Bennelongia Environmental Consultants

Impact assessment of the Mt. Gibson Gold Project in relation to the Lake Goorly Shield-Backed Trapdoor Spider (*Idiosoma kopejtkaorum*)

Prepared for:

Tetris Environmental

On behalf of Crimson Metals

May 2025

Final Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands

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Report Number: 674

Report Version	Prepared by	Reviewed by	Submitted to Client	
			Method	Date
Draft	Kevin Sagastume-Espinoza	Stuart Halse	email	28 October 2024
Draft V2	Kevin Sagastume-Espinoza		email	4 November 2024
Final	Kevin Sagastume-Espinoza		email	5 November 2024
Final V2	Kevin Sagastume-Espinoza		email	7 May 2025

K:\Projects\B_TEV_13\8_Report\Draft\ImpactAssessment\ClientComments\FINAL\BEC_ImpactAssessment_IKopetj_MtGibson_FINAL_V2_7.05.25_FORCLIENT.docx

EXECUTIVE SUMMARY

This report presents results of the impact assessment findings for the Endangered Lake Goorly Shield-backed Trapdoor Spider (*Idiosoma kopejtkaorum*) surveys conducted from 30 March – 3 May, 27-31 May, and 2-6 September 2024 at Crimson Metals' Mt Gibson operations. Crimson Metals is planning to recommence gold mining at the Mt Gibson Mine in a program of operations called the Mt Gibson Gold Project (MGGP). The Mt Gibson Mine is located in the Murchison region, 70 km south-east of Paynes Find. The proposed operations involve the expansion of historical mine pits as well as creation of additional surface infrastructure.

The aim of the survey was to conduct targeted burrow searches to provide information about the identity and distribution of the *Idiosoma* species occurring within the Survey area, with special consideration but not limited to, *Idiosoma kopejtkaorum*. The report has been structured following DCCEEW's 'Guidelines for the Content of a Draft Public Environmental Report' (DCCEEW 2024a) and the advice provided in 'Statement of Reasons for Controlled Actions'(DCCEEW 2024c).

In total, 15 areas were visited across all rounds of survey, including nine impact areas and six reference areas. The methods employed during the targeted burrow surveys differed from the reconnaissance survey in the use of leaf-blowers to uncover spider burrows. Molecular sequencing was employed to confirm the identity of all the *Idiosoma* species within the Survey area, and haplotype analysis was conducted for the available *Idiosoma kopejtkaorum* sequences. To minimize impacts on *Idiosoma kopejtkaorum* populations, a non-lethal molecular technique to confirm the identity of animals was used. This technique consisted of removing one leg from targeted animals for molecular sequencing rather than killing the animals. Additionally, an endoscope inspection camera was used to inspect burrows likely to contain *Idiosoma* species. Extent of Occurrence and Area of Occupancy, as well as local population size, were calculated for *Idiosoma kopejtkaorum* but not for the other *Idiosoma* species given there were insufficient data. Impact assessment criteria were developed in accordance with the EPA's Technical Guidance for Terrestrial Fauna Surveys and by modifying existing criteria to best accommodate the biological requirements of *Idiosoma* species.

A total of 509 mygalomorph spider burrows have been identified across the surveyed areas. Of these, 340 burrows are considered Likely or Probable *Idiosoma* sp. burrows, of which 281 have been categorised as Active. Most of the active burrows were identified from Ace High (n=71), Highway Pit (n=31), and Sundance (n=30).

Molecular sequencing was conducted on 21 specimens, including the non-lethal samples (n = 6). Sequencing analysis confirmed non-lethal samples to be *Idiosoma kopejtkaorum*, in line with morphological identifications during the field surveys. Additionally, molecular analysis and morphological inspection of reference specimens collected across different localities identified four other *Idiosoma* species in the Survey area: the undescribed species *Idiosoma* \`MYG222\` and *Idiosoma* \`BMYG238\`, the Coolgardie shield-backed trapdoor spider *Idiosoma intermedium,* and an undescribed species from the *nigrum*-group and part of the *Idiosoma formosum* complex, namely *Idiosoma* \`BMYG229\` (*formosum*-complex). The *Idiosoma kopejtkaorum* haplotype analysis was not able to determine whether Mummaloo samples represented the same population as those from Mt Gibson given the small sample size. However, haplotype analysis identified high levels of sequence variation even within small geographical distances, suggesting any reduction in population size would result in loss of unique mitochondrial variation.

Current data suggest that the Endangered species *Idiosoma kopejtkaorum* occurs both throughout and outside the Development Envelope. Data from several sources have been consolidated (Bennelongia records, Biota records, and Rix *et al*. 2018 records) to provide 108 known records for this species. Of these, 90 are known from the Mummaloo/Mt Gibson area, 66 of which were generated from this survey. Using the consolidated data set, an updated Extent of Occurrence (EOO) of 4,444 km^2 (estimated at

4,000 km^2 by Rix et al. 2018) and an Area of Occupancy (AOO) of approximately 172 km^2 (17,200 ha) (estimated at <500 km^2 by Rix et al. 2018) were calculated. The EOO shows two distinct sections based on habitat connectivity, continuous habitat (37.2% of EOO) and discontinuous habitat (62.8% of EOO). The MGGP occurs within the continuous habitat portion and has a Development Envelope of 3,723 ha and a Disturbance Footprint of 1,562 ha.

Eight Vegetation and Substrate Associations (VSA's) have been identified as occurring within the Development Envelope and the Disturbance Footprint, all of which occur abundantly outside of the Project. The most abundant VSA within the Distrubance Footpring was VSA 1: Acacia Shrublands (580 ha), followed by VSA 4: Eucalypt Woodland (251 ha) and VSA 5: Mallee Woodland (244 ha). Extended habitat mapping shows the same eight VSA's, but extends the mapped area from 4,082 ha to 6,450 ha, both within and outside the Disturbance Footprint. Of the 281 active Likely or Probable *Idiosoma* burrows identified within the survey area, 63% (n = 177) were found within eucalypt woodland, and 18% (n = 51) within acacia shrublands. Just 8% (n = 23) were found within Callitris woodland and 6% (n = 16) were found within mallee woodland. These findings align with the SPRAT profile for *Idiosoma nigrum* (subsequently divided into numerous species, including *I. kopejtkaorum*) which suggests that populations of the species are usually associated with eucalypt woodlands and acacia shrublands.

Population estimates suggested approximately 4,803 *Idiosoma kopejtkaorum* spiders likely occur within the Survey area. Population estimates suggest there are approximately 17,075 *Idiosoma kopejtkaorum* spiders within the Development Envelope, out of which 4,410 are expected to occur within the Disturbance Footprint. The MGGP Disturbance Footprint is expected to impact 6.48% of the species' AOO. Following the impact assessment criteria, the potential level of impact the Project may have over populations of *Idiosoma kopejtkaorum* is considered to be **moderate**. This is because population declines will occur over a medium-term period (life of mine estimated at 11 years), and a considerable amount of the known AOO of the species will be impacted. A series of threatening processes resulting from the Project development are considered for *Idiosoma kopejtkaorum*:

- Habitat clearing and degradation is categorised as a **minor** impact to populations of *I. kopejtkaorum* because the species is known to occur outside of the Disturbance Footprint and preferred habitat for the species is not restricted to the Project's Development Envelope.
- Fragmentation of habitat and interruption to genetic connectivity is considered a **moderate** impact**.** This is because, even though gene flow will not completely stop between populations outside of the Development Envelope, clearing and fragmentation will result in removal of an important part of the known gene pool for the species.
- Impacts on the species' biological processes may range from **negligible** to **minor**. At a local scale (within the MGGP), the impacts are likely to be minor as only those individuals within the cleared areas will be directly affected. At a regional scale the impacts are likely to be negligible as most of the impacts will affect local populations only and will have little to no impact at a regional scale.
- Disturbances such as dust, light, noise, and vibration may impact populations of *Idiosoma kopejtkaorum* by affecting their biological processes. The impact for this component is considered **minor**. At a local scale, impacts are expected to be moderate and affecting those individuals in the Development Envelope that were not taken during the construction or exploration stages. At a regional scale, impacts are likely to be minor, with dust being the biggest threat at a regional scale given that it can reach populations even outside of the Development Envelope.
- Predators and invasive species are likely to affect spider populations mainly at a local scale; however, it is possible that invasive species will incur in undisturbed habitats outside of the Development Envelope. The impact of this threatening process is considered as **moderate** given that any individuals remaining within the Development Envelope after habitat clearing has occurred may be at risk of being predated or outcompeted for resources by invasive species, which could also affect and reduce reproductive success in the local area.

- Mortality during construction and life of mine is considered as a **moderate** impact based on the potential impacts to individuals that may remain after land clearing, and the potential risk of completely extirpating the local population, and potential risks of failed recolonisation after the mine has closed.
- Potential risks resulting from changes to surface and groundwater conditions are not expected as a result of the Project development. For secondary salinisation to occur, regional scale clearing needs to occur, which is not going to occur as part of the Project development. For such reasons, the impact for this component is considered as **negligible.**

Overall, the MGGP could impact the Endangered Lake Goorly Shield-backed Trapdoor Spider (*Idiosoma kopejtkaorum*). The highest risk could come from the clearing of 6.5% of the species' known AOO which could result in the removal of genetic diversity because of habitat fragmentation, causing interruptions to the species' geneflow across its known localities. Impact over already fragmented and reduced populations along with the species' specific microhabitat requirements and poor dispersal abilities could result in failed recolonisation of the area after close of mine.

Avoidance and mitigation strategies such restoring habitats as soon as possible after any disturbance and considering specific microhabitat requirements are crucial for *Idiosoma kopejtkaorum* to recolonise the area. Planning of clearing activities should also consider the species' less-active periods and ideally, outside of the reproductive season to reduce impact on active populations by reducing the mortality of wandering males and juveniles which are the most exposed during reproductive periods. To overcome habitat fragmentation, techniques such as translocation of spiders to nearby undisturbed habitats may improve their chances of survival and could help maintain the genetic pool. If paired with adequate rehabilitation programs which consider microhabitat requirements and introduction of native plants, mitigation strategies could promote natural ecosystem recovery and benefit the local populations of *Idiosoma kopejtkaorum* at the Development Envelope during the life of mine and after its closure.

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1. INTRODUCTION

Crimson Metals is planning to recommence gold mining at the Mt Gibson Mine in a program of operations called the Mt Gibson Gold Project (hereafter "the Project"). The Mt Gibson Mine is located in the Murchison region, 70 km south-east of Paynes Find (Figure 1). The proposed operations involve the expansion of historical mine pits as well as creation of additional surface infrastructure bounded by a Development Envelope of 3,723 ha and a Disturbance Footprint of 1,562 ha, comprising ~1,190 ha of remnant vegetation and ~372 ha existing disturbance (Tetris Environmental 2023). It is noted that the proposed Airstrip is currently under assessment by the WA Environmental Protection Authority however has not been referred to the Commonwealth Department of Climate Change, Energy, the Environment and Water.

The Project lies in a sub-region rich in mygalomorph spiders, including three conservation significant species belonging to the *Idiosoma* genus, namely Lake Goorly Shield-backed Trapdoor Spider (*Idiosoma kopejtkaorum*), Ornate Shield-backed Trapdoor Spider (*Idiosoma formosum*), and Tree Stem Trapdoor Spider (*Idiosoma [=Aganippe] castellum*). Rix *et al.* (2018a) describes burrows of the protected species as characterised by the "*presence of a 'moustache-like' arrangement of twig-lines and thin flap-type or wafer-type doors which are adorned with leaf litter debris*".

Previous surveys undertaken in the area (Biota 2022, 2023) identified the Endangered species *Idiosoma kopejtkaorum* as occurring within the Survey area and concluded that the Endangered species *I. formosum* and the Priority 4 species *I. [=Aganippe] castellum* are also likely to occur in the survey area. Bennelongia (2024a) conducted a reconnaissance survey, which was conducted as a walk-through that caused little to no disturbance of any kind to the spiders, to provide further information about the occurrence of *Idiosoma* species and to assist in planning exploration drilling programs. The reconnaissance survey found 28 burrows, of which at least 21 were categorised as Likely or Probable *Idiosoma* (Bennelongia 2024a).

Following the reconnaissance survey, an aditional targeted survey was conducted to provide more information about the identity and distribution of the *Idiosoma* species in the survey area. In this, six additional areas were visited during two rounds of survey and 319 mygalomoprh burrows were found across the survey area. Of these, 236 burrows were considered Likely or Probable *Idiosoma* sp. burrows, and 191 of those were categorised as Active (Bennelongia 2024b). The survey identified the presence of three species from the *nigrum*-group as occurring in the survey area, namely *Idiosoma kopejtkaorum, Idiosoma intermedium*, and *Idiosoma* \`BMYG 229\` (*formosum*-complex). In the particular case of *I. kopejtkaorum*, it was identified to occur at four of the seven areas surveyed by Bennelongia (2024a, b). Although the species is known to occur outside of the Project, records suggest that it is localised to the Mummaloo/Mt Gibson broader area, with only six of the 50 (by then) known records of the species being outside of the Mummaloo/Mt Gibson area (Bennelongia 2024b), likely as a consequence of survey efforts around mining projects in the Mt Gibson area.

The current report collates density, distribution, habitat preference, and molecular data generated by Bennelongia (2024a, b), Biota (2022, 2023), and Rix *et al.* (2018a) to assess the impacts of the Project development over populations of the Lake Goorly shield-backed trapdoor spider (*Idiosoma kopejtkaorum*). This reports follows the guidelines for content of a public environmental report (PER) and the statement of reasons for controlled actions (DCCEEW 2024a, c), and it considers advice provided by Commonwealth of Australia (2013) over Matters of National Environmental Significance (MNES).

2. METHODS

In addition to the reconnaissance survey undertaken between 7-9 March 2024 (Bennelongia 2024a) and the two rounds of targeted *Idiosoma* burrow survey undertaken between the 30 April-3 May and 27-31 May 2024 (Bennelongia 2024b), a third targeted survey round was conducted from 2-6 September 2024. Scientific literature (Rix *et al.* 2018a), conservation advice and species profile (DCCEEW 2024b; EPBC

2013) were used to inform survey techniques. The aim of the third targeted burrow survey was to provide further information about the identity and distribution of *Idiosoma* species occurring within and outside the Development Envelope and surrounds, with special consideration for presence of *Idiosoma kopejtkaorum*. Additionally, it provided an opportunity to examine a variety of reference sites, enabling the collection of essential data on habitat characteristics and environmental conditions that could support the species beyond the boundaries of the Development Envelope. This not only contributed to understanding of habitat requirements but also helped assess the potential for habitat preservation or restoration in nearby locations. Staff involved in the targeted burrow search and data analysis are detailed in Appendix 1.

2.1. Survey techniques

Each survey area was surveyed via linear transects and using leaf-blowers to remove leaf litter and to make spider burrows easier to identify. To minimize impacts on *Idiosoma kopejtkaorum*, a non-lethal technique to confirm the identity of animals was used. This technique was modified from Longhorn *et al*. (2007) and consisted of removing one leg from targeted animals for molecular sequencing rather than killing the animals. An endoscope inspection camera (Protech-QC8718) was used to inspect burrows likely to contain *Idiosoma* species to observe diagnostic morphological features of *Idiosoma kopejtkaorum* or any other *Idiosoma* species in the area. Results from the endoscope were used to record presence/absence of *Idiosoma kopejtkaorum* and its habitat characteristics.

Necessary authorization under the WA BC Act 2018 was obtained prior to collecting leg samples of these Endangered animals (Section 40 #TFA 2324-0222). In addition, a subset of the non-target species observed during the survey were collected as whole specimens for further species determination via morphological and molecular methods, and to provide a better understanding of the *Idiosoma* species diversity within the survey area.

2.2. Survey effort

Including the reconnaissance survey and the three rounds of the targeted surveys, a total of 15 areas (referred to as the "survey area") were visited within and outside the Development Envelope, including nine impact areas and six reference areas (Figure 1; Table 1) resulting in a total of 580-man hours. The methods employed during the targeted burrow surveys differed from the reconnaissance survey in use of leaf-blowers to uncover spider burrows in Rounds 1-3 (Table 1; Appendix 2 and 3), rather than finding burrows through visual inspection alone as was done during the reconnaissance survey. Each area, except for Bungeye, was inspected for *Idiosoma* burrows by walking linear transects and using the leaf blowers to uncover spider burrows.

To calculate the survey effort (ha) at each site, a 3 m buffer around the recorded transects was estimated which is the average effective search size when leaf-blowing across transects. Some areas presented vegetation that was too thick and unsafe to walk through, and therefore, were not fully surveyed (Figures 2-3). In total, 52 ha (of the 1,200-ha covered by the survey area) were surveyed within and outside of the survey area during the targeted burrow searches, including 25.84 ha in the Development Envelope, of which 14.04 ha are within the Disturbance Footprint, and 26.4 ha in reference areas (Table 1). Bungeye was not surveyed by Bennelongia and instead was visited solely to inspect targeted mygalomorph spider burrows previously identified by Tetris Environmental (2024a).

Table 1. Survey effort (in ha) at each locality within the Survey area (see Figures 2 and 3).

Locality	Survey Round	Locality area (ha)	Survey effort (ha)	% of Locality	Locality type
Ace High	R2	60.09	2.59	4.31%	Impact
Airstrip	R2/R3	108.98	6.02	5.52%	Reference
Bungeye*	R2	NA	NA	NA	Reference
East Hydro	R1	45.89	2.49	5.44%	Reference
Geotech	R1	45.83	4.91	10.71%	Impact
Highway Pit	R1	75.14	3.20	4.26%	Reference
IWL Mid	R3	100.39	4.17	4.16%	Impact
IWL North	R3	101.93	4.73	4.64%	Impact
Northern A/C	Reconnaissance	312.92	5.25	1.68%	Reference
Sundance	Reconnaissance/R1	29.09	5.02	17.26%	Impact
Ref Airstrip	R3	19.69	0.904	4.59%	Reference
Ref North	R3	103.08	4.23	4.10%	Impact
Ref North-East	R3	45.62	1.61	3.52%	Reference
Ref North-West	R3	29.38	1.22	4.16%	Reference
Ref South-East	R3	84.34	3.77	4.47%	Reference
Ref South-West	R3	38.55	1.94	5.03%	Reference
Total	**NA**	**1,201 ha**	**52 ha**		

*Denotes localities not surveyed by Bennelongia.

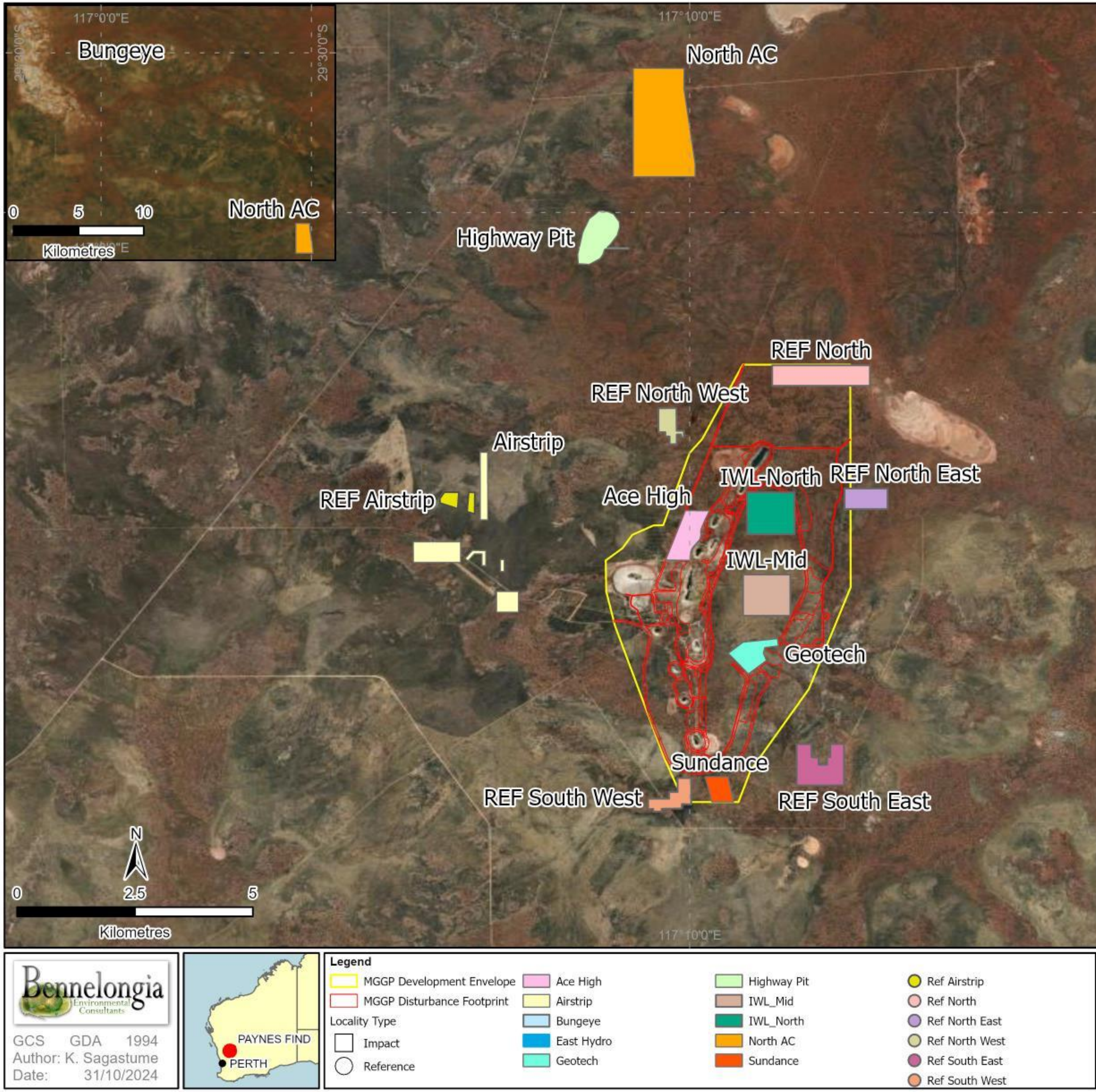
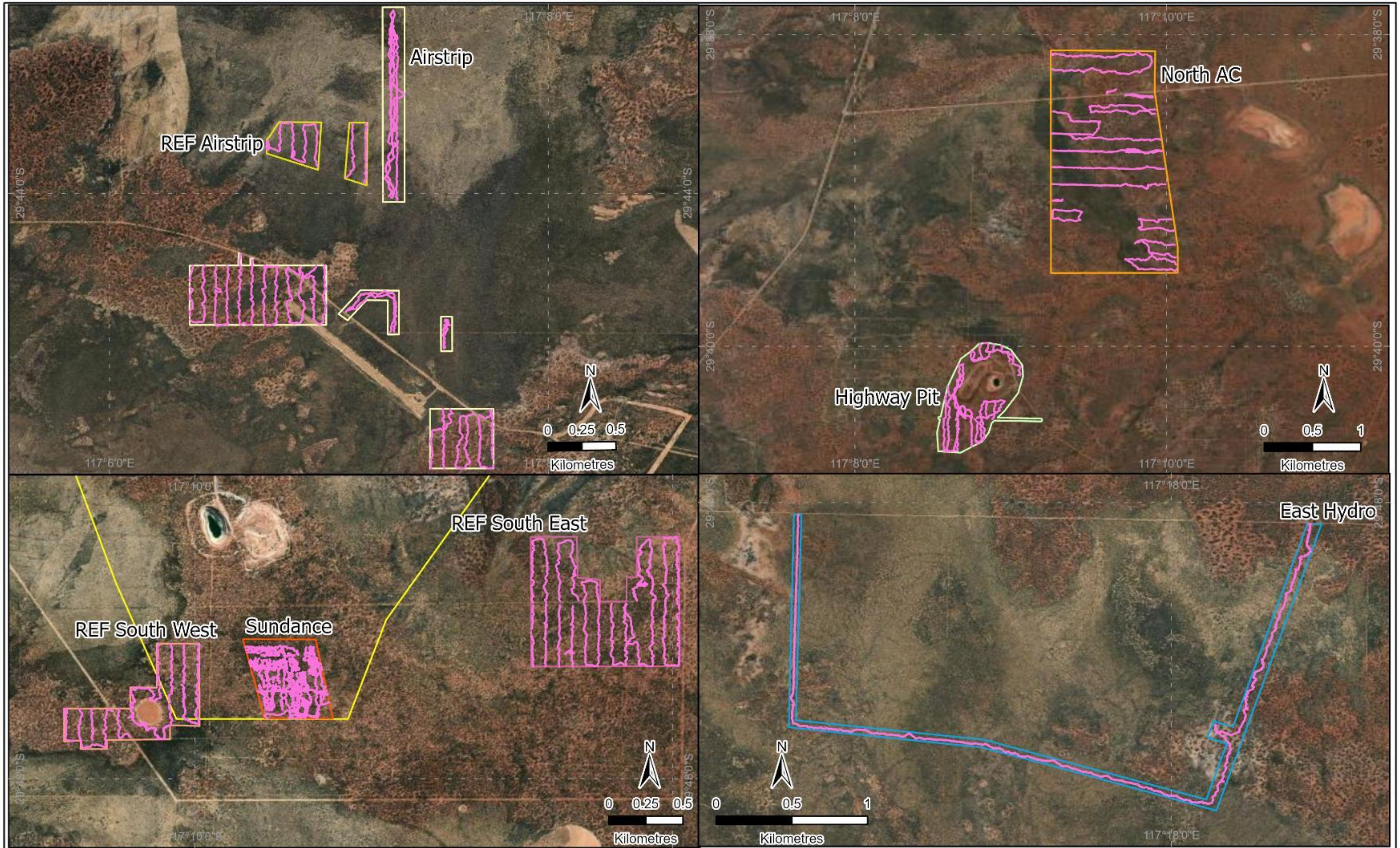


Figure 1. Targeted mygalomorph burrow survey locations within the Survey area.

Note: survey polygons have been modified to reflect the actual areas surveyed by Bennelongia.



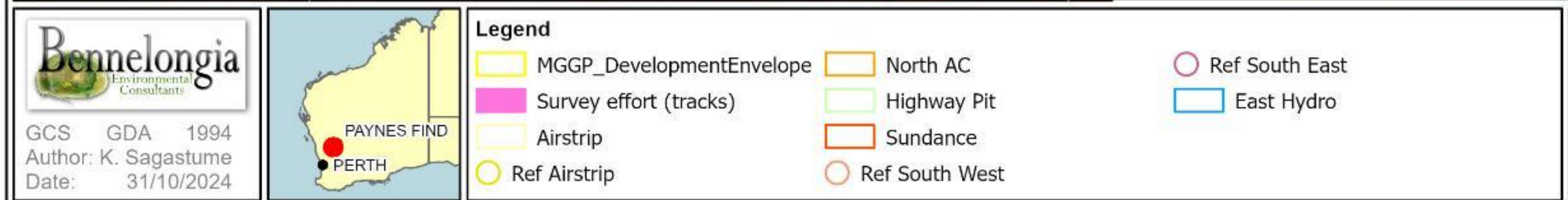
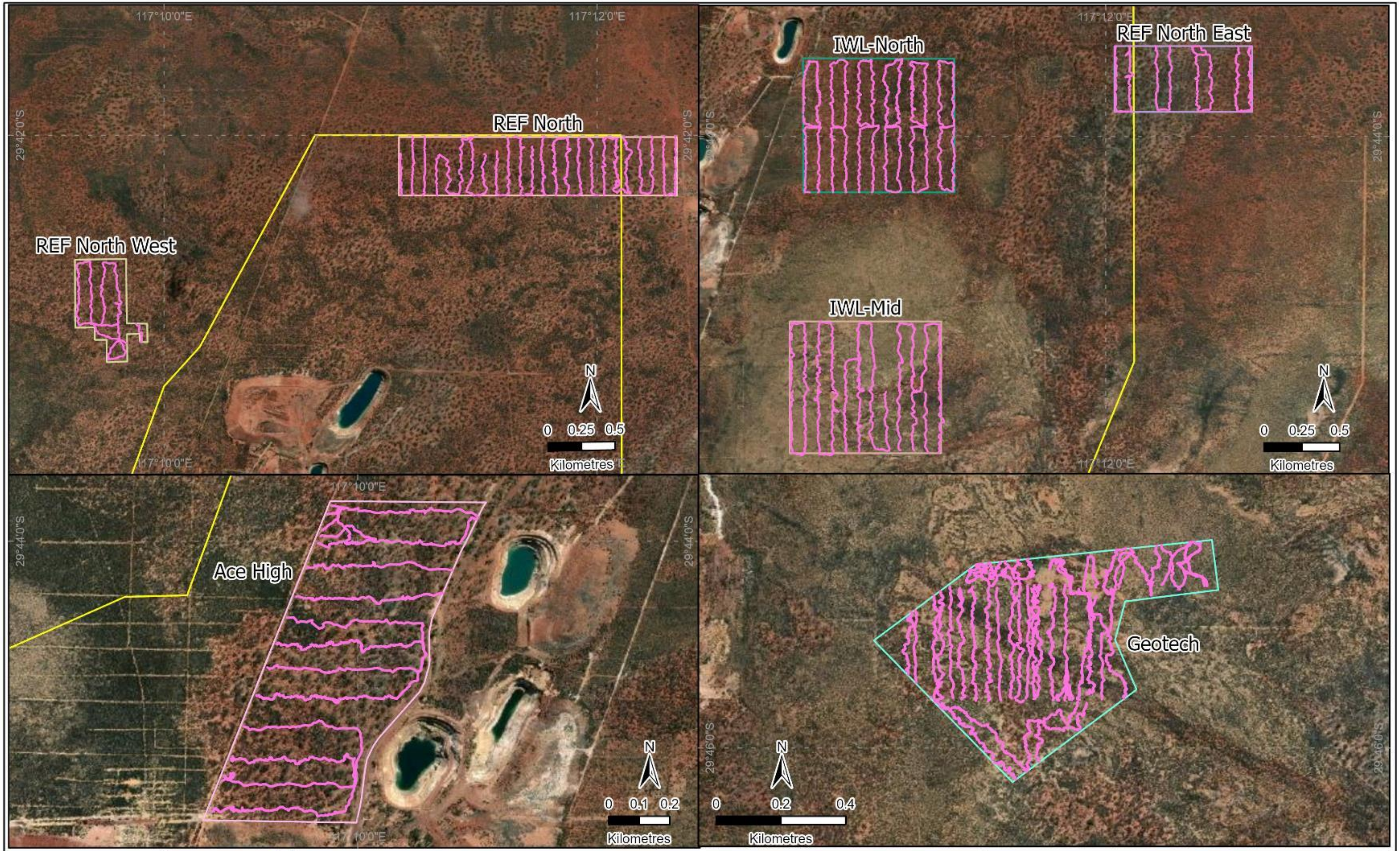


Figure 2. Survey effort (tracks) at selected localities within and around the Survey area.

Note: survey polygons have been modified to reflect the actual areas surveyed by Bennelongia.



Bennelongia Environmental Consultants
GCS GDA 1994
Author: K. Sagastume
Date: 31/10/2024

Legend

- MGGP_DevelopmentEnvelope
- Survey effort (tracks)
- Ref North
- Ref North West
- Ref North East
- IWL_North
- IWL_Mid
- Ace High
- Geotech

Figure 3. Survey effort (tracks) at selected localities within and around the Survey area.

Note: survey polygons have been modified to reflect the actual areas surveyed by Bennelongia.

2.3. Burrow recognition

Burrows of spider species in the *nigrum*-group are characterised by the presence of a 'moustache-like' arrangement of twig lines and thin flap-type or wafer-type doors which are adorned with leaf litter debris (Rix *et al.* 2018a). Adorned burrows are not exclusive to species of the *nigrum*-group and numerous species of *Idiosoma* outside of the *nigrum*-group, along with species of *Gaius* and *Blakistonia*, often adorn their burrows with twig lines (Rix *et al.* 2017).

However, species of *Idiosoma* in the *nigrum*-group are usually differentiated by building a 'moustache-like' arrangement of twig-lines at the burrow entrance (Rix *et al.* 2018a). Burrows of *Gaius* differ from species in the *nigrum*-group by having burrow entrances adorned by radial 'fan' twig lines which can or cannot have flappy doors and much larger size of the door (Rix *et al.* 2018b; Rix *et al.* 2017). Appendix 4 shows details of burrow variability within *Idiosoma kopejtkaorum* specimens.

2.4. Burrow categorisations

Across all areas, each burrow was mapped and assigned to one of three categories based on the likelihood of them belonging to *Idiosoma* species and given an activity status as previously defined by Bennelongia (2024a). Appendix 2 shows examples of *Idiosoma* burrow likelihood and activity categorisations.

Idiosoma likelihood burrow categorisation:

- Unlikely: no visible twig pattern around burrow lid.
- Probable: twig pattern visible, not in "moustache" formation or damaged, precautionary principle applied as it is probable this burrow type belongs to species part of the *nigrum*-group
- Likely: twig pattern clearly in "moustache" formation as typical from species within the *nigrum*-group.

Idiosoma burrow activity categorisation:

- Active: burrow appears to be maintained/structurally sound.
- Inactive: burrow appears to be old, damaged or occupied by another animal.
- Unknown: burrow status is unable to be determined.

2.5. Calculating Extent of Occurrence (EOO) and Area of Occupancy (AOO)

Extent of Occurrence (EOO) is defined as "the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a taxon, excluding cases of vagrancy" (IUCN Standards and Petitions Committee 2024). This parameter measures the spatial spread of the areas currently occupied by a taxon and it is used to measure the degree to which risks from threatening factors are spread spatially across the taxon's geographical distribution. Extent of occurrence is not intended to be an estimate of the amount of occupied or potential habitat, or a general measure of the taxon's range. It can be measured by "a minimum convex polygon, i.e., the smallest polygon in which no internal angle exceeds 180 degrees, and which contains all the sites of occurrence" (IUCN Standards and Petitions Committee 2024).

Area of occupancy (AOO) is a scaled metric that represents the area of suitable habitat currently occupied by the taxon, also defined as "the area within any given species EOO which is occupied by a taxon", and it reflects the fact that a taxon will usually not occur throughout its EOO. Area of occupancy is inversely related to extinction risk, with species at high risk of extinction because of their small AOO often being habitat specialists (IUCN Standards and Petitions Committee 2024), and is closely related to survey effort within the species' EOO. Therefore, AOO is useful for identifying species at risk of extinction because of small population sizes. Estimates of AOO are highly sensitive to the spatial scale at which AOO is measured. The IUCN Standards and Petitions Committee (2024) suggests that to ensure valid use of the criterion and maintain consistency of Red List assessments across taxa, it is essential to scale estimates of AOO using 2 x 2 km (4 km^2) grid cells. Estimating AOO is done by counting the number of occupied cells in a uniform grid that covers the entire range of a taxon (its EOO), and then tallying the total of occupied cells:

AOO= no. occupied cells x area of an individual cell

Example: 63 occupied cells x 4 km^2 = 252 km^2

(see equation 4.1 in IUCN Standards and Petitions Committee 2024)

2.6. Habitat mapping

Habitat mapping was developed through the integration of recognised vegetation units after detailed vegetation assessments were conducted in the Development Envelope by FVC (2023) and considering Vegetation and Substrate Associations (VSAs) as detailed in Tetris Environmental (2024b) and Bamford (2024). Habitat mapping was extended beyond the Development Envelope by following satellite imagery and vegetation mapping using ArcGIS Pro 2.9.

2.7. Population estimates

Considering only the 'Likely' and 'Probable' *Idiosoma* burrows (see section 3.2. Table 3 below), an initial probability of burrows belonging to the targeted species *Idiosoma kopejtkaorum* was calculated by dividing the total number of confirmed *Idiosoma kopejtkaorum* burrows by the total number of inspected burrows (burrow dig or endoscope) and expressed as a percentage.

(1) Probability burrows belong to *Idiosoma kopejtkaorum* = (# of burrows belonging to *Idiosoma kopejtkaorum* / # of inspected burrows) x 100.

After the probability was calculated, the burrow density (per ha) of *Idiosoma kopejtkaorum* was estimated and corrected for the probability of burrows belonging to *Idiosoma kopejtkaorum*.

(2) *Idiosoma kopejtkaorum* burrow density = (# of active Likely & Probable burrows / area (ha)) x Probability of being *I. kopejtkaorum*

Density was used to extrapolate to the total survey area and generate an approximate population estimate within the survey area.

(3) *Idiosoma kopejtkaorum* population estimate within survey area = total survey area x corrected density.

In the absence of any defined population estimate methodologies, this method is considered the best approach to approximating the population size of *Idiosoma kopejtkaorum* based on presence/absence only **within the survey area.** The same formulas were used to estimate population size within the Development Envelope and Disturbance Footprint and adjusting by survey effort at each one of them.

2.8. Impact assessment criteria and ranking

Impact assessment criteria are based on the severity of impacts on fauna assemblages and conservation significant fauna, and are quantified on the basis of predicted population change as a result of direct habitat loss and/or impacts upon ecological processes (Bamford 2024). Following EPA (2016) 'Technical Guidance for Terrestrial Fauna Surveys', Commonwealth Guidelines (DCCEEW 2024b) and by modifying the assessment criteria in Bamford (2024), criteria for assessing the extent of impacts on *Idiosoma kopejtkaorum* were developed (Table 2) to calculate the level of impact the Project development could have over this listed species.

The criteria used were based on rarity of vegetation and landforms, degree of habitat degradation or clearing within the region, and considerations to whether the species is part of fauna protected under international agreements or treaties, a specially protected or priority fauna species (EPA 2016) part of Matters of National Environmental Significance (MNES) (Commonwealth of Australia 2013), along with duration (years) of the impact and reduction of the species' AOO.

Table 2. Assessment criteria for impacts upon *Idiosoma kopejtkaorum*.

Impact Category	**Expected Impact**
Negligible	No population decline expected as a result of the project development, at most, few individuals to be impacted and in line with natural population declines. Duration of the project will be <2 yrs.
Minor	Population decline will occur over short-term period (2-5 yrs) and there will be recovery plans after end of the project (rehabilitation, species monitoring, etc), and/or the expected impact of the project covers <1% of the species known AOO.
Moderate	Population decline will occur over a medium-term period (5-15 yrs) and there will be recovery plans after end of the project (rehabilitation, species monitoring, etc), and/or the expected impact of the project covers between 1-10% of the species known AOO.
Major	Population decline will occur over a long-term period (15-25 yrs) and there will be recovery plans after end of the project (rehabilitation, species monitoring, etc), and/or the expected impact of the project covers between 10-50% of the species known AOO.
Critical	Population decline will be permanent (>25 yrs), with or without recovery plans after end of the project, and/or the expected impact of the project covers >50% of the species known AOO.

2.9. Molecular methods

Twenty-one specimens from the Survey area were taken (either leg or entire animal) and subsequently sequenced. For all spiders, muscle tissue was collected from the legs. DNA was extracted using a Qiagen DNeasy Blood & Tissue kit (Qiagen 2006) using manufacturer's protocols, except for the incubation period in Lysis Buffer ATL and Proteinase K, which was increased to 24 h. Elute volumes were set to 2 x 100 µL.

Primer combinations used for PCR amplifications were jgLCO1490:jgHCO2198 (Geller *et al.* 2013), C1J1718:HCO2198 (Simon *et al.* 1994), targeting the mitochondrial Cytochrome Oxidase I (COI) partial gene. PCR products were sequenced using dual-direction Sanger sequencing carried out by the Australian Genome Research Facility (AGRF). The returned sequences were edited and aligned in Geneious Prime v2024.0.7 (https://www.geneious.com), using MAFFT alignment (Katoh and Standley 2013) and verified in GenBank using the Basic Local Alignment Search Tool nucleotide (BLAST) suite of applications (https://blast.ncbi.nlm.nih.gov/Blast.cgi) (Altschul *et al.* 1990). Pairwise genetic distances to related sequences in the Bennelongia database and in GenBank were calculated as uncorrected p-distances (total percentage of nucleotide differences between sequences) in Geneious. To visualise and analyse phylogenetic relationships between taxa (using novel sequences generated here, and sequences from Bennelongia database and GenBank) maximum likelihood (ML) phylogenetic tree (Appendix 5) was drawn using IQ-tree (Nguyen *et al.* 2015) with TIM2+F+I+G4 as the best fitting model (Kalyaanamoorthy *et al.* 2017) and with 1000 ultrafast bootstrap replicates (Hoang *et al.* 2018).

2.9.1. Haplotype analysis

To determine whether the samples from Mt Gibson and nearby areas such as Mummaloo belong to the same populations, a haplotype analysis was conducted of the available COI sequences (GenBank and Bennelongia Database). A haplotype network of available *Idiosoma kopejtkaorum* sequences (n = 12) was generated with POPart (V1.7) (Leigh and Bryant 2015) and using a Median Joining Network (MJN) analysis.

3. RESULTS

3.1. Survey outcomes-*Idiosoma* burrows in the Survey area

After the reconnaissance and the three rounds of survey, a total of 509 burrows have been mapped from the survey area (Table 3), of which 218 (43%) have been found in reference areas outside the Development Envelope. After filtering out the Unlikely *Idiosoma* records, a total of 340 Likely/Probable *Idiosoma* burrows have been found across the surveyed areas (Table 4; Figure 4). These burrows include *Idiosoma kopejtkaorum* as well as other *Idiosoma* species (see Section 3.4).

Table 3. Spider burrows identified as occurring at the different localities within the Survey area

Locality	Reconnaissance	Round 1	Round 2	Round 3	Total
Ace High			78		78
Airstrip			22	40	62
Bungeye			4		4
East Hydro		17			17
Geotech		44	1		45
Highway Pit		5	43		48
IWL Mid				28	28
IWL North				37	37
Northern A/C	17	2			19
Sundance	7	71			78
Ref Airstrip				11	11
Ref North				25	25
Ref North-East				10	10
Ref North-West	1	5		13	19
Ref South-East				17	17
Ref South-West				6	6
Opportunistic	2			3	5
Total	**27**	**144**	**148**	**190**	**509***

*Total number of burrows inclusive of all burrow categories (Likely, Probable, and Unlikely)

Most of the Likely/Probable burrows (Table 4) have been identified from Ace High (n = 75), followed by Sundance and Airstrip (both n = 43) and Highway Pit (n = 39). IWL Mid yielded the lowest number of burrows (n = 8), closely followed by East Hydro (n = 10). Even though IWL Mid yielded 28 burrows in total, 20 of these were classified as Unlikely *Idiosoma* burrows. This categorisation was supported by seven of the 28 burrows being inspected either through endoscope or by burrow digs that resulted in records of species other than the target *Idiosoma kopejtkaorum*. Together, the six reference areas yielded 56 Likely and/or Probable *Idiosoma* burrows, most of which were found in the Ref North-West (n = 13) and Ref North (n = 12) areas (Table 4).

Even after filtering out the “Inactive” and “Unknown” records from Table 4, a total of 281 **active** burrows were able to be identified from the Survey area (Table 5; Figure 5). Of these, 158 burrows were found inside the Development Envelope, out of which 61 were inside the Disturbance Footprint. Even though inactive burrows have been excluded from the final burrow count for the purpose of this report (Table 5), in general, inactive burrows should not be ignored because they often reflect dynamic populations (i.e., births/deaths; recruits, juveniles, adults, matriarchs) and provide useful information for understanding and guiding conservation and management efforts for threatened mygalomorph spider species (Bain *et al.* 2021). Most of the active burrows were identified from Ace High (n=71), Highway Pit (n=31), and Sundance (n=30). A total of 44 active burrows were identified from reference areas, most of which are found within the Ref North (n = 10), Ref North-West (n = 10), and Ref Airstrip (n = 9) areas (Table 5).

Table 4. Spider burrows per locality, after filtering out the Unlikely *Idiosoma* records.

Locality	**Reconnaissance**	**Round 1**	**Round 2**	**Round 3**	**Total**
Ace High			75		75
Airstrip			20	23	43
Bungeye*			1		1
East Hydro		10			10
Geotech		27	1		28
Highway Pit		2	37		39
IWL Mid				8	8
IWL North				22	22
Northern A/C	13	2			15
Sundance	5	38			43
Ref Airstrip				9	9
Ref North				12	12
Ref North-East				4	4
Ref North-West		3		10	13
Ref South-East				9	9
Ref South-West				4	4
Opportunistic	2			3	5
Total	**20**	**82**	**134**	**104**	**340**

*Denotes localities not surveyed by Bennelongia.

Table 5. Active burrows per locality. Includes only Likely and Probable *Idiosoma* records.

Locality	**Reconnaissance**	**Round 1**	**Round 2**	**Round 3**	**Total**
Ace High			71		71
Airstrip			20	22	42
Bungeye*			1		1
East Hydro		5			5
Geotech		21	1		22
Highway Pit		1	30		31
IWL Mid				8	8
IWL North				18	18
Northern A/C	7	2			9
Sundance		30			30
Ref Airstrip				9	9
Ref North				10	10
Ref North-East				2	2
Ref North-West		2		8	10
Ref South-East				7	7
Ref South-West				3	3
Opportunistic				3	3
Total	**7**	**61**	**123**	**90**	**281**

*Denotes localities not surveyed by Bennelongia.

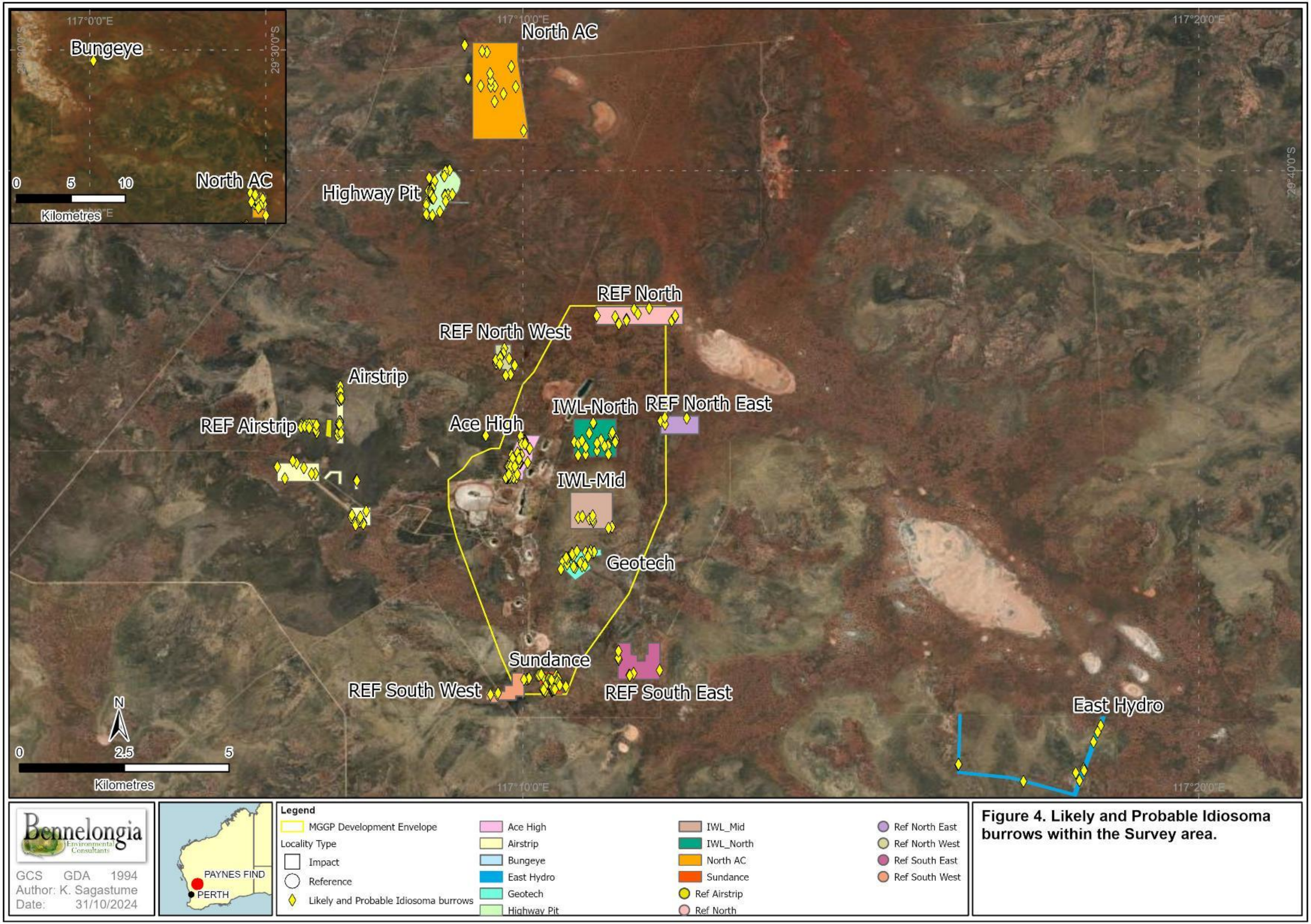


Figure 4. Likely and Probable Idiosoma burrows within the Survey area.

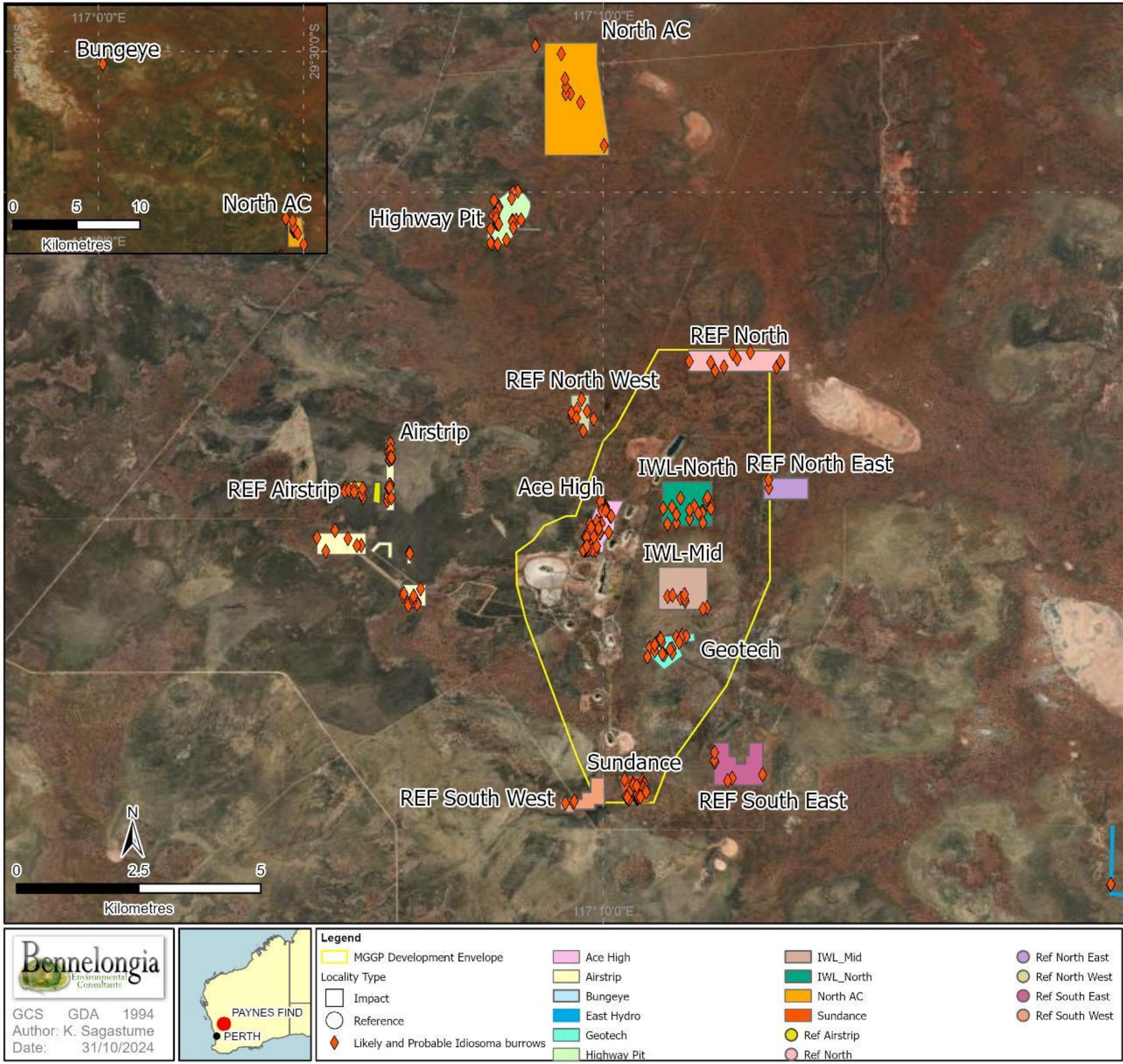


Figure 5. Active Likely and Probable Idiosoma burrows within the Survey area.

3.2. *Idiosoma* molecular analysis

Molecular sequencing (as described in section 2.4) was conducted on 21 specimens (Table 6; Figure 6), including the non-lethal samples (n = 6). Sequencing analysis confirmed the species targeted with non-lethal techniques to be *Idiosoma kopejtkaorum*. Additionally, molecular analysis and morphological inspection of reference specimens collected across different localities identified another four *Idiosoma* species from the Survey area (Table 6; Appendix 3): the undescribed species *Idiosoma* MYG222 and *I.* `BMYG238`, and a new, undescribed species that is part of the *Idiosoma formosum* complex, *Idiosoma* `BMYG229` (*formosum*-complex). The Coolgardie shield-backed trapdoor spider – *Idiosoma intermedium*, which is part of the *nigrum*-group, was found during the survey at a locality outside of the Development Envelope (Bungeye; Figure 6A).

Given the molecular closeness of *Idiosoma* `BMYG229` (*formosum*-complex) to the conservation sensitivity species *I. formosum* (listed as Endangered), the world expert in *Idiosoma* (Dr Michael Rix from the Queensland Museum) was engaged to confirm the identification of a separate species (see section 3.4.3 for further details).

Additionally, the undescribed species *Eucyrtops* `BMYG239`, was collected from the Survey area. This species did not match molecularly with any of the other Idiopidae species known from the Survey area, and therefore was assigned new BMYG code. It is unknown whether it represents a restricted species given the limited dataset for this species.

Table 6. Molecular analysis of *Idiosoma* species collected at the Survey Area.

No	Locality	Species (after sequencing)	Conservation status	Comments
1	Geotech	*Idiosoma* `MYG222`	NA	
2	Highway Pit	*Idiosoma kopejtkaorum*	Endangered	Non-lethal sampling
3	Ace High	*Idiosoma kopejtkaorum*	Endangered	Non-lethal sampling
4	Bungeye	*Idiosoma intermedium*	Priority 3	
5	Airstrip	*Idiosoma* `BMYG229` (*formosum*-complex)	Not yet assessed, although expected to have a restricted distribution as is characteristic of the *formosum*-complex (M. Rix, personal communication, 8 July 2024).	Species morphologically and molecularly closely related with *I. formosum* and confirmed to be part of the *formosum*-complex by M. Rix (2024).
6	Airstrip	*Idiosoma* `BMYG229` (*formosum*-complex)		
7	Airstrip	*Idiosoma* `BMYG229` (*formosum*-complex)		
8	Airstrip	*Idiosoma* `BMYG229` (*formosum*-complex)		
9	Airstrip	*Idiosoma* `BMYG229` (*formosum*-complex)		
10	Airstrip	*Eucyrtops* `BMYG239`	NA	Genus in same tribe (Aganippini) as *Idiosoma* (Rix et al. 2017).
11	Sundance	*Idiosoma kopejtkaorum*	Endangered	Non-lethal sampling
12	Geotech	*Idiosoma kopejtkaorum*	Endangered	Non-lethal sampling
13	Airstrip	*Idiosoma kopejtkaorum*	Endangered	Non-lethal sampling
14	Airstrip	*Idiosoma kopejtkaorum*	Endangered	Non-lethal sampling
15	Ref Airstrip	*Idiosoma* `BMYG229` (*formosum*-complex)	Not yet assessed, although expected to have a restricted distribution as is characteristic of the *formosum*-complex (M. Rix, personal communication, 8 July 2024).	Species morphologically and molecularly closely related with *I. formosum* and confirmed to be part of the *formosum*-complex by M. Rix (2024).

No	Locality	Species (after sequencing)	Conservation status	Comments
16	IWL Mid	*Idiosoma* \`BMYG238\`	NA	No match to any of the known species from the area, new code assigned.
17	IWL North	*Eucyrtops* \`BMYG239\`	NA	Genus in same tribe (Aganippini) as *Idiosoma* (Rix et al. 2017).
18	IWL Mid	*Idiosoma* \`BMYG238\`	NA	No match to any of the known species from the area, new code assigned.
19	IWL Mid	*Idiosoma* \`MYG222\`	NA	
20	IWL Mid	*Idiosoma* \`MYG222\`	NA	
21	AWC	*Idiosoma* \`BMYG229\` (*formosum*-complex)	Not yet assessed, although expected to have a restricted distribution as is characteristic of the *formosum*-complex (M. Rix, personal communication, 8 July 2024).	Species morphologically and molecularly closely related with *I. formosum* and confirmed to be part of the *formosum*-complex by M. Rix (2024).

3.3. Haplotype analysis results

Twelve haplotypes network from *Idiosoma kopejtkaorum* COI sequences were analysed using Median Joining Network (MJN) analysis. From these, only one shared COI haplotype was found, which occurred in two specimens sequenced from Airstrip (approximately 650 m from each other). All other sequences were separated by 3-52 mutations between them. The high number of mutations between sequences suggests that the gene flow in the species is restricted and localised and likely occurs over much smaller distances than was tested for here, which aligns with the short-range endemic criterion of low mobility and poor dispersal abilities (Harvey 2002).

Sequences from Buntine and Maya (see Figure 7-8) were more similar to each other and separated from other regions. Three sequences, one from Charles Darwin, one from Mummaloo, and one from the Survey area, showed a higher level of clustering together, while all the other sequences were separated by multiple mutations (Figure 8).

Based on this haplotype analysis, the patterns seen with the currently available data (n = 12 COI sequences) is not consistent with structured populations within Charles Darwin, Mummaloo and the Survey area, which is likely compounded by the low sample numbers and non-uniform distribution of samples. Even so, there is some evidence for a possible Buntine/Maya sub-population. The limited data suggests there is high diversity in mitochondrial DNA. This was evidenced by multiple mutations, and relatively high intraspecific distances between sequences, even within the study area, with samples collected from the Airstrip separated from the closest Survey area sequences at Sundance (approx. 7.8 km apart) showing intraspecific distances of 4% (with>25 mutational steps between them). This level of intraspecific distances is often seen in species with broad distributions such as *I. clypeatum* which averages 5.4% intraspecific variation in an extent of occurrence of 120,000 km^2 (Rix *et al.* 2018a).

The *Idiosoma kopejtkaorum* haplotype analysis suggests that genetic variation is high even within geographically close localities. Even if habitat connectivity is not completely interrupted, fragmentation could affect unique mitochondrial variation. The importance of this loss to the genetic robustness of the species is currently not clear.

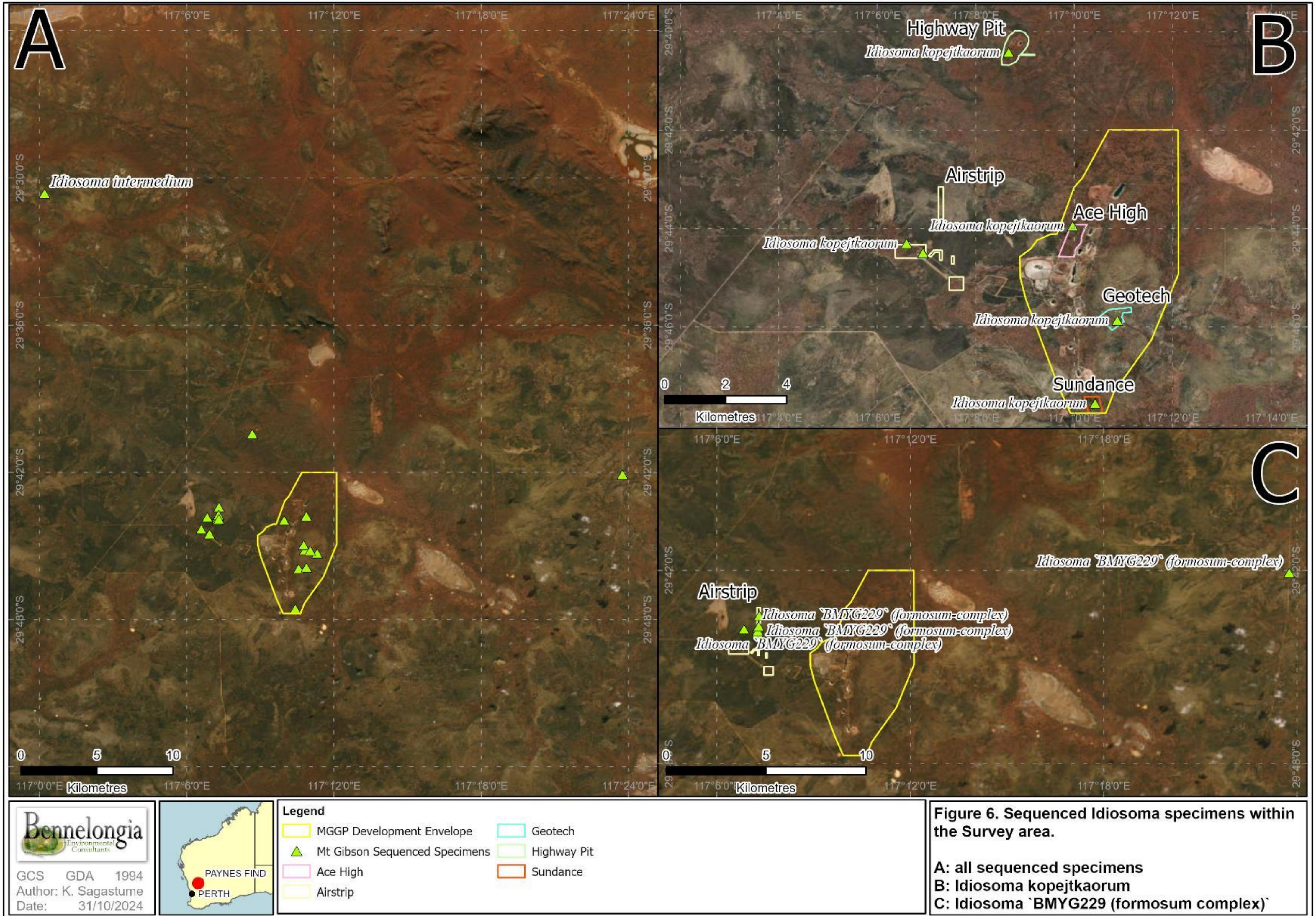


Figure 6. Sequenced Idiosoma specimens within the Survey area.

A: all sequenced specimens
B: Idiosoma kopejtkaorum
C: Idiosoma `BMYG229 (formosum complex)`

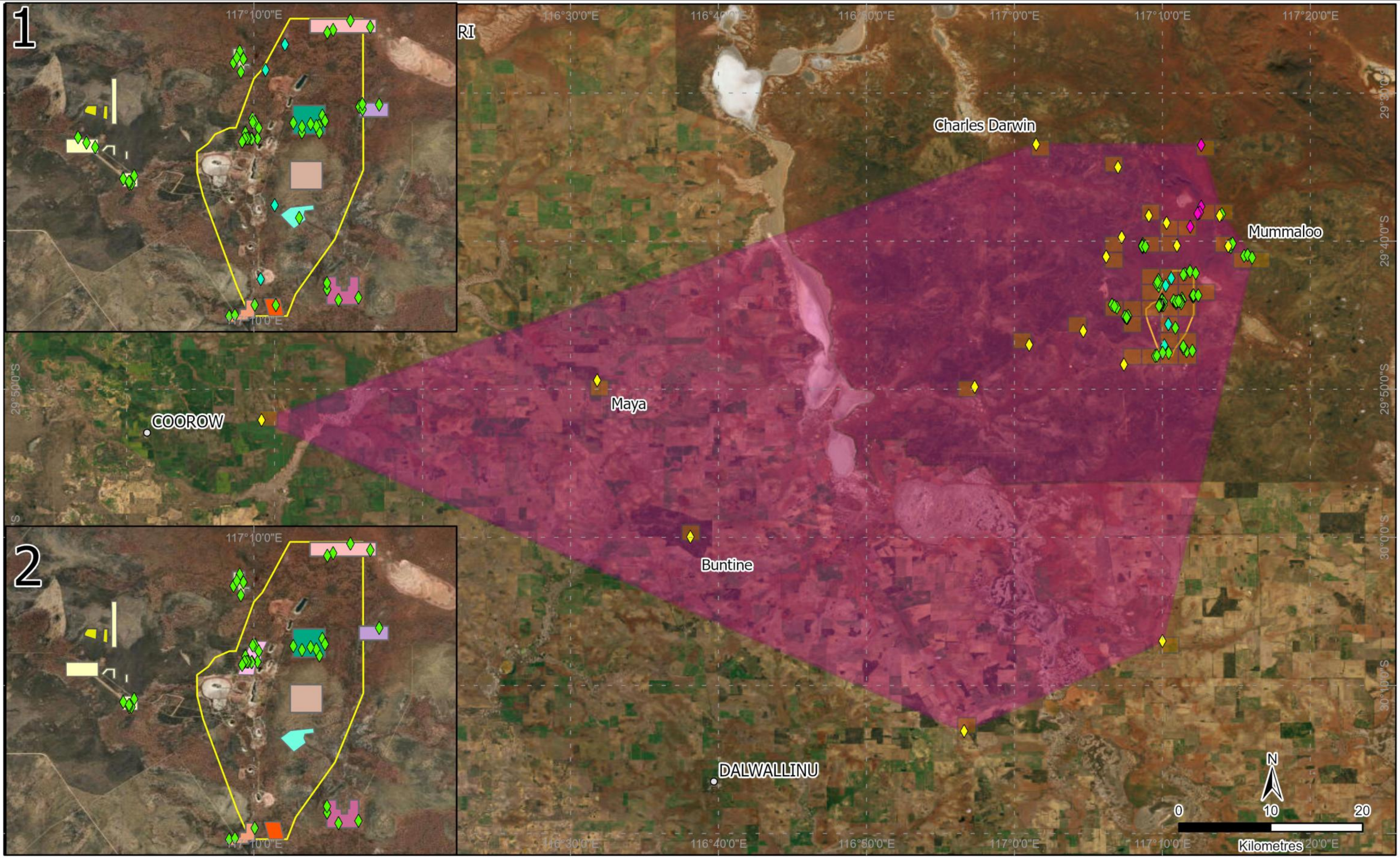
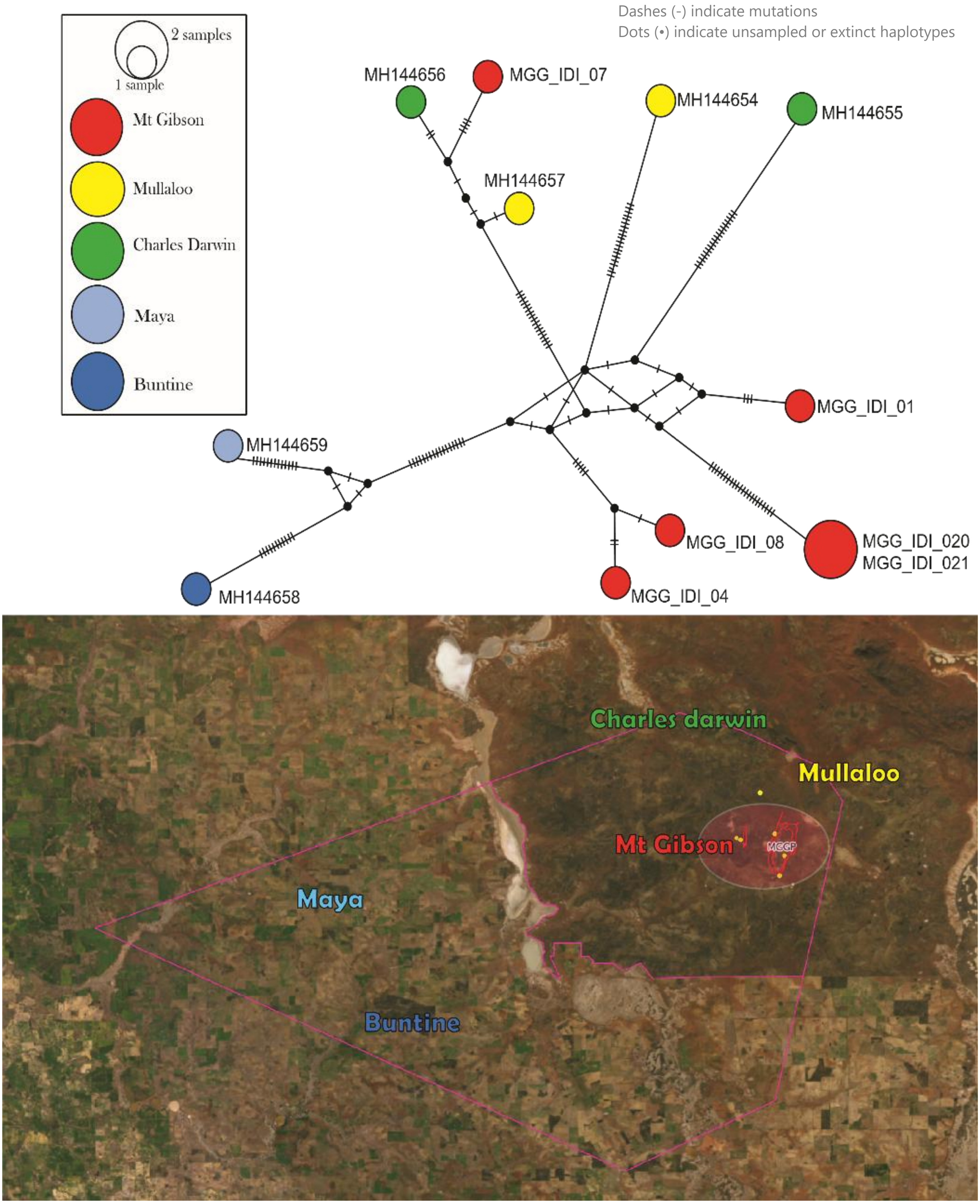


Figure 7. Idiosoma kopejtkaorum known records and species EOO. AOO is shown by the 2x2 km brown grids.

Inset 1 shows confirmed records from the Survey area. Inset 2 shows only records confirmed via endoscope.

Figure 8. *Idiosoma kopejtkaorum* haplotype analysis.



3.4. *Idiosoma* species in the Survey area

3.4.1. *Idiosoma kopejtkaorum*

Idiosoma kopejtkaorum is a member of the northern *clypeatum*-clade within the *nigrum*-group (Rix *et al.* 2018a). It has a restricted distribution in the north-eastern Wheatbelt bioregion and is only found in a small area surrounding Lake Goorly (Rix *et al.* 2018a). The species was assessed as Endangered in 2017 and it was suggested to have a known Extent of Occurrence (EOO) of 3,571 km^2 and an Area of Occupancy (AOO) within that range of <500 km^2 (Rix *et al.* 2018a).

Sequenced specimens (n=6) of *I. kopejtkaorum* were collected from Airstrip, Ace High, Geotech, Highway Pit, and Sundance (Table 6; Figure 6B; Appendix 4), confirming via molecular data the presence of the species within the Survey area. Additionally, 61 specimens from across the survey area were inspected either via burrow dig (n = 8) or endoscope (n = 53; Figure 7) and confirmed morphologically to be the target species *I. kopejtkaorum* confirming its presence also within IWL North, Ref South-East, Ref South-West, Ref North, Ref North-East, and Ref North-West (Figure 7; Appendix 4). When adding the species records from this survey, along with records for other consultancy surveys (Bennelongia 2012; Biota 2022, 2023) and scientific literature (Rix *et al.* 2018a), a total of 108 *I. kopejtkaorum* records across the species extent of occurrence (EOO) were found. Of these, 90 are found within the Mummaloo/Mt Gibson area (Figure 7) and of those, 66 were found by the Project study team.

Analysis of the existing survey data, in addition to opportunistic data collected by Tetris in April 2025, suggests that the **EOO** increases from **4,377 km^2** (this survey) to **4,444 km^2** (inclusive of Tetris-April 2025 data) and the **AOO** increases from **160 km^2** (**16,000 ha;** this survey) to **172 km^2** (**17,200 ha;** inclusive of Tetris-April 2025 data). The AOO was estimated using the formula detailed in Section 2.4, where only 40 of the 2 x 2 km grids covering the species EOO were occupied by the species. If we consider that most (n = 32) of the grids were occupied just by single points or multiple points covering just half of the grid (i.e., 0.5; Figure 5), the AOO could be as low as 108 km^2. However, for the purpose of this report, we consider the species' AOO to be 172 km^2.

3.4.2. *Idiosoma intermedium*

Idiosoma intermedium is one of the few *nigrum*-group species which has a relatively widespread, but poorly defined, distribution in the eastern Wheatbelt and north-western Coolgardie bioregions. Its known range extends from Bodallin in the eastern Wheatbelt to further east near the Helena-Aurora Range, Mount Manning, and Koolyanobbing in the Coolgardie bioregion. It has been assessed as a Priority 3 species given its occurrence in areas prospective for mining and mineral resources (Rix *et al.* 2018a). *Idiosoma intermedium* was collected from outside of the Development Envelope, at Bungeye (Figure 6A), from an area outside of previously surveyed areas by Tetris Environmental. The closest known records for this species are found approximately 110 km southeast of the Bungeye record (Atlas of Living Australia 2024; Rix *et al.* 2018a). Molecular sequencing resulted in 92.32 % similarity of animals from Bungeye and publicly available sequences (GenBank) of other records (Appendix 3). Possible *Idiosoma* burrows have been identified within the Bungeye area by Tetris Environmental (2024a). These have the potential to align with *I. intermedium*. Given the current known distribution for this species, it is likely to occur across the northern section of the Mt Gibson area.

3.4.3. *Idiosoma* \`BMYG229\` (*formosum*-complex)

Specimens collected from Airstrip (Figure 6C) were analysed through morphological methods, which along with geographical data, suggested the collected specimens belonged to the listed species *Idiosoma formosum*. However, in-house molecular sequencing analysis grouped the records as a sister species to *I. formosum* sequences, with a 90.6-91.3 % similarity (Appendix 3). Sequence data, collection localities, and specimen images generated by Bennelongia were shared with Dr Rix to aid in the species determination. His analysis included a dataset with only representative sequences from species in the *nigrum*-group, resulting in a total analysis of 261 terminals (Rix, unpublished data). Based on his analysis and noting that this result is in absence of male morphology or nuclear DNA, Rix (personal communication, 8 July 2024) suggests sequenced specimens are genetically consistent with a new, undescribed species of the *formosum*-complex, namely *Idiosoma* `BMYG229` (*formosum*-complex). In *Idiosoma*, distinctive taxa can differ by as little as ~8% COI divergence, whereas others can differ by up to 13%. The evolution of COI is such that these values are dependent on the biology, distribution, recency and gene flow of the species in question.

No formal conservation assessment is known for this undescribed species; however, it is part of the *nigrum*-group which is known to have numerous species with restricted distributions and of conservation significance such as the Endangered *I. formosum* and Priority 1 *I. mcnamarai* (M. Rix, personal communication, 8 July 2024). This species was matched molecularly with one specimen collected from AWC suggesting the species has linear range of at least 26 km (Figure 4C). This species represents the third species within the *nigrum*-group known from the MGGP.

3.4.4. *Idiosoma* `BMYG238`

Two specimens of *I.* `BMYG238` were collected from IWL Mid which after molecular sequencing analysis did not match any of the sequenced species known from the Survey area (Appendix 3). This species is not part of the *nigrum*-group and, although impossible to be sure with the current data, it is not expected to represent a conservation sensitive species.

3.4.5. *Idiosoma* `MYG222`

Idiosoma `MYG222` is an undescribed species with a widespread distribution within the Goomalling-Merredin sub-region, where it has a linear range of at least 190 km (Bennelongia 2022; Biota 2022). This species was collected from Geotech during Bennelongia surveys and has also been collected from approximately 500 m west of the Geotech boundary by Biota (2022). No conservation assessment has been made for this undescribed species but given the current known distribution, it is not expected that it is a restricted species. Molecular analysis resulted in 96.35 % similarity with specimens previously collected from Arrowsmith Central, 190 km northwest from Mt Gibson (Appendix 3).

4. HABITAT ASSESSMENT

The EOO of *Idiosoma kopejtkaorum* can be divided into two broad categories based on habitat connectivity: discontinuous habitat and continuous intact habitat (Figure 9). Discontinuous habitat is defined by fragmented, and generally poor-quality habitat within the species EOO, and represents habitat that lacks connectivity between populations. In this case, discontinuous habitat is associated with the cleared agricultural zone of the Avon Wheatbelt Bioregion. Continuous habitat is defined by good quality, unfragmented habitat which has the potential to provide connectivity between populations. Continuous habitat represents 1,653 km^2 (37.2%) and discontinuous habitat represents 2,791 km^2 (62.8%) of the 4,444 km^2 of the EOO. The Survey area is located within the continuous habitat portion and is bounded by a Development Envelope of 3,723 ha, and has a proposed Disturbance Footprint of 1,562 ha (Tetris Environmental 2023).

Eight Vegetation and Substrate Associations (VSAs) have been identified as occurring within the Disturbance Footprint (Bamford 2024). The most abundant VSA within the Development Envelope was VSA 4: Eucalyptus woodlands (1,317 ha) followed by VSA 1: Acacia shrublands (840 ha) and VSA 3: Callitris woodland (466 ha). The most abundant VSA within the Distrubance Footprint was VSA 1: Acacia Shrublands (543 ha), followed by VSA 4: Eucalyptus woodland (251 ha) and VSA 5: Mallee woodland (237 ha). Our extended habitat mapping follows the same eight VSAs previously described by Bamford (2024), but extends the mapped area from 4,082 ha within the Development Envelope to 6,454 ha, both within and outside the Development Envelope and covering all of the polygons within the survey area (Figure 9; Table 7). The most abundant VSAs are Eucalypt woodland and Acacia shrubland, while the less common (natural) VSAs was mixed shrublands.

Table 7. VSAs within the DE, DF and total survey area.

VSA	Development Envelope (ha)	Disturbance Footprint (ha)	Total survey area (ha)	Percentage total survey area	Description (Bamford 2024).
VSA 1: Acacia shrubland	840	543	1,329	20.6%	Shrublands to tall shrublands of *Acacia* spp. with occasional *Allocasuarina* sp. on pale brown/raw umber sandy loam with some gravel.
VSA 2: Allocasuarina shrubland	35	20	605	9.4%	Tall shrubland dominated by *Allocasuarina acutivalis* subsp. *acutivalis* with some *Acacia* spp. on play yellowish sands and sandy loam.
VSA 3: Callitris woodland	466	144	636	9.9%	Low woodland of *Callitris columellaris* with occasional eucalyptus over a diverse and varied shrub storey on red-brown loam.
VSA 4: Eucalypt woodland	1,317	251	2,467	38.2%	Open woodland dominated by *Eucalyptus* spp. over a low, mid-open chenopod shrubland on red-brown clay or clayey loam.
VSA 5: Mallee woodland	424	237	613	9.5%	Open woodland dominated by *Eucalyptus* spp. over *Acacia* spp. shrubland on red-brown loam or red sandy loam.
VSA 6: Mixed shrubland	33	1	124	1.9%	Complex shrubland often dominated by *Melaleuca* spp.
VSA 7: Rehabilitation	456	232	477	7.4%	Previously mined or disturbed areas that have been rehabilitated.
VSA 8: Cleared	154	134	203	3.1%	Cleared or disturbed areas.

Of the 281 active Likely or Probable burrows identified within the survey area (as per Table 5), **63%** (n = 177) were found **within eucalypt woodland**, and **18%** (n = 51) **within acacia shrublands** (Figure 7). Just 8% (n = 23) were found within callitris woodland, and 6% (n = 16) were found within mallee woodland. The remaining 14 individuals (i.e., 5%) were found either outside of the DE (n = 4), in Allocasuarina shrubland (n = 7), or mixed shrubland (n = 3). This finding aligns with the SPRAT profile for *Idiosoma nigrum* (subsequently divided into numerous species, including *I. kopejtkaorum*), which suggests that populations of *I. kopejtkaorum* are usually associated with eucalypt woodlands and acacia shrublands (DCCEEW 2024b).

5. POPULATION ESTIMATE

5.1. Survey Area

Out of the 281 active Likely and Probable burrows identified within the survey area, 90 were inspected either via endoscope or burrow dig (section 3.4.1; Table 5, Figure 7). From these, 67 burrows were confirmed as the targeted *Idiosoma kopejtkaorum*, while the remaining (n = 23) were other, non-target species. The *survey area* covers a total of 1,201 ha, with a survey effort of 52 ha within it. It includes all the polygons surveyed by Bennelongia along the multiple survey rounds, including polygons both inside and outside of the DE. Following the formulas detailed in section 2.6, the probability of burrows belonging to *Idiosoma kopejtkaorum* was estimated as follows:

(1) Probability burrows belong to *Idiosoma kopejtkaorum* = (67 *Idiosoma kopejtkaorum* burrows / 90 inspected burrows) x 100.

Which resulted in a probability of 74% of Likely and Probable burrows being the targeted species *Idiosoma kopejtkaorum*. Burrow density (burrow/ha) was estimated and corrected for the probability of burrows belonging to *Idiosoma kopejtkaorum* as follows:

(2) *Idiosoma kopejtkaorum* burrow density = (281 active Likely or Probable burrows / 52 ha survey effort within the survey area) x 74%

Resulting in a burrow density of 4 *Idiosoma kopejtkaorum* burrows per ha. This density was used to extrapolate to the total survey area and generate an approximate population estimate within the survey area as follows:

(3) *Idiosoma kopejtkaorum* population estimate within survey area = 1,201 ha x 4 burrows per ha.

Resulting in an estimated *Idiosoma kopejtkaorum* population along the survey effort (52 ha) of 208 spiders. Extrapolating this population estimate to the entire survey area (1,201 ha), suggests an estimated population of **4,803 spiders within the entire survey area**, of which 3,131 spiders are expected to occur within the suitable habitats (eucalypt woodland and acacia shrublands; 783 ha) inside the survey area.

5.2. Development Envelope

Populations estimates within the Development Envelope were made by following the same formulas but adjusting by survey effort within the Development Envelope. Population estimates specifically within eucalyptus woodland and acacia shrubland (the preferred habitats for the species) were also estimated.

The survey effort within the Development Envelope was of 25.84 ha, out of which 18.65 ha corresponded to eucalyptus woodland and acacia shrublands. Total area of the DE (remnant vegetation only) is 3,115 ha, of which ~2,158 correspond to suitable habitats (eucalypt woodland and acacia shrubland).

Population estimates for *Idiosoma kopejtkaorum* inside the Development Envelope as follows:

(1) Probability burrows belong to *Idiosoma kopejtkaorum* = (30 *Idiosoma kopejtkaorum* burrows / 40 inspected burrows) x 100. Suggesting a probability of 75% of burrows within the Development Envelope belonging to *Idiosoma kopejtkaorum*.

(2) *Idiosoma kopejtkaorum* burrow density = (158 active Likely or Probable burrows / 25.84 ha within Development Envelope) x 75% Resulting in a density of 4.6 *Idiosoma kopejtkaorum* burrows per ha within the Development Envelope.

(3) *Idiosoma kopejtkaorum* population estimate within Development Envelope = 25.84 ha x 4.6 burrows per ha. Suggesting 119 *Idiosoma kopejtkaorum* spiders within the survey effort areas inside the Development Envelope.

Extrapolating this result to the entire Development Envelope area (remnant vegetation only 3,115 ha) suggests an *Idiosoma kopejtkaorum* population estimate of **14,329 spiders inside the DE**.

Considering eucalyptus woodland and acacia shrubland represented 2,158 ha of the Development Envelope, there is an estimated population of **9,895** *Idiosoma kopejtkaorum* spiders within these habitats occurring inside the Development Envelope.

5.3. Disturbance Footprint

Populations estimates within the Disturbance Footprint were made by following the same formulas but adjusting by survey effort within the Development Envelope. Population estimates specifically within eucalyptus woodland and acacia shrubland (the preferred habitats for the species) were also estimated.

The survey effort within the Disturbance Footprint was of 14.04 ha, out of which 10.54 ha corresponded to eucalyptus woodland and acacia shrublands.

Population estimates for *Idiosoma kopejtkaorum* inside the Disturbance Footprint as follows:

(1) Probability burrows belong to *Idiosoma kopejtkaorum* = (20 *Idiosoma kopejtkaorum* burrows / 13 inspected burrows) x 100. Suggesting a probability of 65% of burrows within the Disturbance Footprint belonging to *Idiosoma kopejtkaorum*.

(2) *Idiosoma kopejtkaorum* burrow density = (61 active Likely or Probable burrows / 14.04 ha within Disturbance Footprint) x 65% Resulting in a density of 2.8 *Idiosoma kopejtkaorum* burrows per ha within the Disturbance Footprint.

(3) *Idiosoma kopejtkaorum* population estimate within Disturbance Footprint (remnant vegetation only) = 1,196 ha x 2.8 burrows per ha. Suggesting **3,349** *Idiosoma kopejtkaorum* spiders within the Disturbance Footprint.

Considering eucalyptus woodland and acacia shrubland represent 794 ha of the Disturbance Footprint, there is an estimated population of **2,223** *Idiosoma kopejtkaorum* spiders within these habitats occurring inside the Disturbance Footprint.

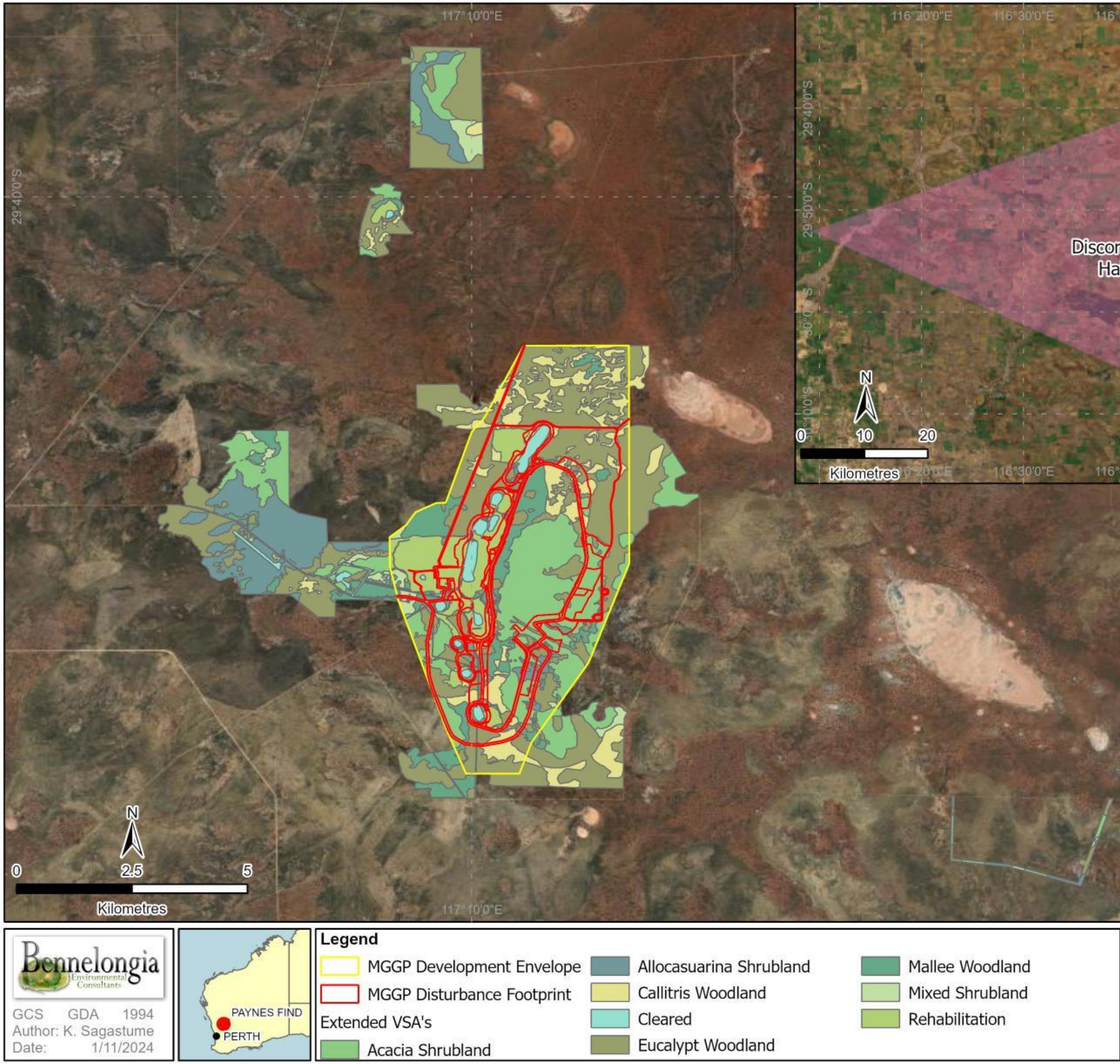
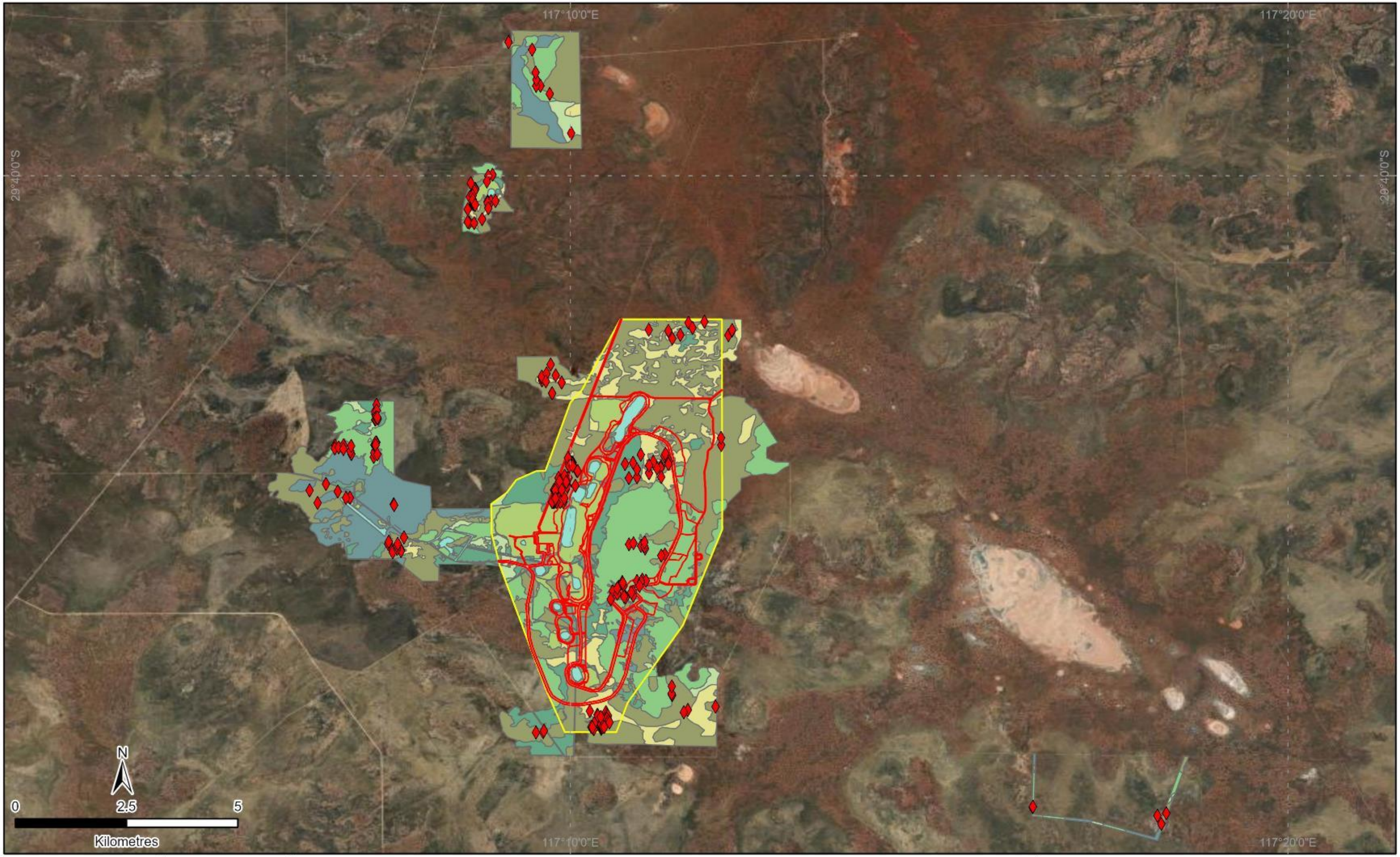


Figure 9. VSA mapping within the Survey area.

Inset shows broad habitat connectivity within Idiosoma kopejtkaorum Extent of Occurrence (EOO).



Bennelongia Environmental Consultants

GCS GDA 1994
Author: K. Sagastume
Date: 1/11/2024

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Legend

- MGGP Development Envelope
- MGGP Disturbance Footprint

Extended VSA's

- Acacia Shrubland
- Allocasuarina Shrubland
- Callitris Woodland
- Cleared
- Eucalypt Woodland
- Mallee Woodland
- Mixed Shrubland
- Rehabilitation

Figure 10. Likely and Probable Active Idiosoma burrows over VSA habitats within the Survey area.

6. IMPACT ASSESSMENT

6.1. Impact over species' EOO and AOO

Most of the species' EOO is found within discontinuous habitat (Figure 9). Almost all the known localities for the species within the discontinuous habitat, except for one within Buntine Nature Reserve, most likely represent isolated, non-viable populations restricted to remnant bushland and at risk of population bottleneck due to lack of genetic connectivity and ongoing anthropogenic pressures (farming, housing, etc). Rix *et al.* (2018a) identified that in the heavily cleared north-eastern Wheatbelt the threats to *Idiosoma kopejtkaorum* are manifold, but specifically over the Mummaloo/Mt Gibson region, the species is and will continue to be at risk from mining and minerals resource development.

Of the Disturbance Footprint's 1,562 ha, 447 ha are found outside of the species' known AOO. This means the Project will directly impact 1,115 ha, or **6.48%**, of *Idiosoma kopejtkaorum*'s known AOO. Following the impact assessment criteria (section 2.7, Table 2), based on the current understanding of the species' AOO from surveys to date, the potential level of impact the Project may have on populations of *Idiosoma kopejtkaorum* is considered to be **moderate**. This is based on population decline expected to occur over a medium-term period (life of mine estimated at 11 years), and a considerable amount of the species' AOO to be impacted. Individual threatening processes resulting from the Project development are discussed below. An impact categorisation is assigned to each one of them.

6.2. Habitat clearing and degradation

The MGGP Development Footprint comprises 1,562 ha, of which approximately 1,190 ha (76%) represents native vegetation (Bamford 2024; Tetris Environmental 2023). This represents approximately 0.9% of the native vegetation within 15 km of the survey area (Bamford 2024). Additionally, all the identified VSAs are known to occur extensively outside of the Development Envelope. Nonetheless, vegetation within the Development Envelope has been considered in its majority (67.33%) as being in 'Excellent' condition (FVC 2023) with only between 3% (this report) to 8% (Tetris Environmental 2024b) of the mapped habitat being already cleared.

Loss of habitat is likely to affect populations of *I. kopejtkaorum* because *Idiosoma* species are highly dependent on specific soil types and microhabitats to build their burrows (Rix *et al.* 2018a). Habitat clearing could lead to population declines or complete extirpation in some areas because of loss microhabitats or changes in microclimate resulting from habitat clearing (mainly temperature and humidity).

According to Tetris Environmental (2024b), two VSAs within the Development Envelope represent most (49.3%) of the Disturbance Footprint, namely acacia shrublands (34.4%) and eucalypt woodland (14.9%). These same VSAs are the ones where most of the *I. kopejtkaorum* records (>81%) have been found.

This level of habitat clearing and degradation is categorised as a **minor** impact to populations of *I. kopejtkaorum* based on the fact that, although adverse impacts can occur to local populations, the species is known to occur outside of the proposed impact area, and habitat for the species is intact in the local region and not restricted to the Project's Disturbance Footprint.

6.3. Fragmentation

Clearing of habitat leads to fragmented habitats, which isolates individuals or small groups of spiders and creates fragmented populations with low to no connectivity between each other. Given that *Idiosoma* species are sedentary and have limited dispersal abilities (Harvey 2002), fragmentation poses serious challenges as they rely on specific microhabitat conditions and rarely venture far from their burrow locations. The only exception is reproductive male mygalomorph spiders, which often travel under 100 m per day (Janowski-Bell and Horner 1999) and up to 500 m in search of females for mating

(DCCEEW 2024b). Even juvenile dispersal is often limited to short distances from the maternal burrow (few meters) forming family clusters that is typical of mygalomorph spiders (DCCEEW 2024b). Isolation of populations within fragmented habitat patches results in extremely low chances of individuals moving between the patches. Consequently, this results in genetic isolation and reduced genetic connectivity, limiting gene flow between populations. It has been highlighted that because shield-back trapdoor spiders' low dispersal abilities, fragmentation and isolation could play a role in the declining populations of species within the *nigrum*-group (DCCEEW 2024b). Since dispersal of mygalomorph spiders is limited by their long generation times, ecological niches, and poor dispersal abilities, mygalomorph spiders are particularly susceptible to vicariance by habitat fragmentation and/or parapatric divergence (Wong *et al.* 2017).

When genetic connectivity is lost, exchange of beneficial traits and adaptations between populations is also lost. It is important for sedentary animals to maintain a certain level of genetic connectivity as adaptive traits between populations, such as adaptations to climate change or habitat alterations, cannot spread between populations without gene flow.

Overall, fragmentation leads to reduced population viability which results in vulnerable populations. When populations become too small and genetically homogeneous, they become more vulnerable to be wiped out by catastrophic events such as drought, wildfires, or diseases. Without gene flow from nearby populations which can recolonise and/or reproduce with the isolated populations, local extinctions and permanent loss of populations can occur, reducing the overall range of the species.

As was discussed in section 3.3, the *Idiosoma kopejtkaorum* haplotype analysis suggests that genetic variation is high even within geographically close localities. Even if habitat connectivity is not completely interrupted, fragmentation could affect unique mitochondrial variation. The importance of this loss to the genetic robustness of the species is currently not clear.

Given the low dispersal abilities of the species, and the likely loss of genetic diversity, the level of impact to genetic connectivity as a result of habitat fragmentation is considered **moderate.** This is because, even though gene flow will not completely stop between populations outside the Development Envelope, clearing and fragmentation will remove part of the known gene pool for the species.

6.4. Species biological processes

The increased exposure to sunlight, which results from vegetation removal may alter soil moisture levels or increase internal burrow temperatures, making the environment unsuitable for survival, burrow maintenance, or creation of new burrows by younger (spiderlings) life stages. As a result of habitat degradation, increased reduction of prey availability (small insects) on which the species rely on may occur. Not only the abundance, but also the variety of prey can be affected, which may result in the spiders' ability to feed and affects their growth and reproductive capacity.

As trapdoor spiders have long life cycles (Mason *et al.* 2018c) and often show differences in habitat preference depending on their life stage (Mason *et al.* 2018a), habitat degradation can disrupt their reproductive processes. Habitat fragmentation can exacerbate the issues with reproductive capacity as it makes it harder for males to locate females for mating, and fragmented populations tend to have limited access to potential mates, reducing mate choice and potentially leading to inbreeding.

Dispersal is another critical phase for trapdoor spiders which may be affected due to habitat clearing and fragmentation. Particularly, juvenile specimens who need to leave the maternal burrows may have difficulties to find suitable areas to establish their own burrows. Physical barriers such as agricultural fields reduce the number of suitable microhabitats and often lead to overcrowding of the few suitable remaining patches, also causing high mortality rates among dispersing individuals who cannot build their burrows.

Burrow construction is a crucial part of trapdoor spiders' ambush strategy. However, habitat degradation can alter soil quality, making it harder for spiders to build and/or maintain their burrows. Soil compaction and loss of vegetation cover can change the structure and moisture of the soil, reducing its suitability for burrow construction, which would lead to spiders losing their primary method of securing food and refuge. These changes will usually be accompanied by microclimate alterations and changes in water retention which will lead to burrows becoming too dry and result in the spiders' desiccation (particularly for juveniles). Burrow maintenance is likely also going to be affected because of the reduction of structural materials. In species from the *nigrum*-group, this is particularly important as they need materials such as leaf litter, twigs, and organic debris to create the radiating twig-lines that extend from the edge of the burrow trapdoor (Rix *et al.* 2018a).

Based on the likely impacts, this component can range from **negligible** to **minor** impact on the species biological processes**.** At a local scale (within the MGGP), the impacts are likely to be minor as only those individuals within the clearing areas will be directly affected. At a regional scale the impacts are likely to be negligible as this will mostly affect local populations and will have little to no impact at a regional scale.

6.5. Disturbance (Dust, Light, Noise, and Vibration)

Uncontrolled dust emissions have the potential to affect burrow construction and operation by clogging burrow entrances and trapdoors which the spiders rely on to ambush prey. It consequently affects the spider's ability to hunt and could force them to spend more energy on cleaning and maintaining duties. Dust could potentially seep into the burrow itself, clogging air passages and altering microclimate within the burrow. If dust enters the burrows, the spiders' respiratory structures (book lungs) could be compromised, particularly in juvenile stages.

Light pollution from mining operations could affect *Idiosoma kopejtkaorum* as they are nocturnal hunters that rely on darkness and camouflage (burrow) to effectively capture their prey. Artificial lighting can affect prey's natural (nocturnal) activity patterns, reducing the spiders' ability to catch prey. Additionally, it may increase the risk of predators within well-lit areas as wandering males and dispersing juveniles will become easier to detect under artificial lighting.

Given that prey capture by *Idiosoma* species is often based on vibration cues generated by the prey, noise pollution from heavy machinery or vehicles can generate vibrations or ambient noise that mask or confuse the natural important vibratory signals. In addition to this, whilst unlikely, excessive vibration from machinery operation or vehicle traffic could cause sensory overload, creating misleading and/or missed hunting opportunities, or false defensive responses to non-threatening vibrations. Even though it has been suggested that vibrations from vehicles and exploration drilling have the potential to affect nearby trapdoor spider populations (DCCEEW 2024b), no immediate or short term effects of vibrations on the survival of *Idiosoma nigrum* have been found (Phoenix 2009).

Based on the potential impact disturbances such as dust, light, noise, and vibration may have over populations of *Idiosoma* and the effect over their biological processes (section 6.3), the impact for this component is considered as **minor**. At a local scale, impacts are expected to be moderate and affecting those individuals directly over the Disturbance Footprint that were not taken during the construction or exploration stages. At a regional scale, impacts are likely to be minor, with dust being the biggest threat as it can reach populations even outside of the Development Envelope. Light, noise, and vibration are not expected to have impacts at a regional scale.

6.6. Predators and invasive species

The loss of vegetation cover can make the spiders more vulnerable to predation, reducing the camouflage of their burrows and becoming easier to detect by predators. Given they rely heavily on the camouflage effect of their trapdoors, any reduction in vegetation or leaf litter cover around the burrow could increase predator risk. Development projects may increase populations of invasive predators, particularly small mammals, increasing the predation pressure on spider populations living near these areas. This has been demonstrated by Doherty *et al.* (2015) who identified that land clearing and other processes that reduce habitat complexity appear to be the strongest facilitators of invasive predator impacts and can also exacerbate impacts on native species by improving habitat suitability for invasive predators and increase their hunting efficiency.

Invasive species pose significant threats not only to trapdoor spiders, but also to other native fauna as they disrupt local ecosystems, alter food webs, and compete for resources. Invasive mammals such as rodents or feral cats can become efficient predators of *Idiosoma kopejtkaorum*, particularly wandering males which have been shown to be more susceptible to invasive predators than to natural ones such as wasps (Mason *et al.* 2018b). Additionally, invasive invertebrates such as ants can invade, destroy, and outcompete trapdoor spiders, affecting the spiders' prey capture and resource availability.

The risk of invasive species increases when considering indirect impacts such as competition. Competitors may include other *Idiosoma* species as well as other mygalomorph spiders, centipedes, scorpions, and insectivorous mammals which feed on the same prey resources and are better adapted to changes in habitat. These, better adapted competitors, could come from outside the Development Envelope to colonise disturbed environments and compete for prey and suitable habitat (such as burrowing sites).

Any potential impacts by predators and invasive species are likely going to affect local populations, however, it is possible that invasive species will incur in undisturbed habitats outside of the Development Envelope. Impact of this component is considered as **moderate** given that any remnant individuals outside of the proposed clearing areas within the Development Envelope could be at risk of being predated or outcompeted by invasive species, which could also affect and reduce reproductive success in the local area.

6.7. Mortality during construction and life of mine

Habitat clearing or disturbances caused by mining can lead to direct burrow destruction and spider mortality. As *Idiosoma kopejtkaorum* have sedentary habits and live in permanent burrows, land clearing activities such as bulldozing or vegetation removal often result in complete destruction of burrows, and given that spiders cannot flee from disturbances quickly, any individuals which are not directly killed by burrow destruction are likely to perish by other causes (predators, crushed by driving, desiccation).

Even if a burrow is not directly destroyed, the surrounding habitat which provides cover such as leaf litter, branches, or shade, will be removed. The loss of shelter will likely expose the burrow to physical damage and harsh environmental conditions such as temperature fluctuations and desiccation, leading to increased spider mortality. Additionally, the trapdoor spiders' poor dispersing abilities will likely result in an inability to relocate and establish new burrows. Particularly when the habitat has been cleared and/or fragmented, with fewer suitable burrowing locations, spiders will succumb to predators, environmental stress, or starvation.

Vehicle mortality is likely to occur during the operational phase, particularly on access roads, haul roads, and around mining infrastructure. This is more likely to affect wandering males and juveniles, affecting the reproduction success of the local population. The ongoing noise and vibrations (section 6.4) will affect the spiders throughout the operational phase, likely affecting the ability to maintain burrows because of changes to the soil conditions, leading to burrow abandonment and eventually, death.

Based on the potential impacts over any remnant individuals that may remain after land clearing, and the potential risk of completely extirpating the local population within the Disturbance Footprint and potential for failed recolonisation after the mine has closed, the impact of this component is considered as **moderate**.

6.8. Changes to surface and groundwater conditions

Groundwater changes such as secondary salinisation is not expected to impact populations of *Idiosoma kopejtkaorum* as it requires region-sized clearing to produce noticeable effects, and the level of clearing proposed by the Project is much smaller than this.

Potential risks resulting from changes to surface and groundwater conditions are unlikely to occur because of the Project development. Any possible impacts would need to extend way past the Development Footprint and at a regional scale which is not expected to happen. For such reasons, the impact for this component is considered as **negligible.**

7. AVOIDANCE AND MITIGATION MEASURES

Avoidance and mitigation measures are critical to minimize the disturbance and degradation of habitats while maintaining the ecological integrity of areas where *Idiosoma kopejtkaorum* occurs. The main strategies revolve around habitat clearing and fragmentation, vibration and light, predators and invasive species, dust deposition, and potential changes in water salinity.

7.1. Habitat clearing and degradation

Avoidance measures can start by minimizing the amount of habitat to be cleared and focusing on previously disturbed areas, or areas with low ecological value rather than intact ecosystems. The mitigation hierarchy has been contemplated as the Project is proposed to expand on previously developed mining areas (Tetris Environmental 2023), and the Disturbance Footprint undergoing numerous iterations to reduce clearing, particularly Eucalypt Woodlands to as low as reasonably practicable to enable safe development and operation of the Project. Nonetheless, most of the Eucalypt Woodlands and Acacia Shrublands within the Disturbance Footprint has been categorised as having vegetation in "Excellent" conditions (FVC 2023).

Mitigation measures will require progressive habitat rehabilitation by restoring habitats as soon as possible after any disturbance. When possible, clearing should occur progressively during less-active periods, and ideally outside of the reproductive season (Sept.-Nov. as per Rix *et al.* (2018a) to reduce impact on active populations. This will reduce the mortality of wandering males or settling juveniles which are the most exposed during reproductive periods as they venture outside of the safety of their burrows in search of mates or areas to establish.

7.2. Fragmentation

Avoidance measures have considered the reduction of the Disturbance Footprint to avoid fragmentation as much as possible, and leaving intact Eucalyptus woodland corridors within both, the Disturbance Footprint and Development Envelope. These natural corridors maintain suitable microhabitats, such as areas with adequate soil, leaf litter, vegetation cover, and prey availability.

Mitigation measures to overcome habitat fragmentation are hard to identify for sedentary groups such as trapdoor spiders, however, recent scientific developments have proposed activities such as translocating spiders. Translocation trials have been developed at southwestern WA (Thannoo 2024) demonstrating that careful planning and adequate ecological management may improve the chances of survival of very restricted mygalomorph spiders. Strategies such as assisted migration of reproductive males from nearby localities could help to maintain gene flow between isolated populations, however this may exacerbate competition for mates and resources.

7.3. Vibration and Light

Buffer zones for temporary activities such as drilling could be implemented around areas known to contain *Idiosoma kopejtkaorum* populations to reduce the impact of vibration. A minimal light design could be considered to prevent impacts from direct light over areas with high density of burrows.

Phased activities could allow time for wildlife, including spiders, to adjust or recolonise away from disturbed areas. For light sources, motion sensors could be employed rather than having continuous lightning in areas where human activity is intermittent. Where permanent lighting is required for safe mining operations at night, light should be directed away from intact habitat adjacent to the Disturbance Footprint. This would reduce constant light exposure to the environment and minimize disturbance to feeding patterns and potential increased predation.

7.4. Predators, invasive species and feral herbivores

Avoidance measures such as exclusion zones delimited by native vegetation barriers around key *Idiosoma* habitats to prevent feral herbivores or invasive species such as rodents could be implemented. This could also keep invasive predators and herbivores that might compete with native species away. Additionally, targeted removal to eradicate or reduce populations of invasive species could be implemented.

If invasive species are detected, implementation of rapid response actions to prevent population growth and further habitat degradation can be crucial to mitigate their impact over *Idiosoma kopejtkaorum*. If paired with adequate rehabilitation programs and introduction of native plants, it could promote natural ecosystem recovery and benefit the local populations of *Idiosoma kopejtkaorum* at the Survey area.

7.5. Dust deposition

Dust suppression techniques such as water sprays, non-toxic chemical dust suppressants, or gravel on roads can be used as an avoidance measure to reduce dust generation. Avoiding work on especially windy days can help prevent dust traveling to neighbouring populations outside of the Disturbance Footprint. Where dust suppression is undertaken using saline water, measures to prevent salt drift to vegetation adjacent to the Disturbance Footprint should be implemented to avoid unnecessary impacts to *Idiosoma kopejtkaorum* habitat through vegetation death.

Adequate habitat rehabilitation over impacted areas could help reduce dust generation by planting native species which will help stabilize the soil and re-establish conditions that spiders need for burrow construction.

8. DISCUSSION AND CONCLUSIONS

The subregion around the MGGP is recognised as being highly diverse in *Idiosoma* species (M. Rix, personal communication, 8 July 2024). In addition to *Idiosoma kopejtkaorum*, a distinct species complex (the *formosum*-complex) occurs across the Mt. Gibson area. This complex includes *I.* MYG641 in the north-west., *I. formosum* centrally and *I. mcnamarai* in the south-east. Our field surveys collected a fourth species in the Mt Gibson area, *I.* \`BMYG229\` (*formosum*-complex) and reflects the particularly diverse radiation the genus has undergone in this part of Australia (M. Rix, personal communication, 8 July 2024). The presence of three species from the *nigrum*-group, namely *Idiosoma kopejtkaorum, Idiosoma intermedium,* and *Idiosoma* \`BMYG 229\` (*formosum*-complex) in the Survey area and surrounds highlights not only the diversity of the *Idiosoma* species but also the importance of the Mt Gibson area for this species group.

A combination of *Idiosoma kopejtkaorum* records from different sources suggests the species may be localised to the Mummaloo/Mt Gibson area, with 90 of the known records (n = 108) found within this area. Current data shows an EOO of 4,444 km^2 (estimated at 4,000 km^2 by Rix et al. 2018) and an AOO of approximately 172 km^2 (estimated at <500 km^2 by Rix et al. 2018). Our data suggests 63% of the Active Likely and Probable *Idiosoma* burrows were found within eucalypt woodland, and 18% within acacia shrublands. Population estimates for *Idiosoma kopejtkaorum* suggest there are approximately 4,803 spiders within the Survey area, 17,075 within the Development Envelope, and 4,410 within the Disturbance Footprint.

Overall, the MGGP could impact the Endangered Lake Goorly Shield-backed Trapdoor Spider (*Idiosoma kopejtkaorum*). The highest risk could come from the clearing of 6.5% of the species' known AOO which could result in the removal of genetic diversity because of habitat fragmentation, causing interruptions to the species' geneflow across its known localities. Impact over already fragmented and reduced populations along with the species' specific microhabitat requirements and poor dispersal abilities could result in failed recolonisation of the area after close of mine.

Avoidance and mitigation strategies such restoring habitats as soon as possible after any disturbance and considering specific microhabitat requirements are crucial for *Idiosoma kopejtkaorum* to recolonise the area. Planning of clearing activities should also consider the species' less-active periods and ideally, outside of the reproductive season to reduce impact on active populations by reducing the mortality of wandering males and juveniles which are the most exposed during reproductive periods. To overcome habitat fragmentation, techniques such as translocation of spiders to nearby undisturbed habitats may improve their chances of survival and could help maintain the genetic pool. If paired with adequate rehabilitation programs which consider microhabitat requirements and introduction of native plants, mitigation strategies could promote natural ecosystem recovery and benefit the local populations of *Idiosoma kopejtkaorum* at the Development Envelope during the life of mine and after its closure.

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10. APPENDICES

Appendix 1. Staff involved in the Mt Gibson targeted burrow searches and data analysis.

Name	**Qualification**	**Survey round**	**Role**
Stuart Halse (Bennelongia)	BSc (Hons), PhD (Zoology)	NA	Project supervision
Kevin Sagastume-Espinoza (Bennelongia)	BSc, MSc (Biological Sciences/Zoology)	R1; R2; R3	Field data collection, data analysis, report writing
Jaxon Haines (Bennelongia)	BSc (Environmental Science)	Reconnaissance; R1; R2; R3	Field data collection
Blake Wyber (Bennelongia)	BSc, MSc, PhD (Zoology)	Reconnaissance	Field data collection
Vitor Marques (Bennelongia)	BSc (Biological Sciences)	R3	Field data collection, GIS support
Veera Haslam (Bennelongia)	BSc (Hons.), PhD (Genetics)	NA	DNA extraction, sequences and haplotype analysis
Dan White	BSc, MSc, PhD (Genetics)	NA	Sequence analysis and DNA supervision
James Hesford (Tetris)	BSc (Environmental Management/ Biology)	Reconnaissance; R1; R3	
Mat Lyons (Capricorn Metals)	BSc (Environmental Management)	Reconnaissance; R1	

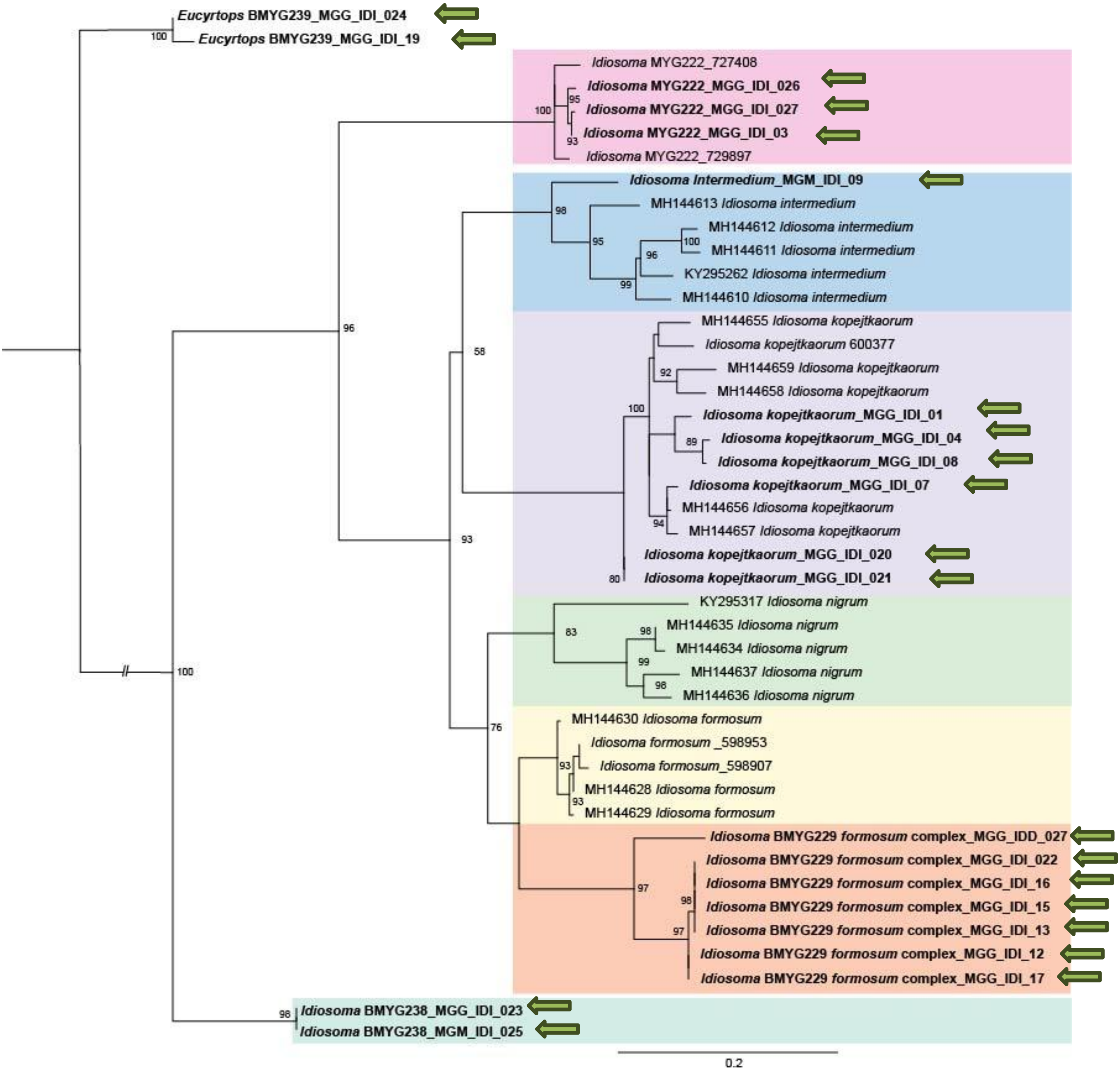
Appendix 2. *Idiosoma* burrows and activity categorisation examples.

Burrow ID	Locality	Classification	Closed Burrow	Open Burrow	Status
Mygal Burrow 01	Sundance	Likely			Active
Mygal Burrow 11	East Hydro	Probable			Unknown

Burrow ID	Locality	Classification	Closed Burrow	Open Burrow	Status
Mygal Burrow 14	East Hydro	Probable			Inactive
Mygal Burrow 40	Geotech	Unlikely			Active

Appendix 3. *Idiosoma* genetic distances tree.

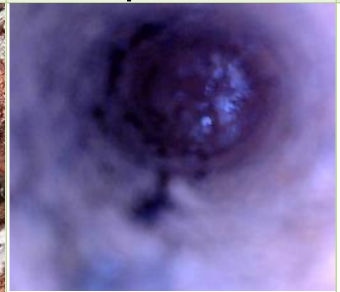
Bold text and green arrows denote specimens collected from the Mt. Gibson survey area.



Appendix 4. *Idiosoma kopejtkaorum* burrows.

Burrow ID	Locality	Classification	Closed Burrow	Open Burrow	Specimen	Status
Mygal Burrow 33	Geotech	Likely				Active
Mygal Burrow 156	Highway Pit	Likely				Active

Burrow ID	Locality	Classification	Closed Burrow	Open Burrow	Specimen	Status
Mygal Burrow 264	Ace High	Likely				Active
Mygal Burrow 286	Sundance	Likely		Open burrow photo N/A		Active
Mygal Burrow 330	Airstrip	Likely				Active

Burrow ID	Locality	Classification	Closed Burrow	Open Burrow	Specimen	Status
Mygal Burrow 484	IWL North	Likely				Active
Mygal Burrow 467	Ref North	Likely				Active
Mygal Burrow 372	Ref North-East	Likely				Active

Burrow ID	Locality	Classification	Closed Burrow	Open Burrow	Specimen	Status
Mygal Burrow 384	Ref North-West	Likely				Active
Mygal Burrow 374	Ref South-East	Likely				Active
Mygal Burrow 500	Ref South-West	Likely				Active