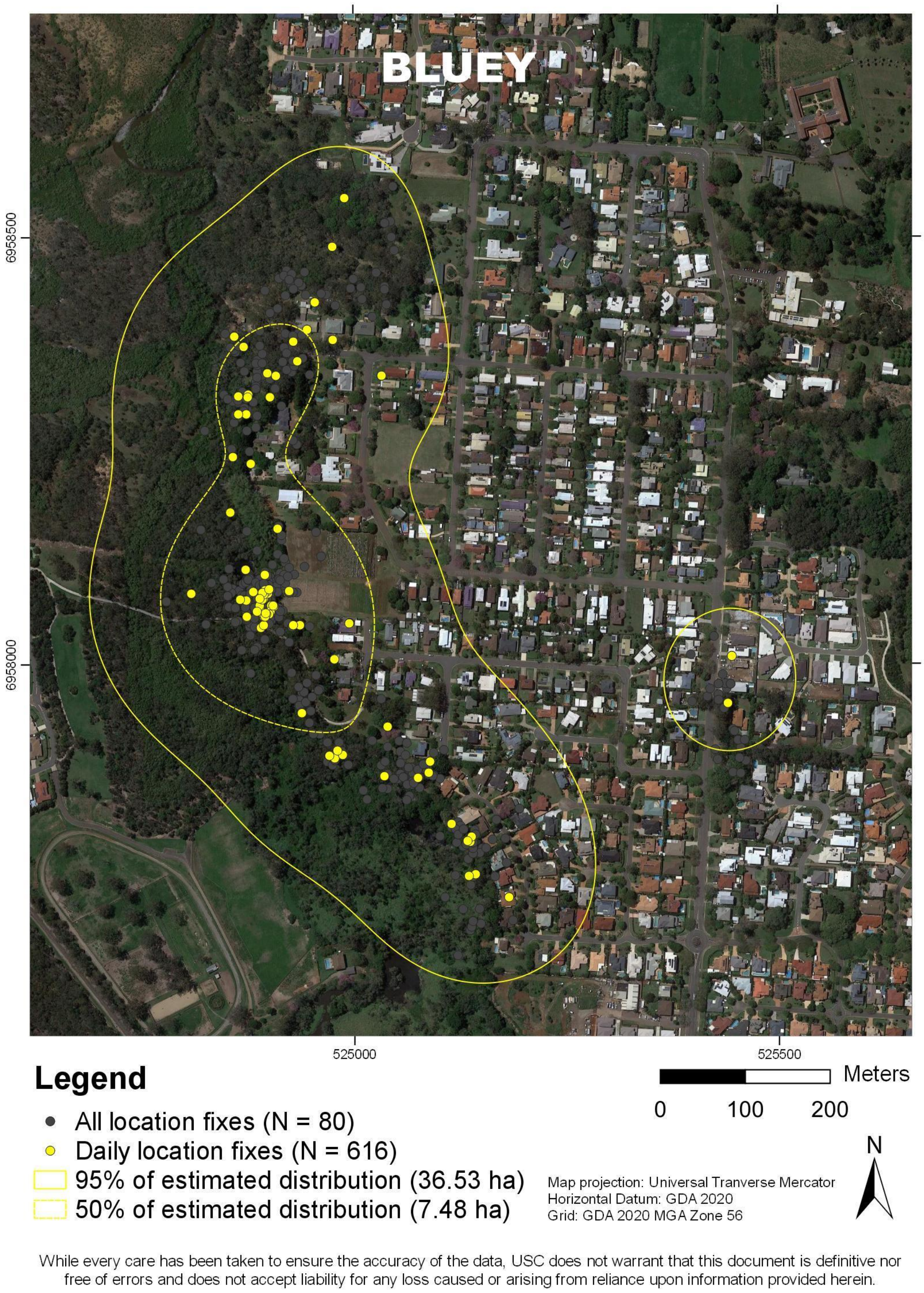

Figure 23. Home-range (95%) and core-range (50%) of the koala named "Bluey". Suburb: Ormiston.

Brian

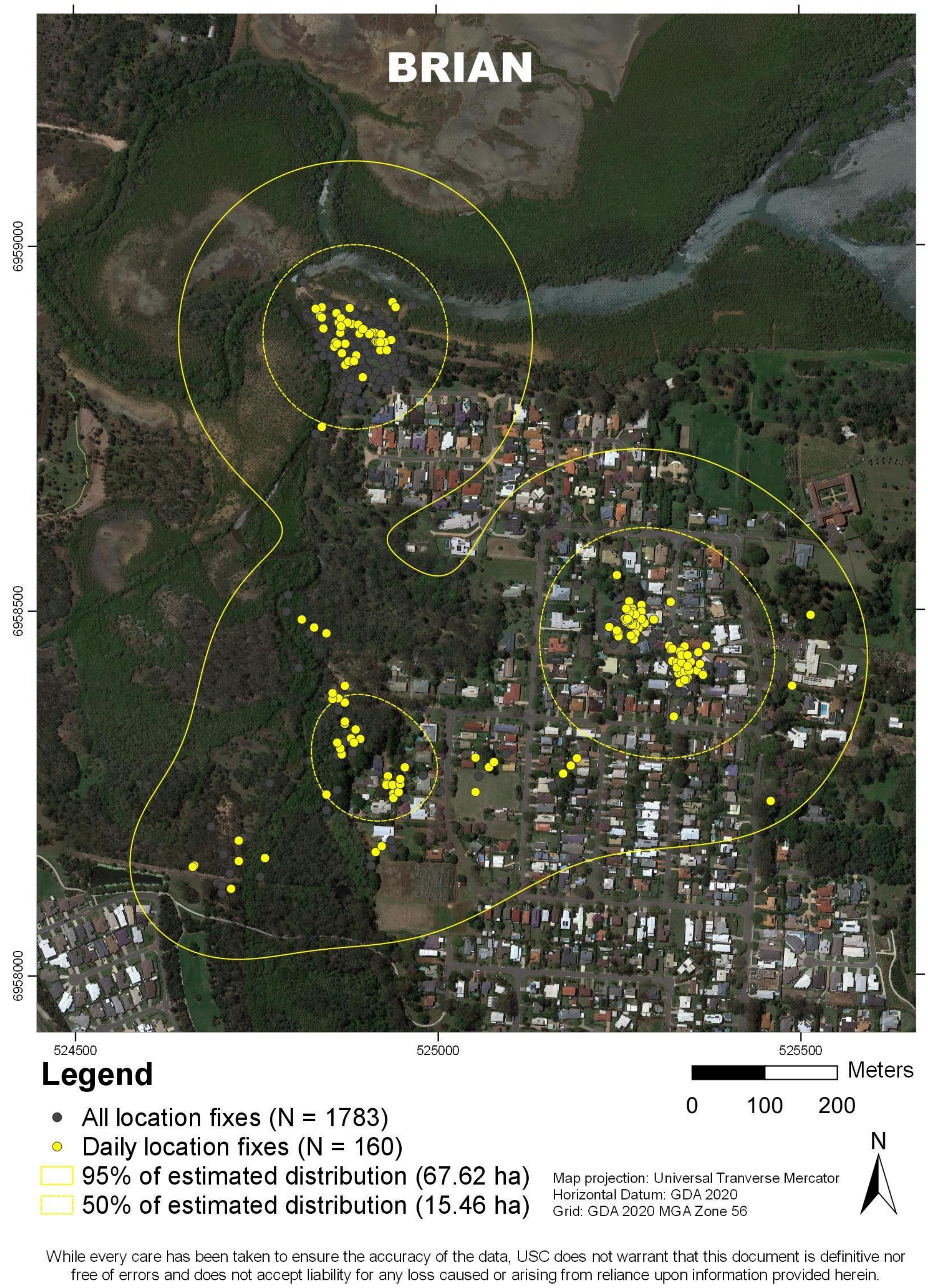

Figure 24. Home-range (95%) and core-range (50%) of the koala named "Brian". Suburb: Ormiston.

Bruce

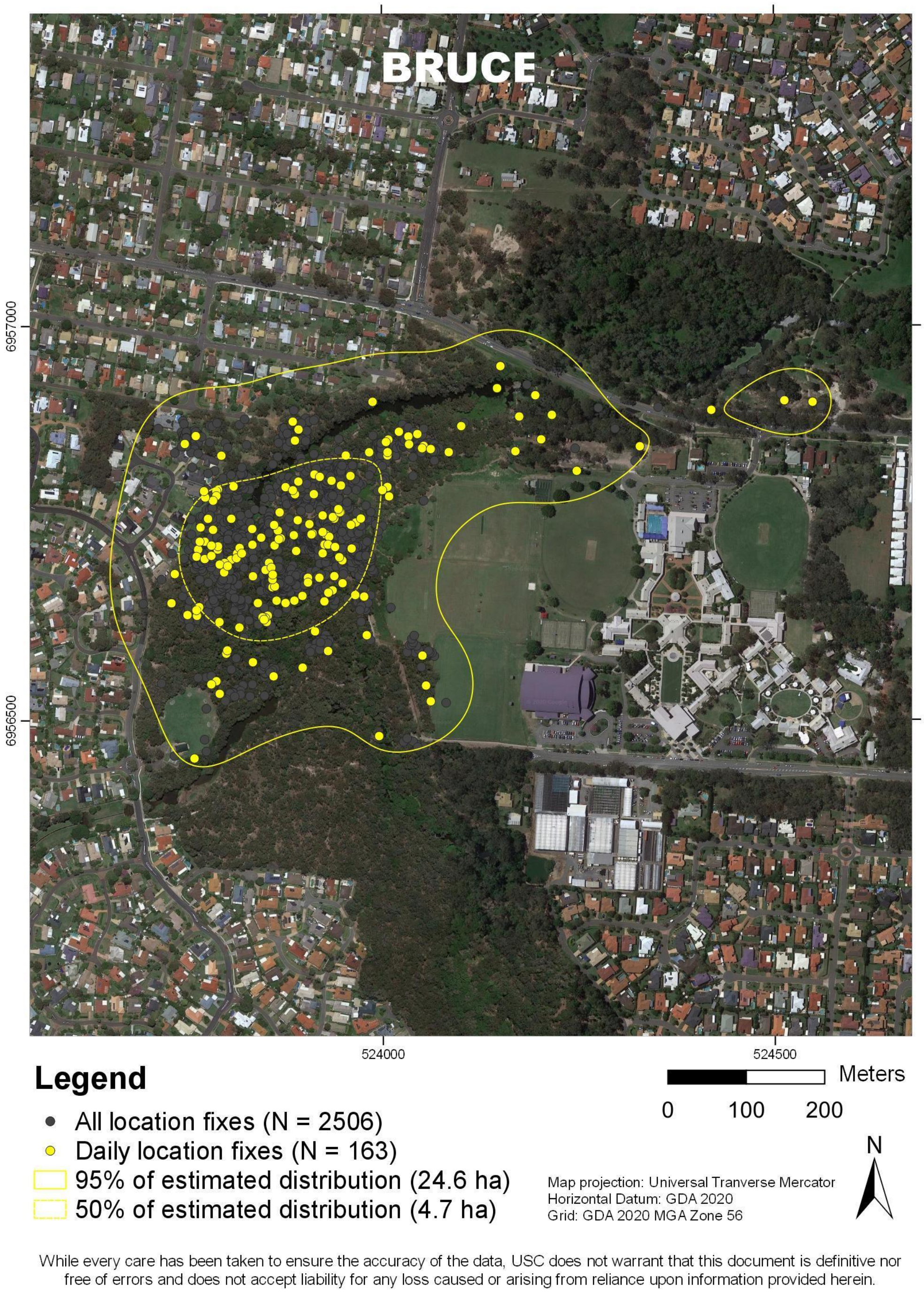

Figure 25. Home-range (95%) and core-range (50%) of the koala named "Bruce". Suburb: Ormiston.

Chips

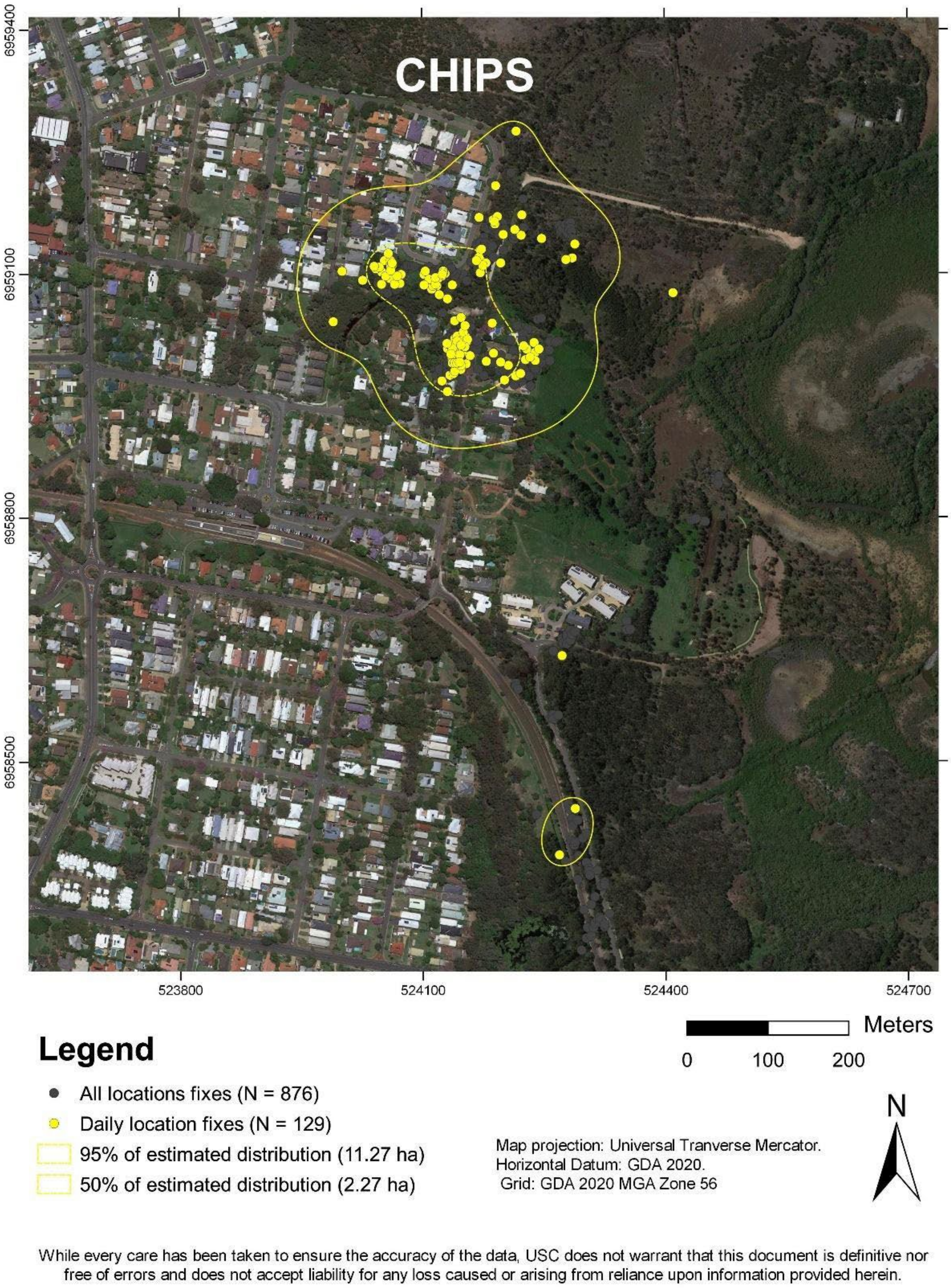

Figure 26. Home-range (95%) and core-range (50%) of the koala named "Chips". Suburb: Wellington Point

Cuddles

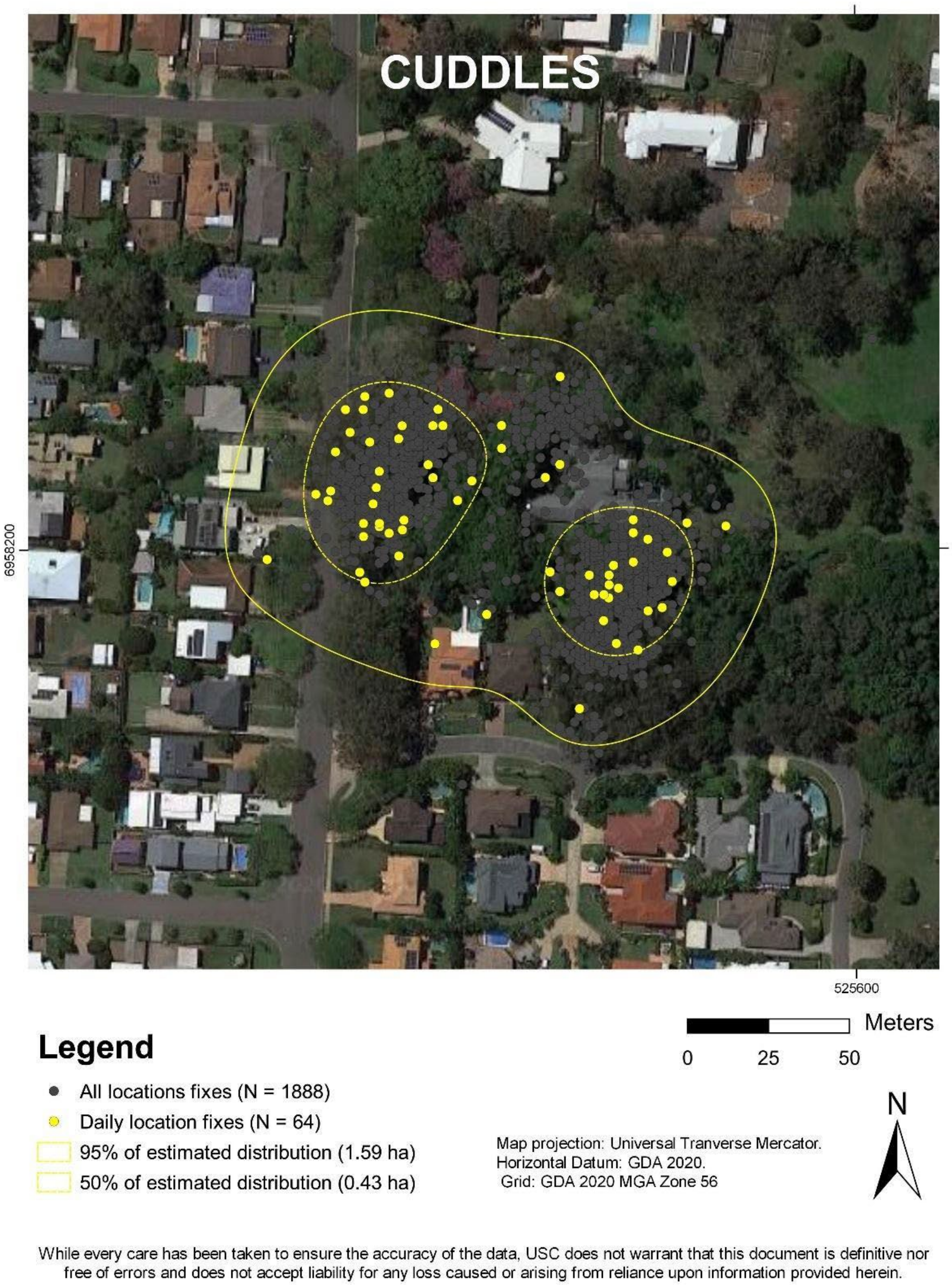

Figure 27. Home-range (95%) and core-range (50%) of the koala named "Cuddles". Suburb: Ormiston.

Ember

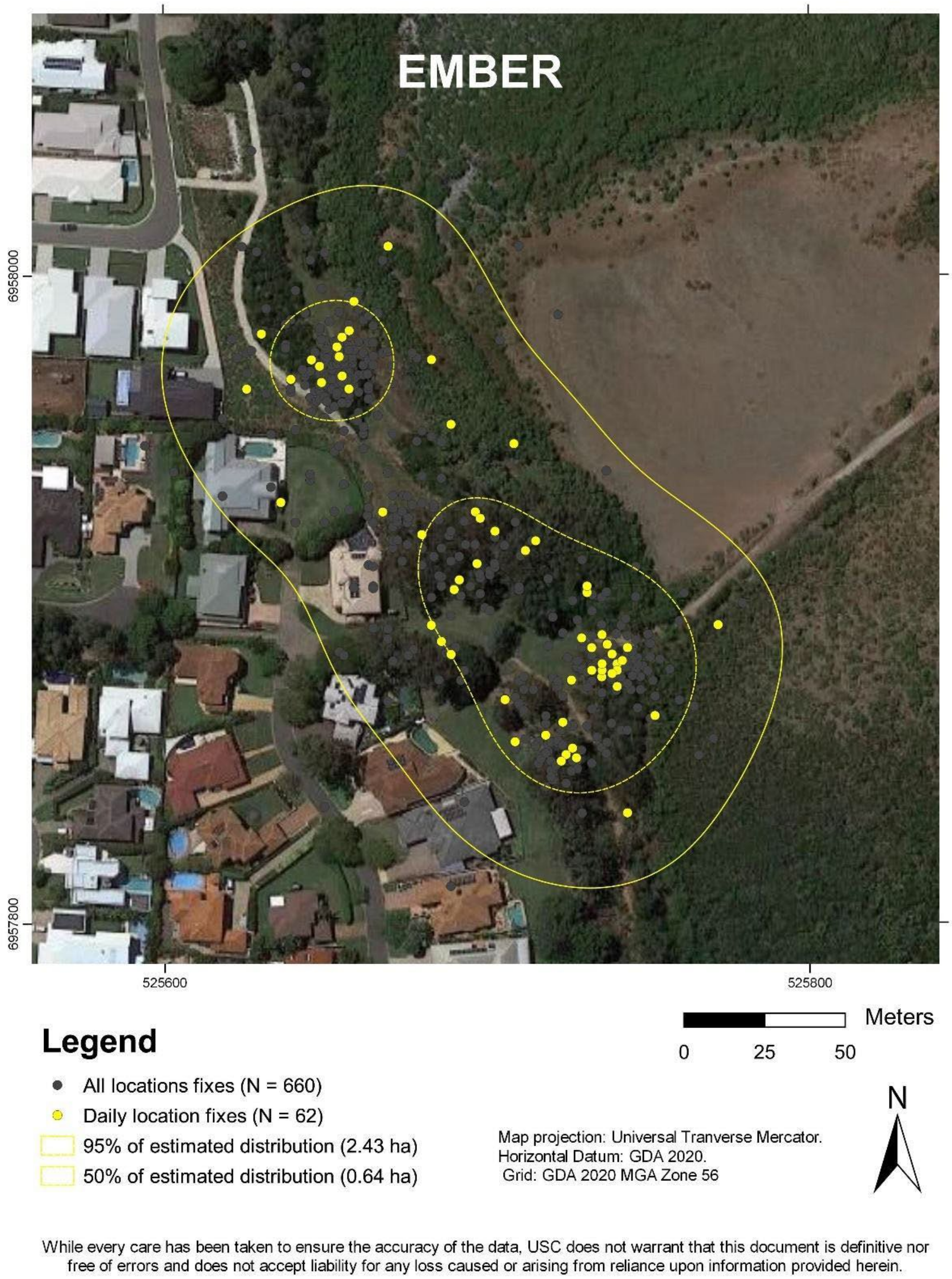

Figure 28. Home-range (95%) and core-range (50%) of the koala named "Ember". Suburb: Wellington Point

Gumnut

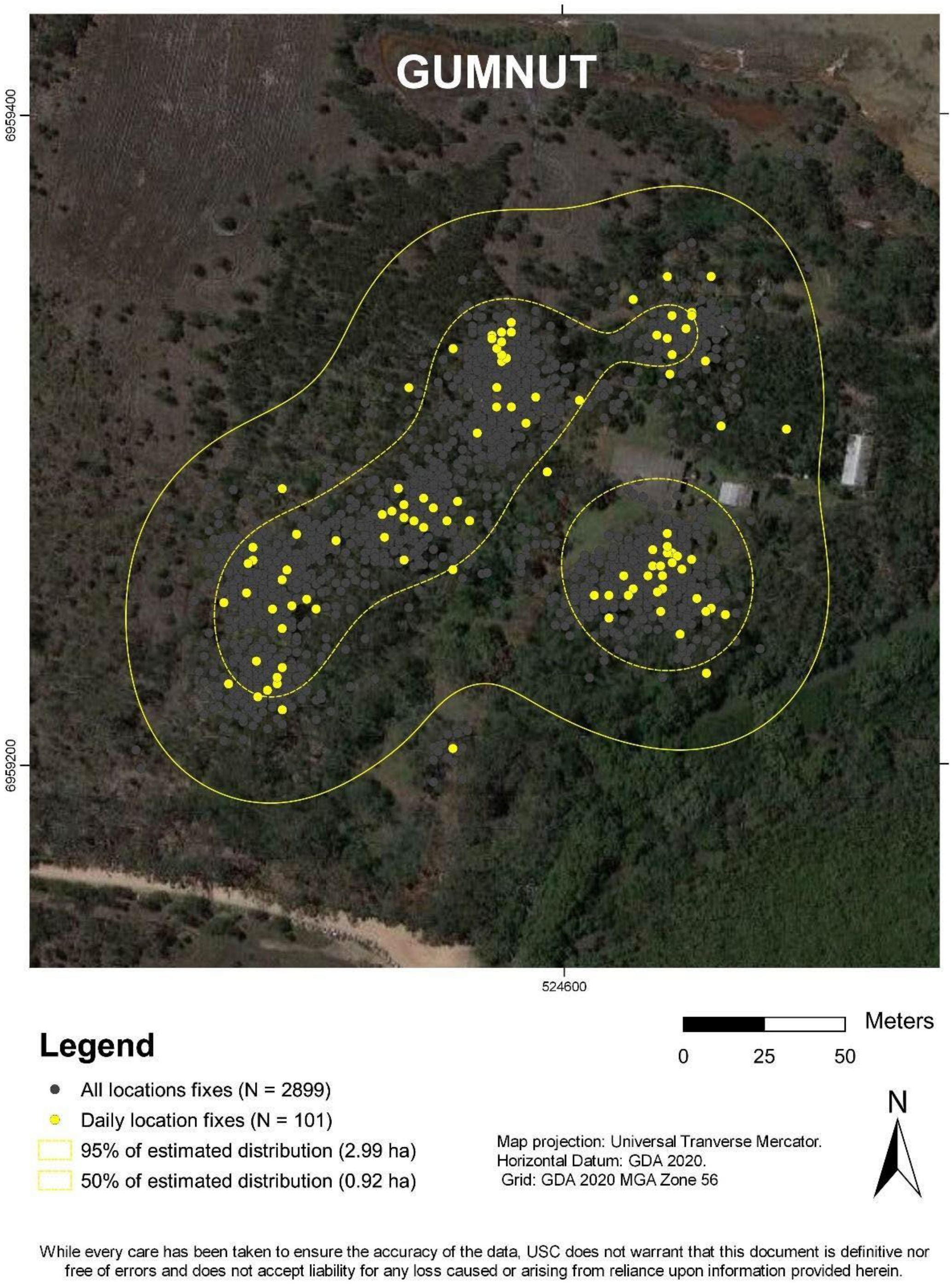

Figure 29. Home-range (95%) and core-range (50%) of the koala named "Gumnut". Suburb: Wellington Point

Kimo

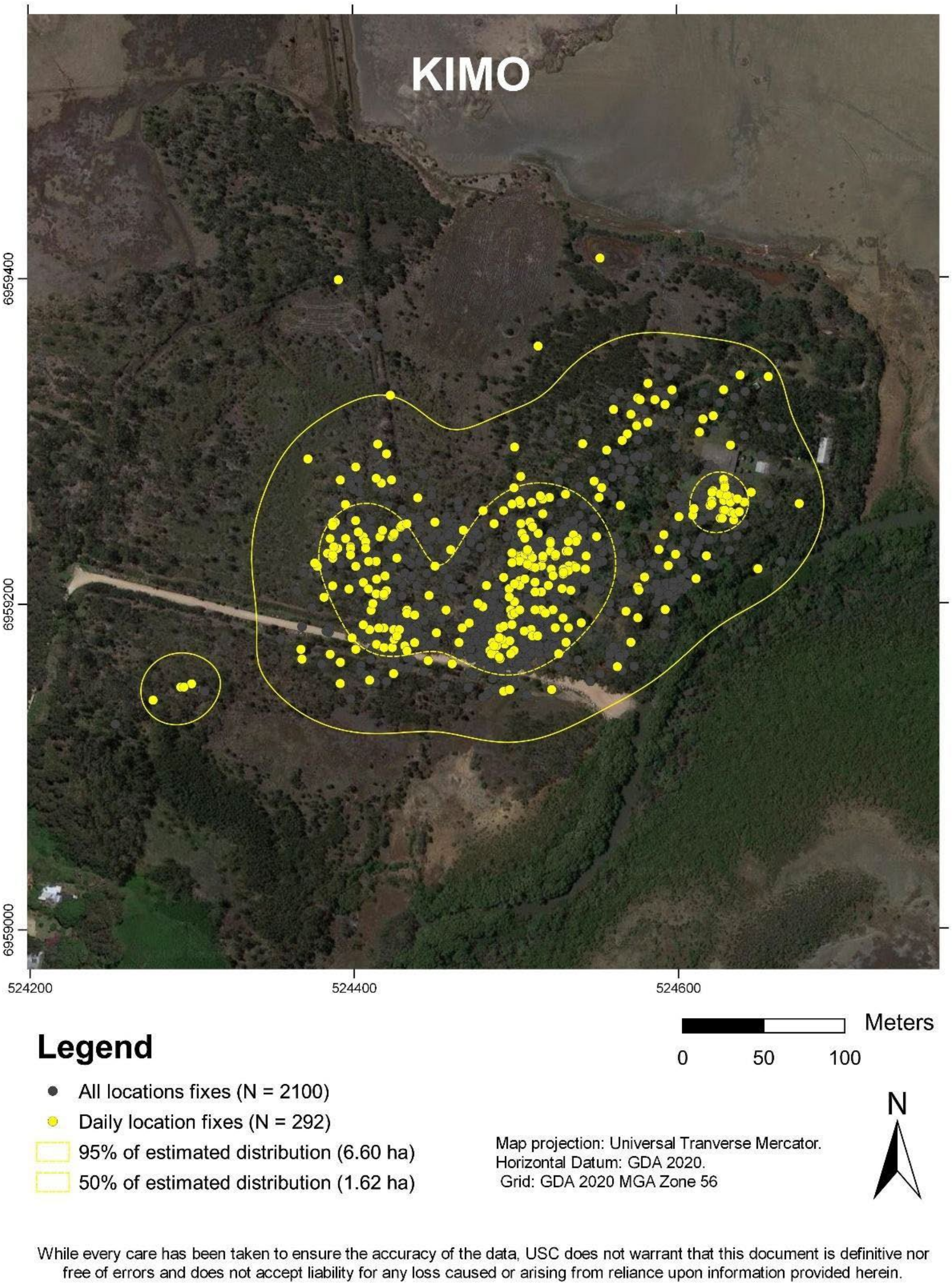

Figure 30. Home-range (95%) and core-range (50%) of the koala named "Kimo". Suburb: Wellington Point

Leaf

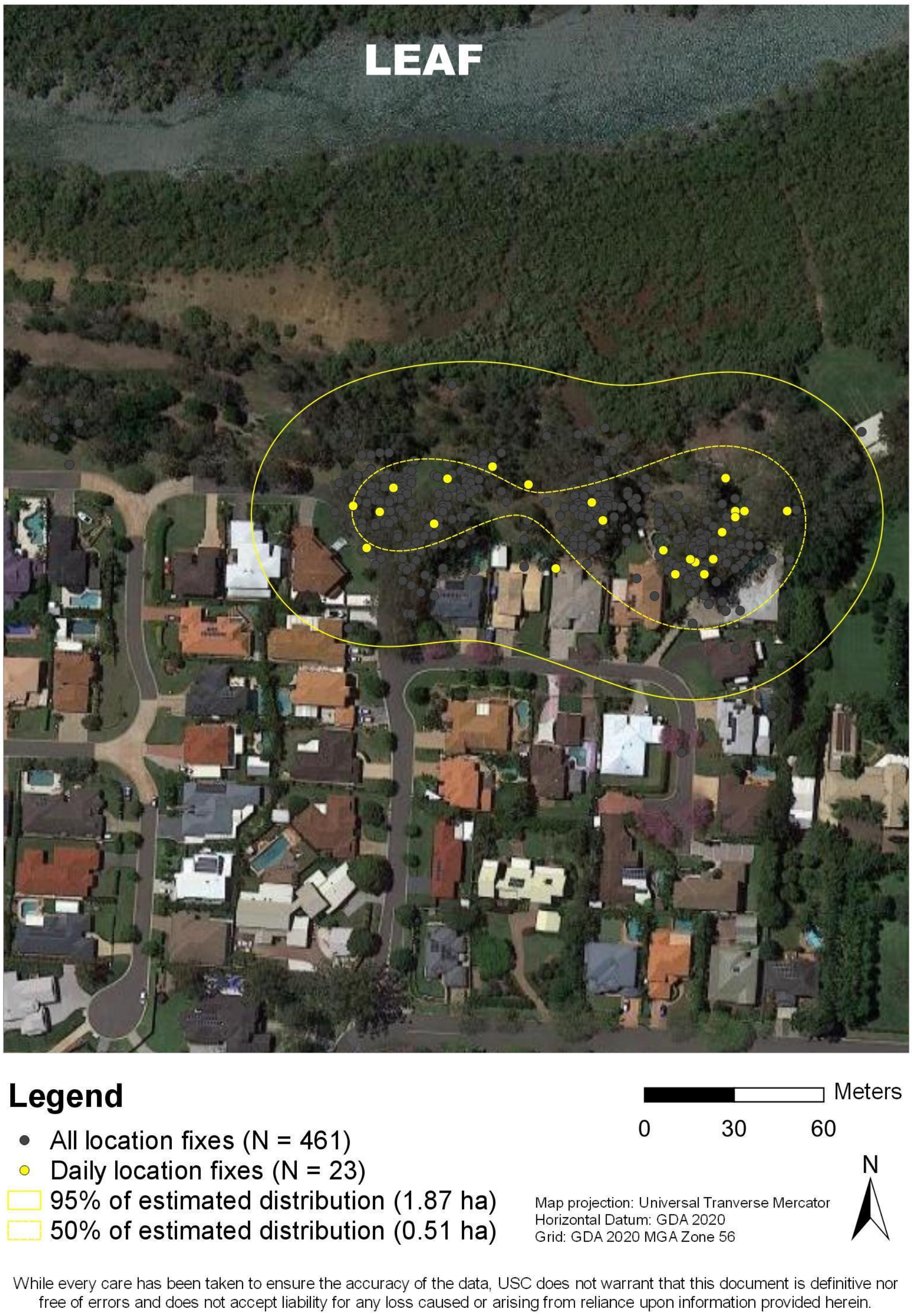

Figure 31. Home-range (95%) and core-range (50%) of the koala named "Leaf". Suburb: Ormiston.

Lucky

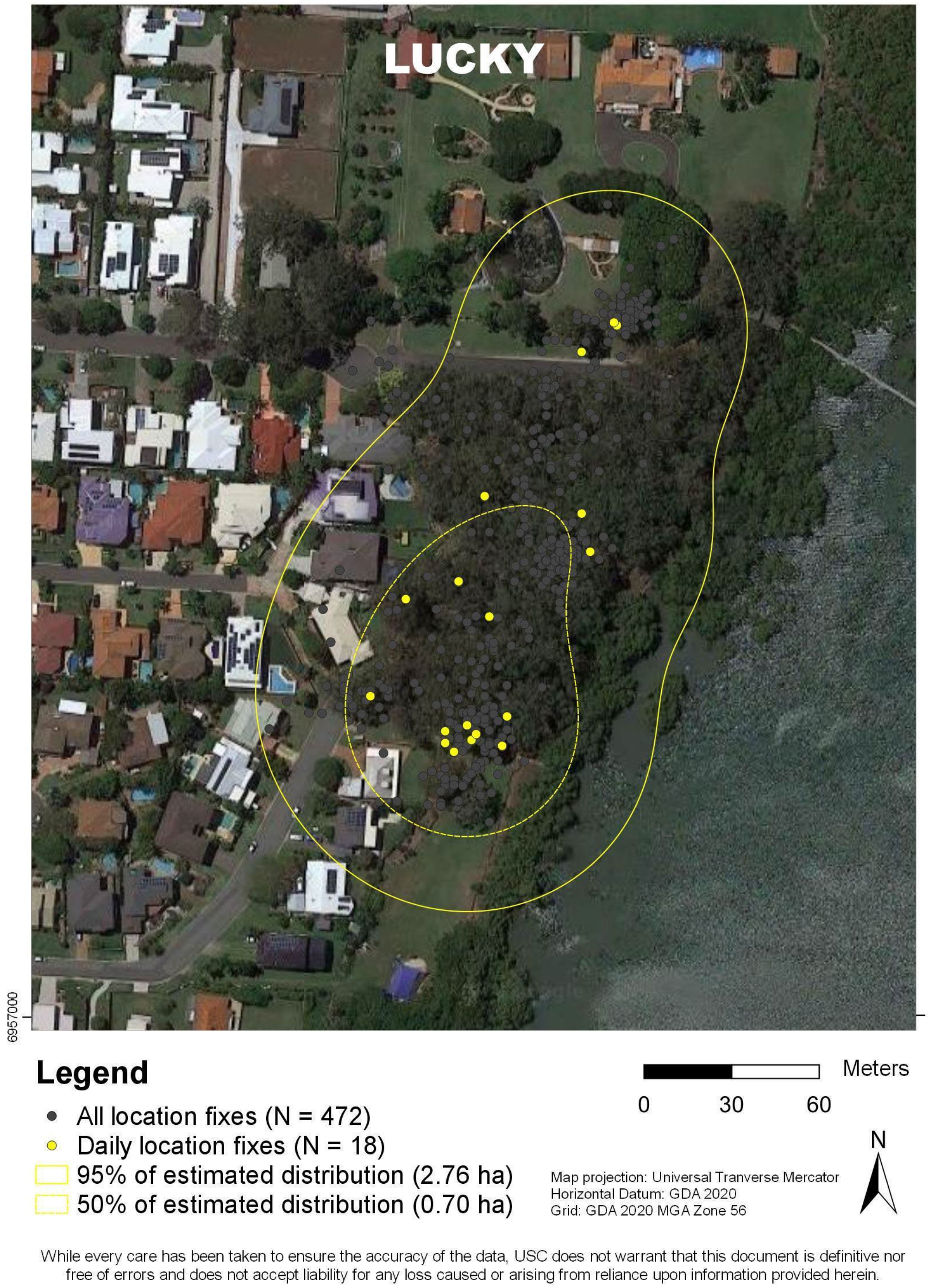

Figure 32. Home-range (95%) and core-range (50%) of the koala named "Lucky". Suburb: Ormiston.

Lulu

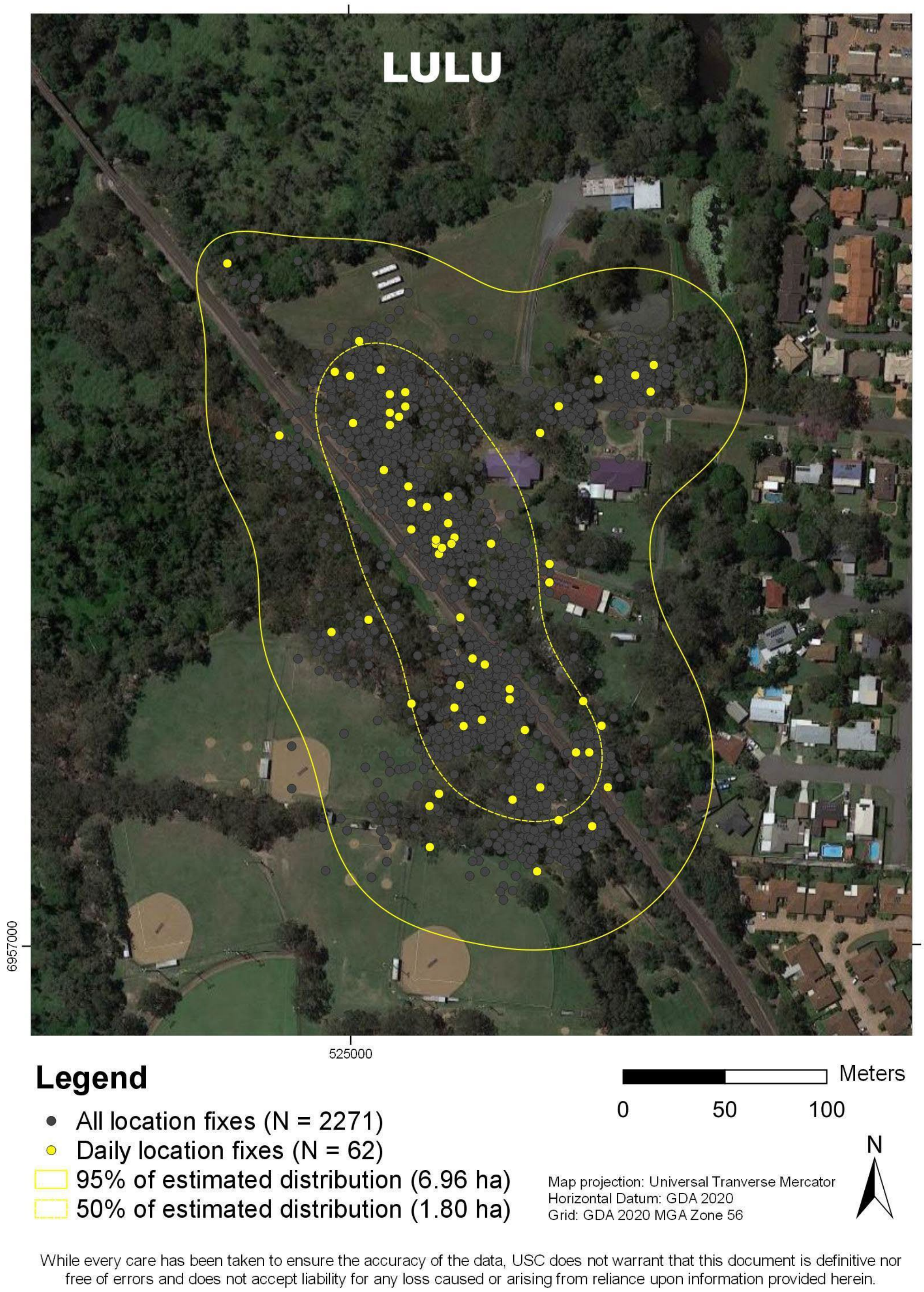

Figure 33. Home-range (95%) and core-range (50%) of the koala named "Lulu". Suburb: Wellington Point

Milo

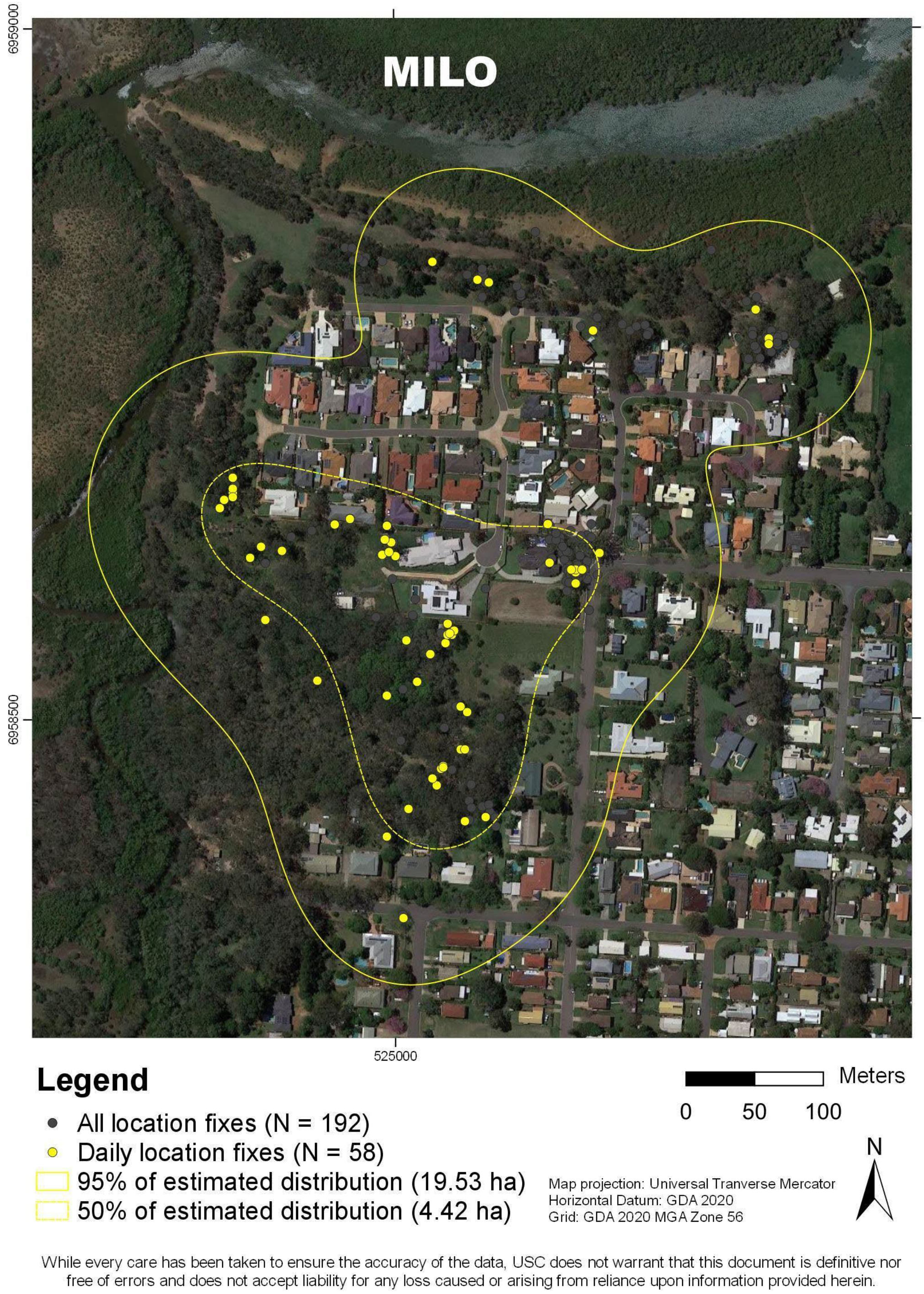

Figure 34. Home-range (95%) and core-range (50%) of the koala named "Milo". Suburb: Ormiston.

Monty

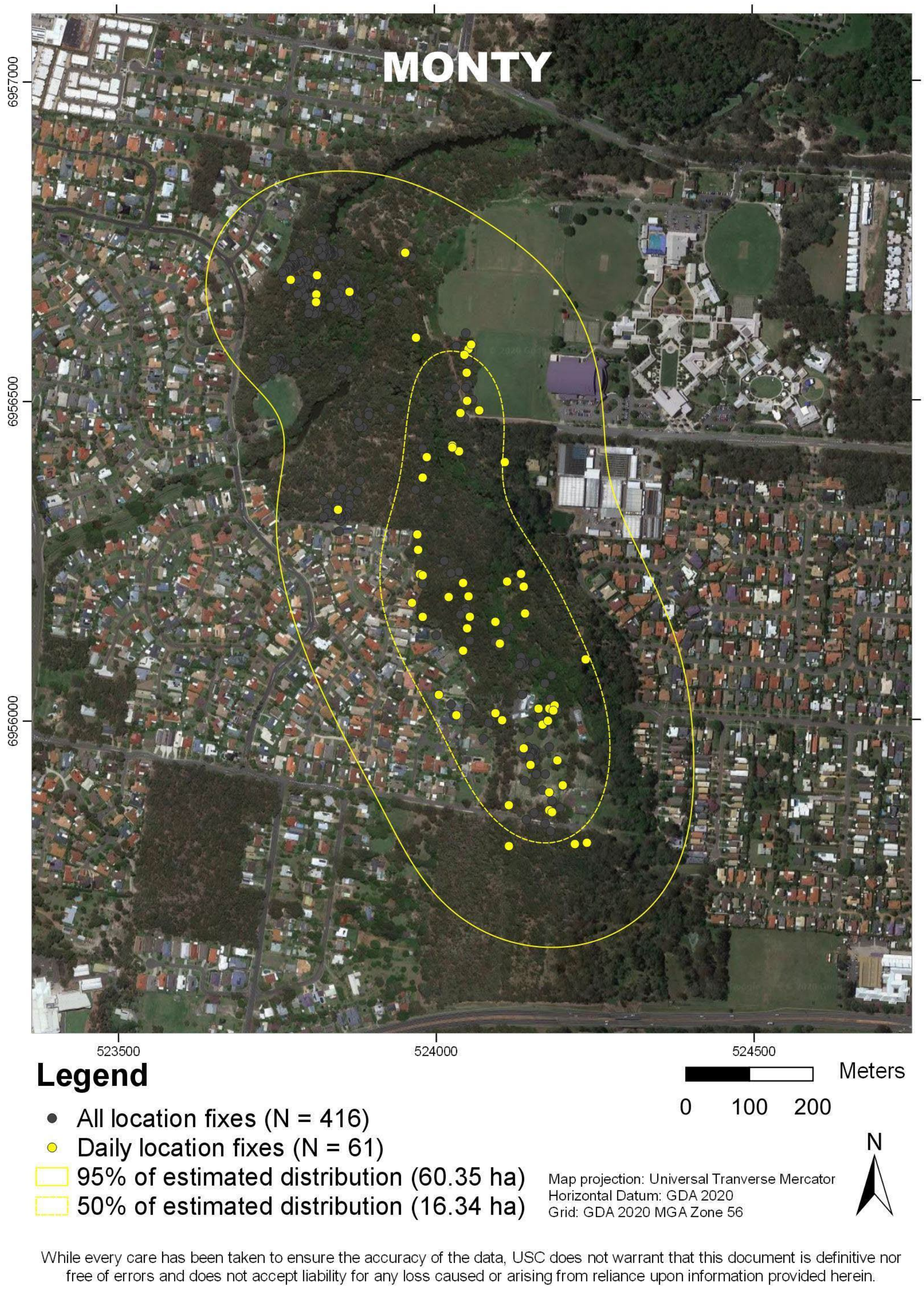

Figure 35. Home-range (95%) and core-range (50%) of the koala named "Monty". Suburb: Ormiston.

Poppy

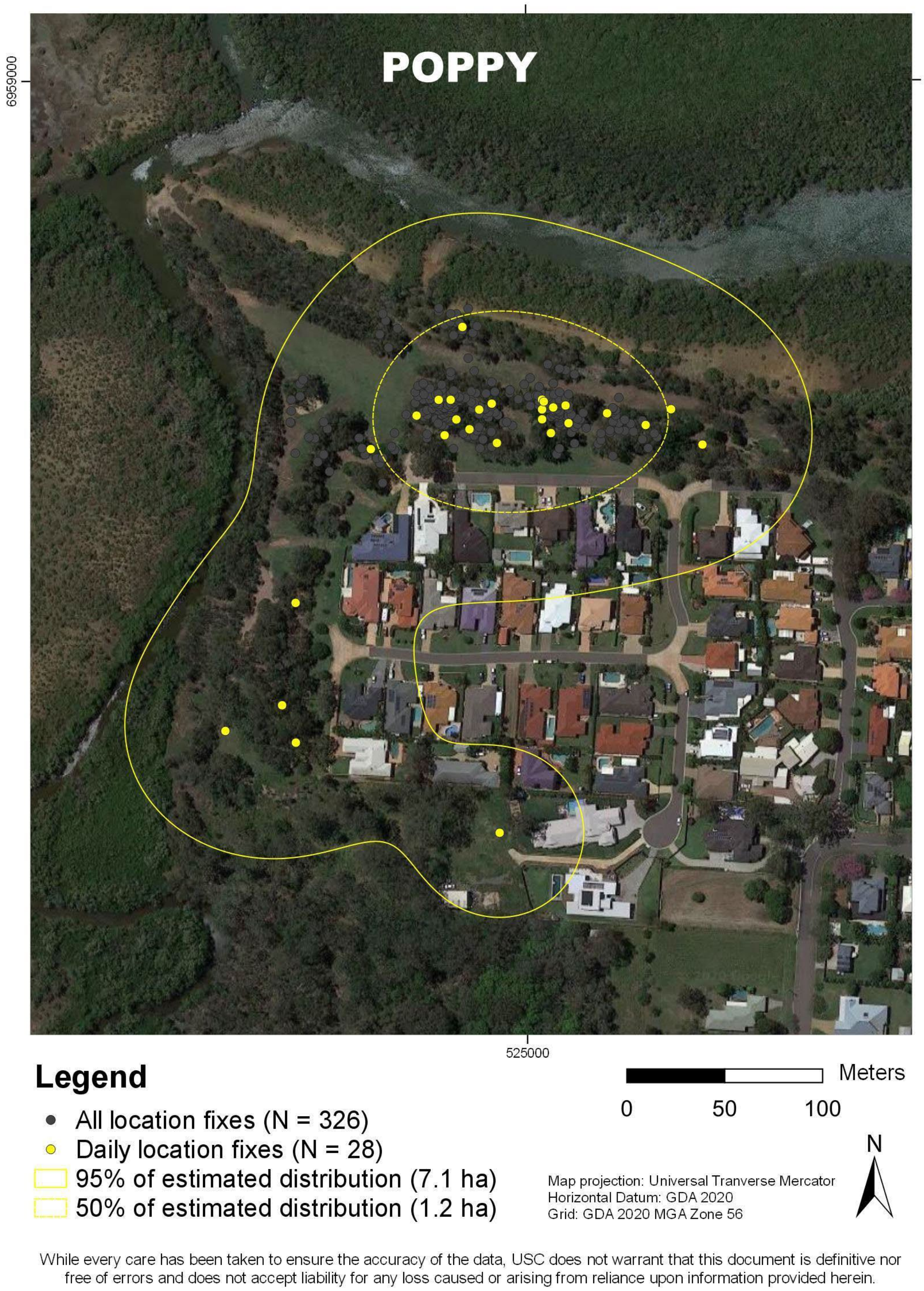

Figure 36. Home-range (95%) and core-range (50%) of the koala named "Poppy". Suburb: Ormiston.

Rainbow

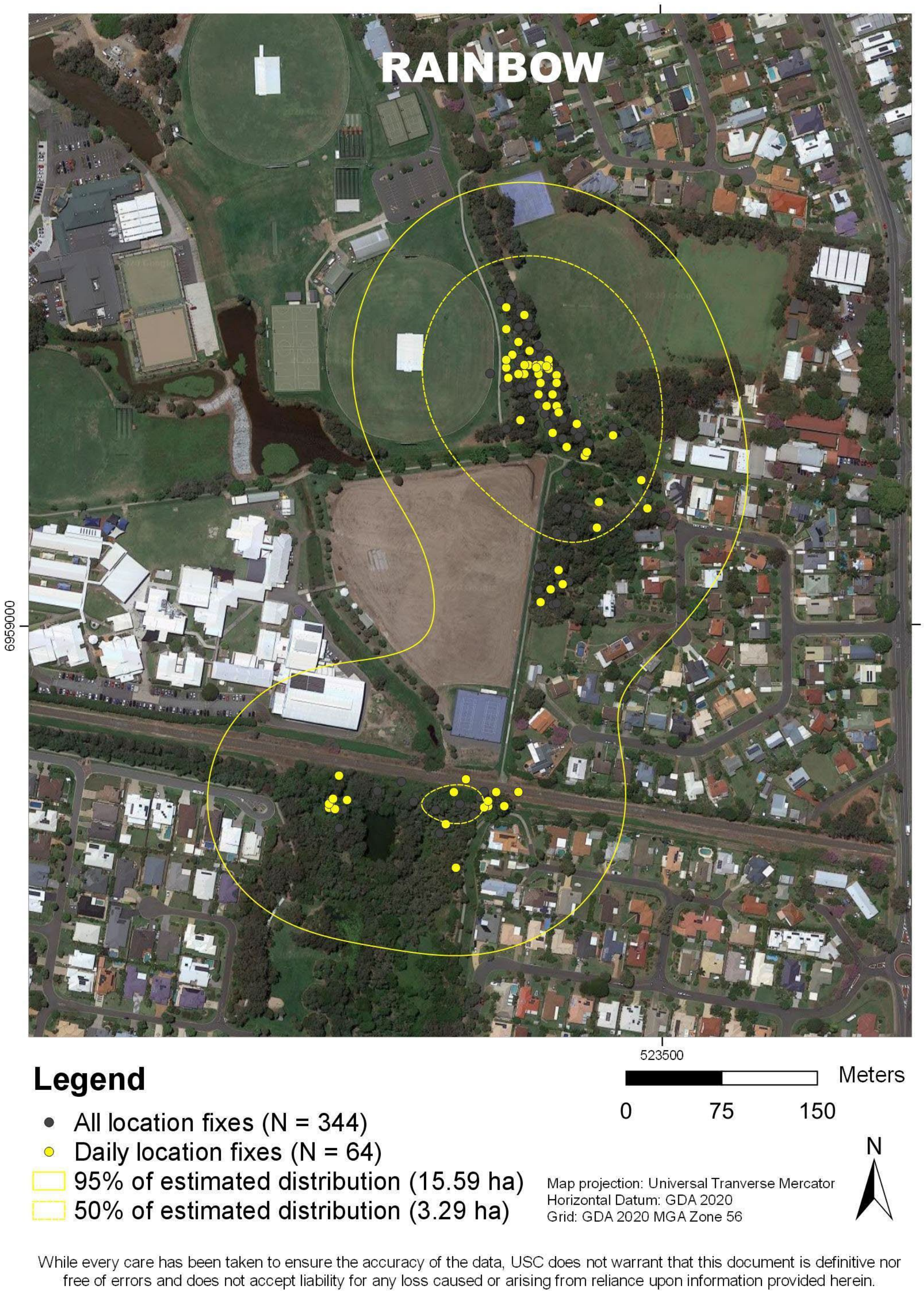

Figure 37. Home-range (95%) and core-range (50%) of the koala named "Rainbow". Suburb: Birkdale.

Rubin

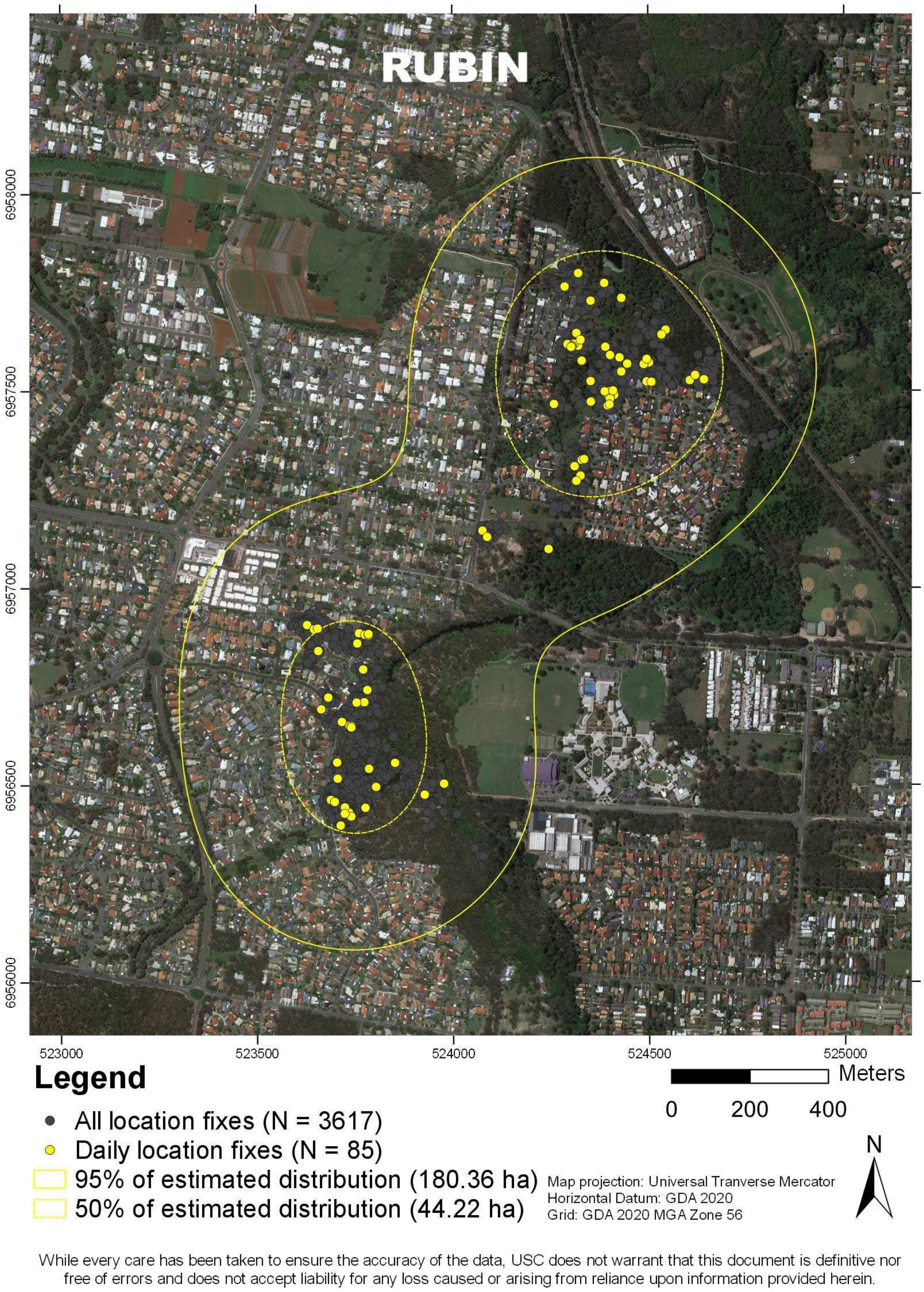

Figure 38. Home-range (95%) and core-range (50%) of the koala named "Rubin". Suburb: Ormiston.

Silkie

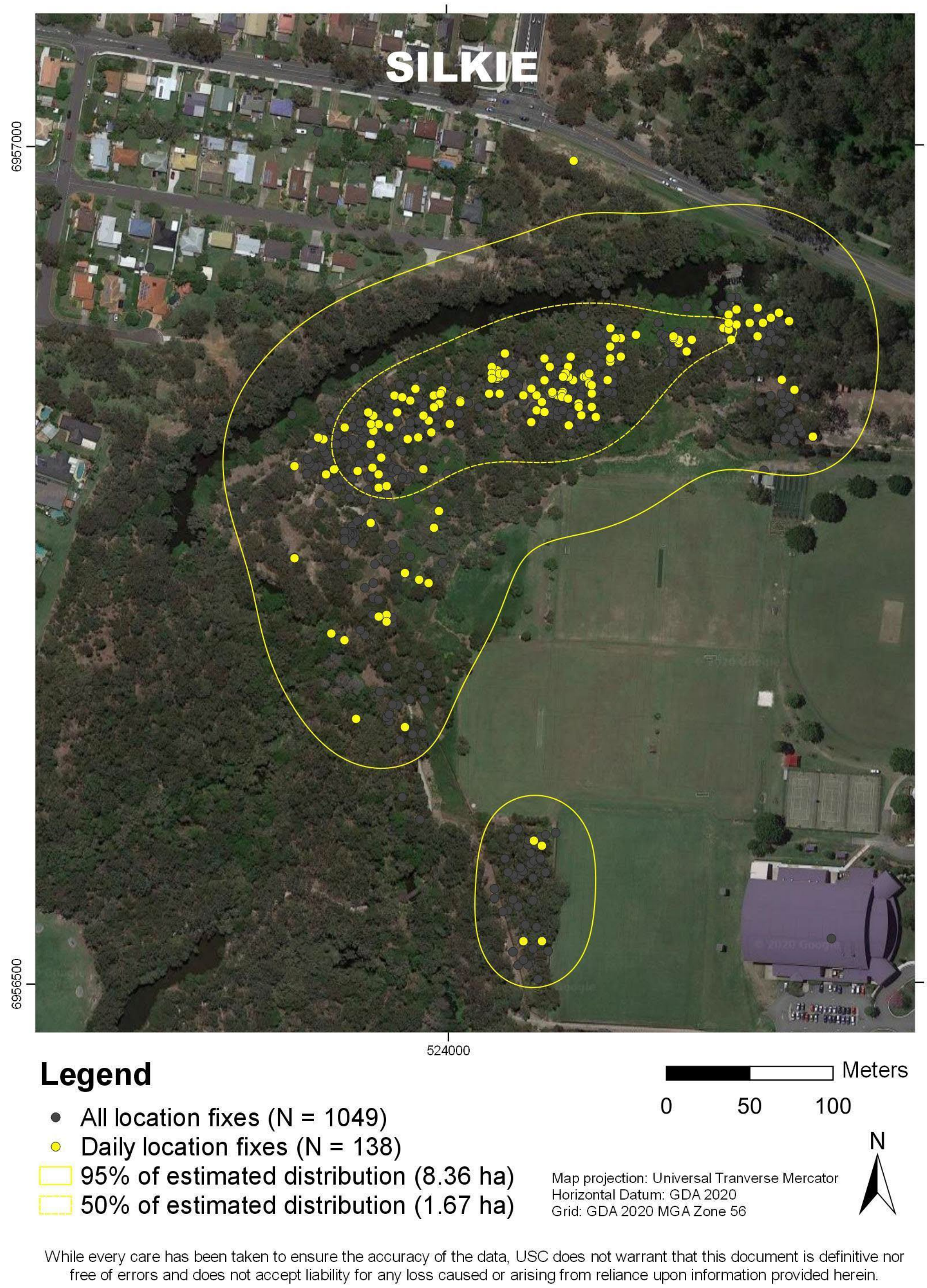

Figure 39. Home-range (95%) and core-range (50%) of the koala named "Silkie". Suburb: Ormiston.

Slinky

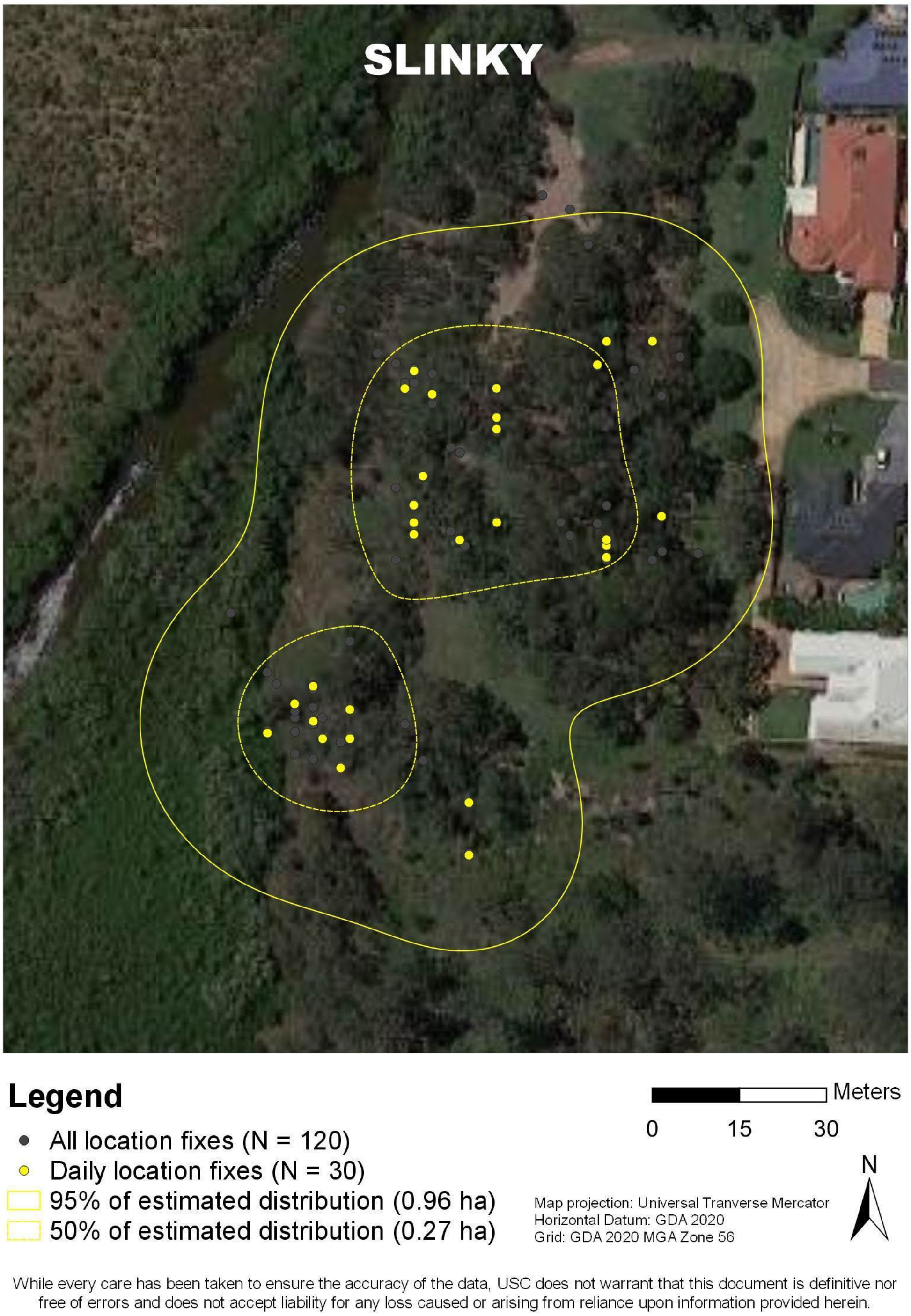

Figure 40. Home-range (95%) and core-range (50%) of the koala named "Slinky". Suburb: Ormiston.

Summer

Figure 41. Home-range (95%) and core-range (50%) of the koala named "Summer". Suburb: Thornlands.

Tally

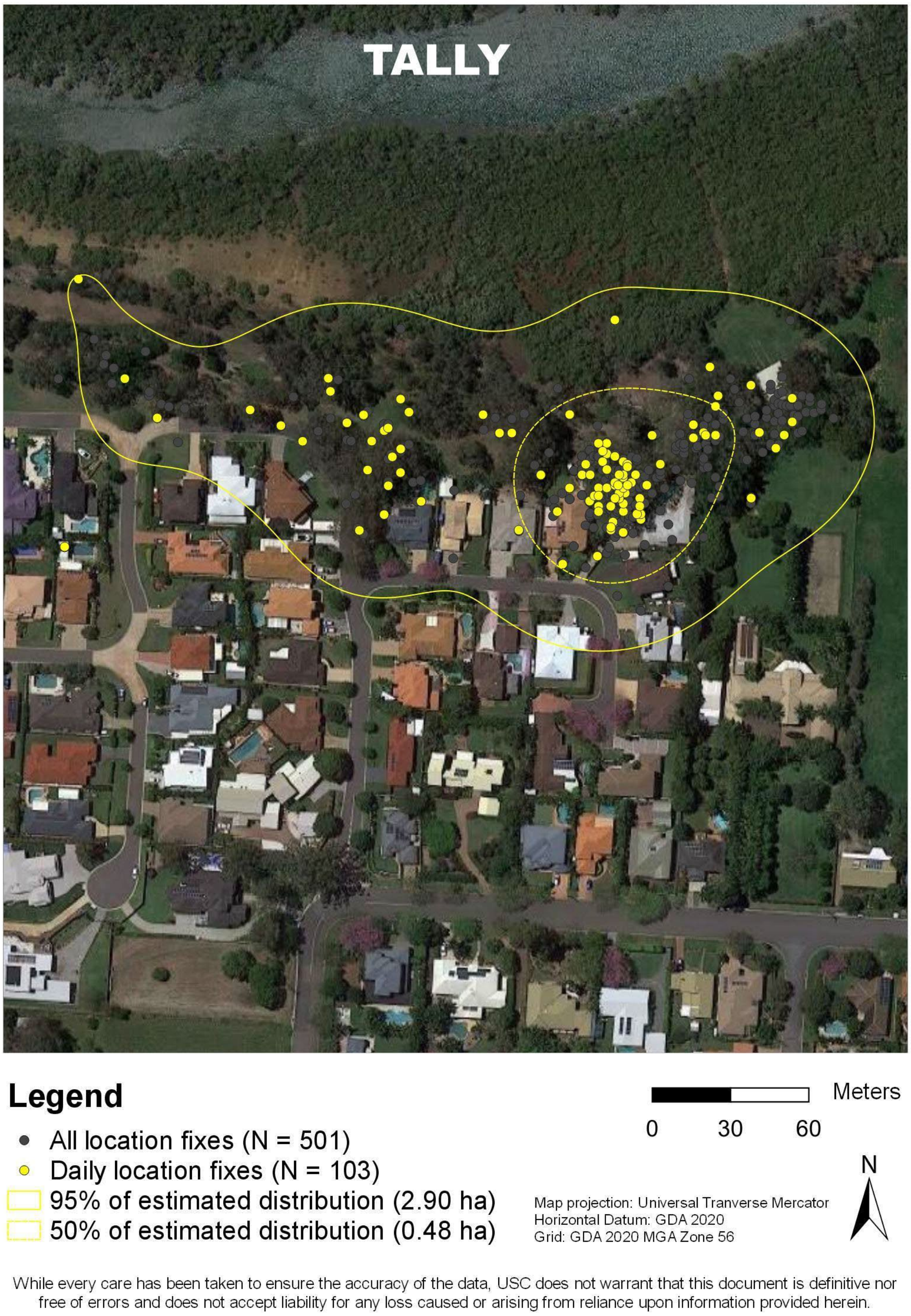

Figure 42. Home-range (95%) and core-range (50%) of the koala named "Tally". Suburb: Ormiston.

Ted

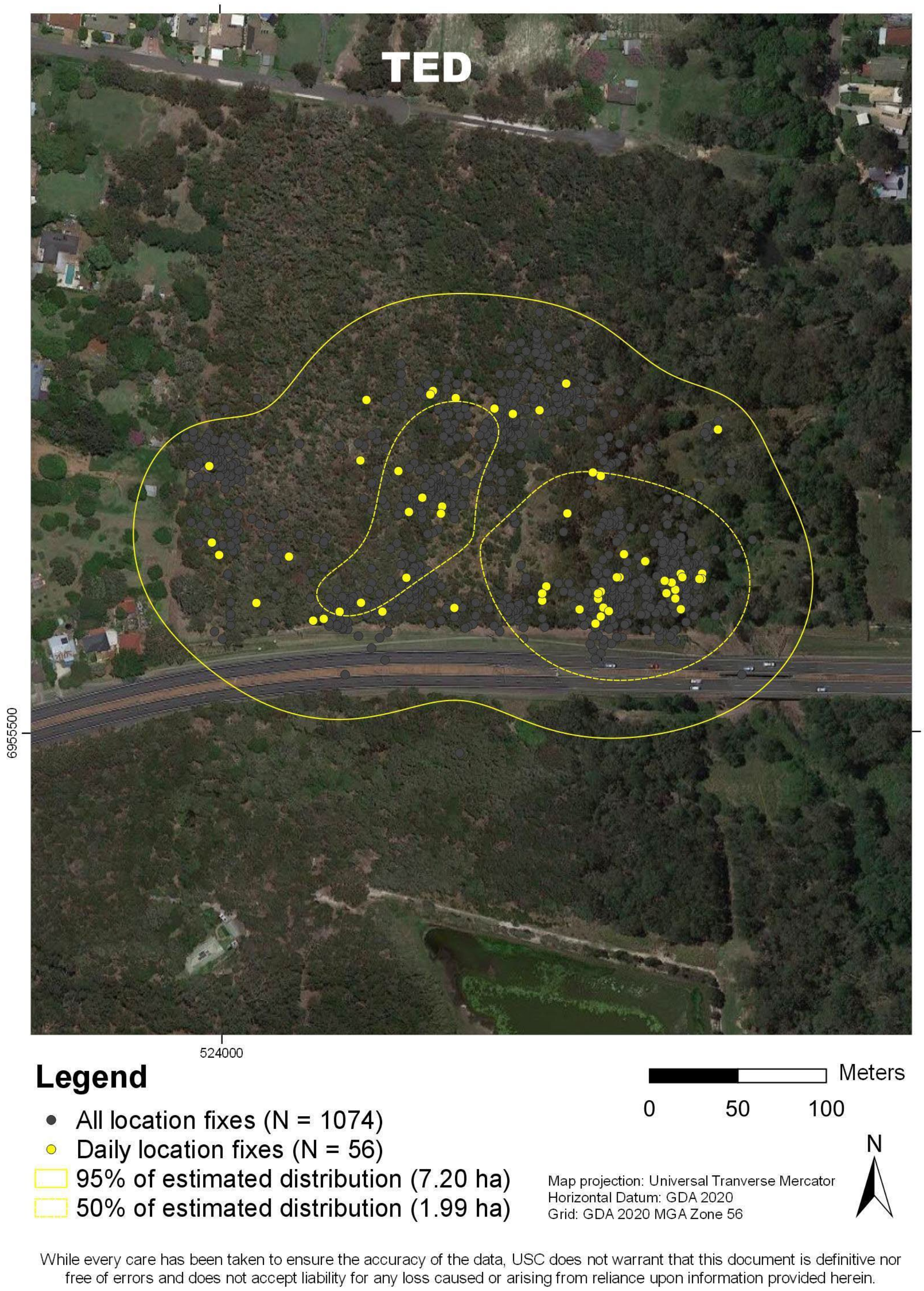

Figure 43. Home-range (95%) and core-range (50%) of the koala named "Ted". Suburb: Ormiston.

Uka

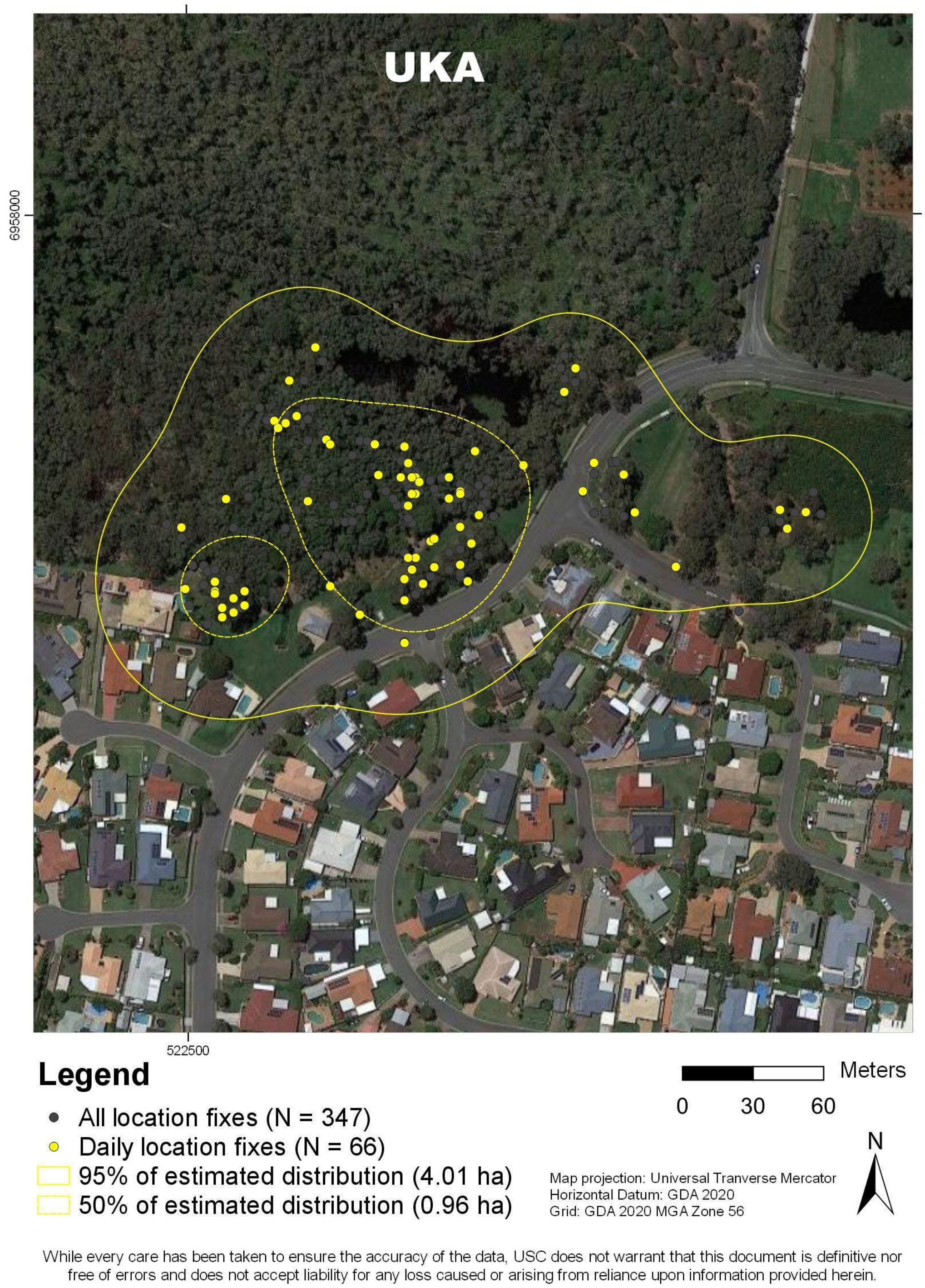

Figure 44. Home-range (95%) and core-range (50%) of the koala named "Uka". Suburb: Birkdale.

Wonky

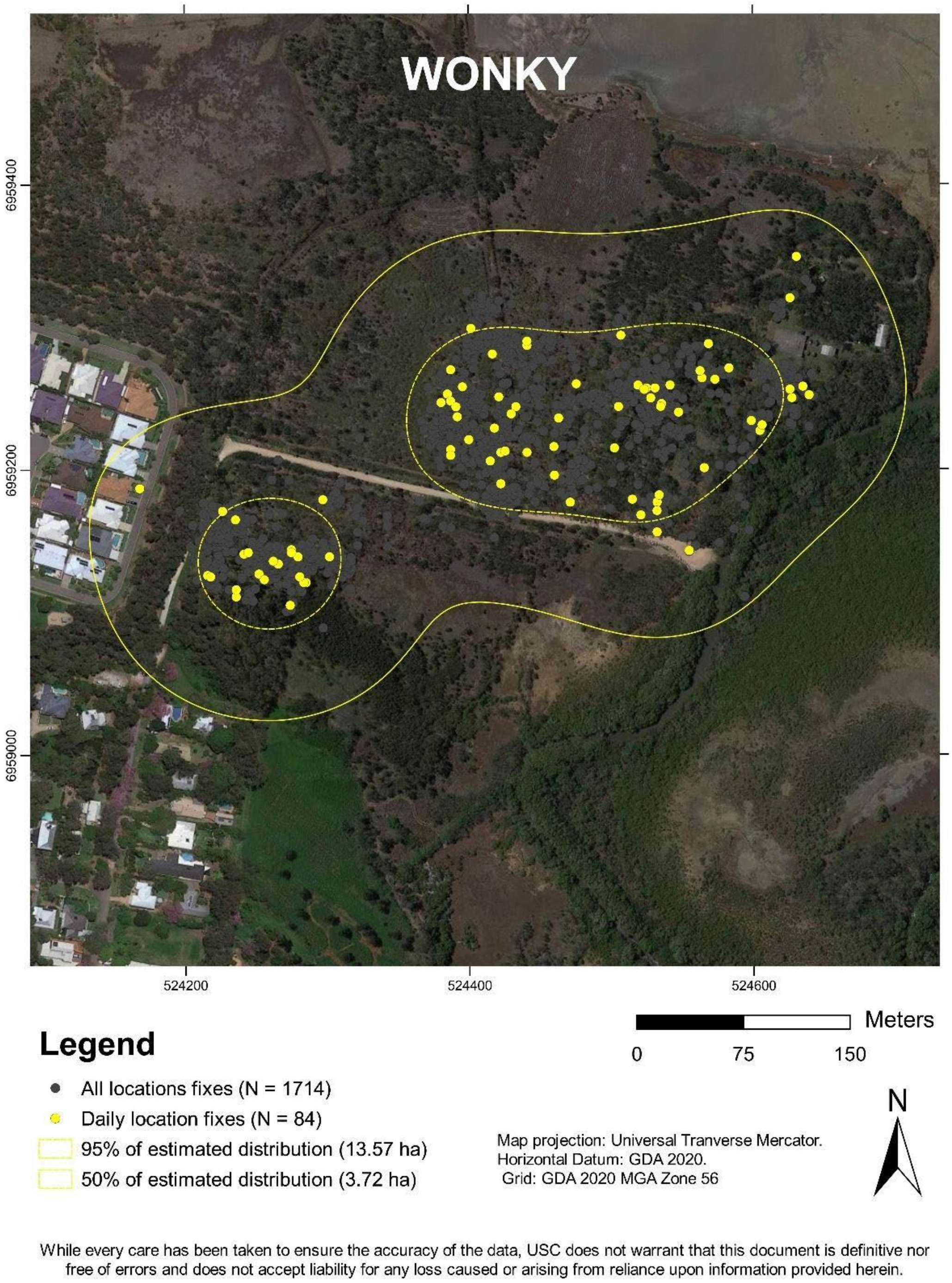

Figure 45. Home-range (95%) and core-range (50%) of the koala named "Wonky". Suburb: Wellington Point

End of report