



Ecology Survey Report Wak Wak Solar Farm

TE H2 Australia Pty Ltd



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Appendix B	EPBC Protected Matters Search Tool Report
Appendix C	Threatened species likelihood of occurrence assessment
Appendix D	Sandsheet heath floristic site data
Appendix E	<i>Stylidium ensatum</i> site data
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1 INTRODUCTION

1.1 Overview

TE H2 Australia Pty Ltd (TE H2) proposes to develop a ~2,500 ha solar farm known as the ‘Wak Wak Solar Farm’.

The solar farm is proposed to be located approximately 40 km south-east of Darwin (see Figure 1-1).

The solar farm project will be referred for assessment under both NT and Commonwealth environmental approvals processes. The NT process requires assessment of terrestrial ecosystem values, with a particular focus on significant vegetation communities and threatened species (see Section 1.3). The primary focus of the Commonwealth assessment will be threatened species. EcOz Environmental Consultants (EcOz) were engaged to undertake all the ecological investigations necessary to determine the presence and extent of those values within the area of NT Portion 4477 over which TE H2 has exclusivity. The results will inform the design of the project and environmental approval documentation.

The information presented in this report was collected in stages over a two-year period, as summarised in Table 1-1. Initially, the *study area* that was surveyed encompassed most of NT Portion 4477 – an area of approximately 13,000 ha – as depicted in Figure 1-1. However, as the survey results progressively came in, the study area was refined to 8,812 ha – as shown in Figure 1-1. Consequently, not all the study area was surveyed for all ecological values.

Table 1-1. Summary of timing of ecological surveys

Survey	2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Reconnaissance survey								
<i>Typhonium praetermissum</i> survey								
Sandsheet heath assessment								
Targeted surveys for wet season flora & fauna								
Targeted surveys for dry season flora & fauna								
Howard River Toadlet survey								
Targeted surveys for wet season flora								
Small mammal survey								
Land type and habitat mapping								

1.2 Scope

This report includes:

- A desktop review of the existing environment (land use, broad habitats, fire history and land type mapping).
- Methods and results of land unit ground-truthing.
- Methods and results of significant vegetation type surveys and targeted threatened species surveys.
- A 'likelihood of occurrence' assessment using desktop information and observations from surveys to determine which threatened species have a reasonable likelihood of occurring within the study area.
- A qualitative assessment of the significance of threatened species identified as occurring (or likely to occur) within the study area.

1.3 Ecological values considered in this report

Terrestrial ecosystems have myriad values that range from the aesthetic through to functional. Under both Commonwealth and NT environmental legislation, two features of terrestrial ecosystems are given particular attention – significant vegetation communities and significant species. Surveys of these two values are a focus of this report.

1.3.1 Significant vegetation

Significant vegetation is a term applied in the NT to spatially-restricted vegetation communities – such as rainforest and sandsheet heath – that are important to specialist wildlife (including threatened species) and provide valuable ecosystem services (such as riparian vegetation preventing erosion of watercourses and mangroves acting as fish nurseries). Determining the value of these vegetation types is discussed in the *Land Clearing Guidelines* (DEPWS 2024).

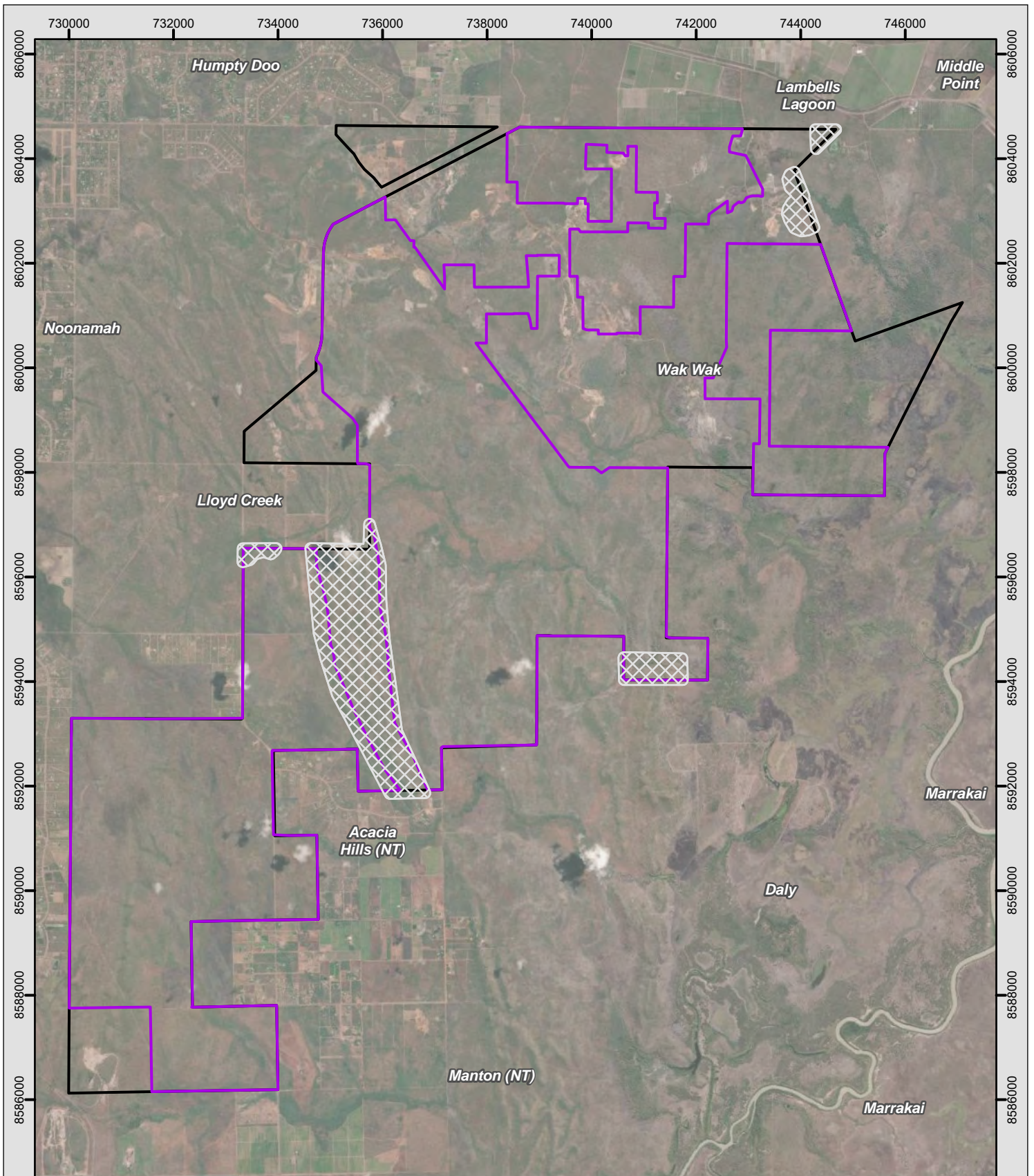
The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* allows for the listing of Threatened Ecological Communities (TEC). Only one TEC is listed in northern NT – the Arnhem Plateau Sandstone Shrubland Complex, which is restricted to the massive sandstone environments of the Arnhem Plateau and outliers. As such, it is not relevant to this project.

1.3.2 Threatened species

The International Union for Conservation of Nature nominates a set of criteria used to identify species at risk of extinction. These criteria are used to define categories of risk which are used by the NT Government to determine which threatened species are listed under the *Territory Parks and Wildlife Conservation Act (TPWC Act)*, and by the Commonwealth Government to determine which threatened species are listed under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. This report focusses on species that are listed as Vulnerable, Endangered or Critically Endangered under either Act.

1.3.3 Migratory species

Australia is a signatory to three bilateral migratory bird agreements with Japan, China and the Republic of Korea, as well as the Bonn Convention. These agreements provide a basis for cooperation on activities for the conservation of migratory animals that move between each country. Species listed on the annexes to these agreements are a Matter of National Environmental Significance (MNES) under the *EPBC Act* as listed migratory species.



- Legend**
- Study area
 - Refined study area
 - Sacred sites - known



0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 27/06/2025
 Client: Total Eren Australia
 Mapper: Elliot, Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 1-1. Map of the study area and refined study area

2 ENVIRONMENTAL CONTEXT

This section describes the existing environmental values within the study area – based on a desktop review of aerial photography and online land information databases. This information is used in Section 2.5 to inform the initial 'likelihood of occurrence' of threatened species, and as a basis for the design of the additional ecological surveys discussed in Sections 5 and 6.

2.1 Previous biodiversity surveys

To the authors' best knowledge, the central and southern parts of the study area have not been previously subject to any ecological surveys. Some areas within the northern part of the study area have been surveyed to inform extractive activities, but often the results of those surveys are not in the public domain.

More than a decade ago, the Flora and Fauna Division of the NT Department of Lands, Planning and Environment (DLPE) undertook targeted surveys for *Ptychosperma macarthurii* in the far north-western section of the study area; as well as for *Typhonium praetermissum* in the northern section of the study area in 2021. EcOz also surveyed for *Typhonium praetermissum* along the Utilities Corridor adjacent to the north-west boundary of the study area in 2022; as did Connect Environmental in the east in 2020. The parcels of land between the study area and Redcliffe Road (i.e. to the west) were subject to detailed flora and fauna surveys by EcOz for Intrapac between 2014 and 2018.

The only known fauna surveys within the study area are for the Howard River Toadlet (*Uperoleia daviesae*) on behalf of some of the extractive operators active in the area. These were concentrated in the northernmost section of the study area.

2.2 Land use

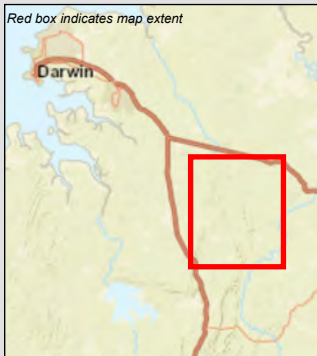
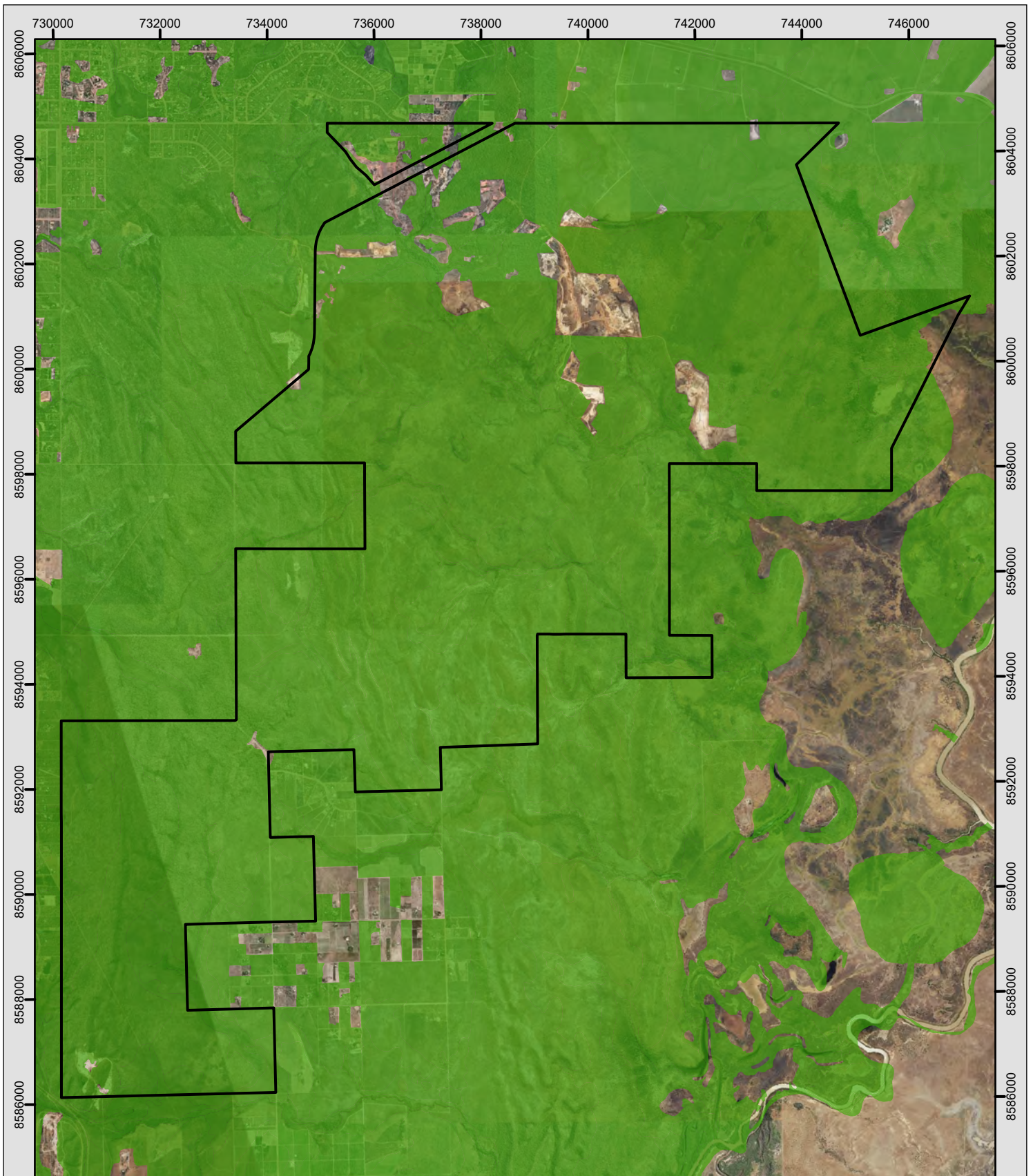
The study area is pastoral land under a Perpetual Pastoral Lease. Disturbance and land use in the central and southern parts of the study area are minimal, with some pastoral activities assumed to have been undertaken throughout the region in the past, but no evidence of recent commercial cattle grazing within the study area. However, there are large areas in the northern section that have been subject to extractive activities, particularly for sand.

Figure 2-1 shows the extent of remnant vegetation and disturbance from sand mining within the study area.

2.3 Broad habitats

The study area comprises large tracts of plains, rises, and low hills supporting Eucalypt communities (typically *Eucalyptus miniata* and *Eucalyptus tetradonta*), as well as drainage system communities supporting broad lowland plains associated with watercourses. Drainage system communities occur most extensively in the north-east. These communities are generally centred around the major watercourses, supporting *Lophostemon lactifluus*, *Melaleuca*, *Grevillea* and *Eucalyptus* species typically associated with drainage systems. Low hills and steeper rises supporting Eucalypt vegetation occur in the south-west of the study area, with extensive ridgelines occurring to the east and west of Townend and Mocatto Roads, near Noonamah.

These habitats are presented in Figure 2-2, using the landforms assigned to land unit data collected by the NT Land Conservation Unit (2004) at a scale of 1:25,000.



Legend

- Study area
- Remnant vegetation

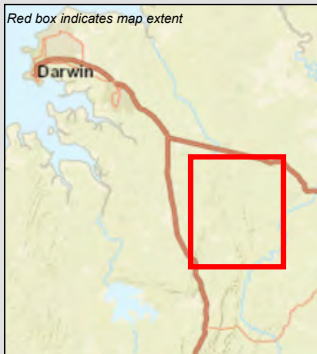
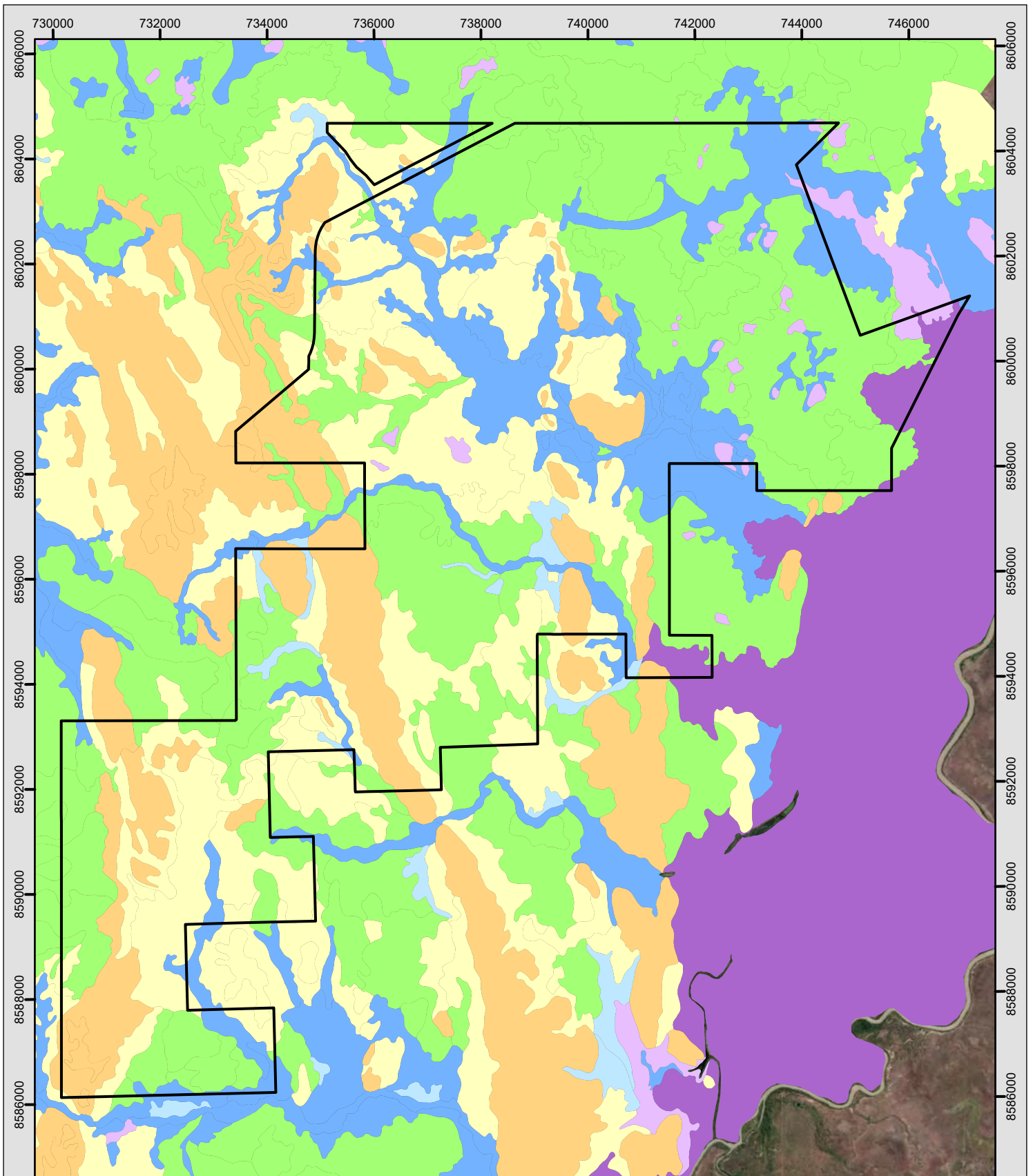


0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
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 Date Saved: 24/06/2025
 Client: Total Eren Australia
 Mapper: erin.barritt
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 2-1. Map of remnant vegetation within the study area



- Legend**
- Study area
 - Landform**
 - Low hills
 - Rises
 - Plains
 - Alluvial plains
 - Drainage systems
 - Swamps
 - Marine



0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GCS GDA 1994
 Date Saved: 24/06/2025
 Client: Total Eren Australia
 Mapper: erin.barritt
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 2-2. Map of landform types relevant to the study area

2.4 Fire

The northern savannas constitute the most fire-prone landscapes in Australia (Russell-Smith & Whitehead 2015), and regular fires have always been a natural part of the environment in the Top End. However, frequent fires can result in fewer flora species and reduced structural complexity (McKay 2017), both of which can also significantly diminish the habitat quality for fauna and facilitate weed invasion.

Fires are a regular occurrence in the region. Regional fire history and fire scar mapping was obtained through the [Northern Australia and Rangelands Fire Information](#) website. Most of the study area has burnt upwards of 20 times since 2000, but there are small areas within the study area that have burnt less often (between seven and 19 times) (see Figure 2-3).

Late season fires (from August onwards) are typically hotter than those occurring earlier in the Dry season. They are often anthropogenic in origin (i.e. not caused by lightning), and their effect on native flora and fauna is usually more detrimental. These hotter, more intense fires affect not just the ground and mid strata, which have evolved to adapt to fire, but also the more fire-sensitive canopy stratum. As Figure 2-4 shows, parts of the southern section of the study area have been subject to late season burns; however, this has only occurred in between one and four years since 2000. The northern section of the study area has experienced more frequent late season fires than the south, with some areas being subject to late season burns approximately twelve times since 2000.

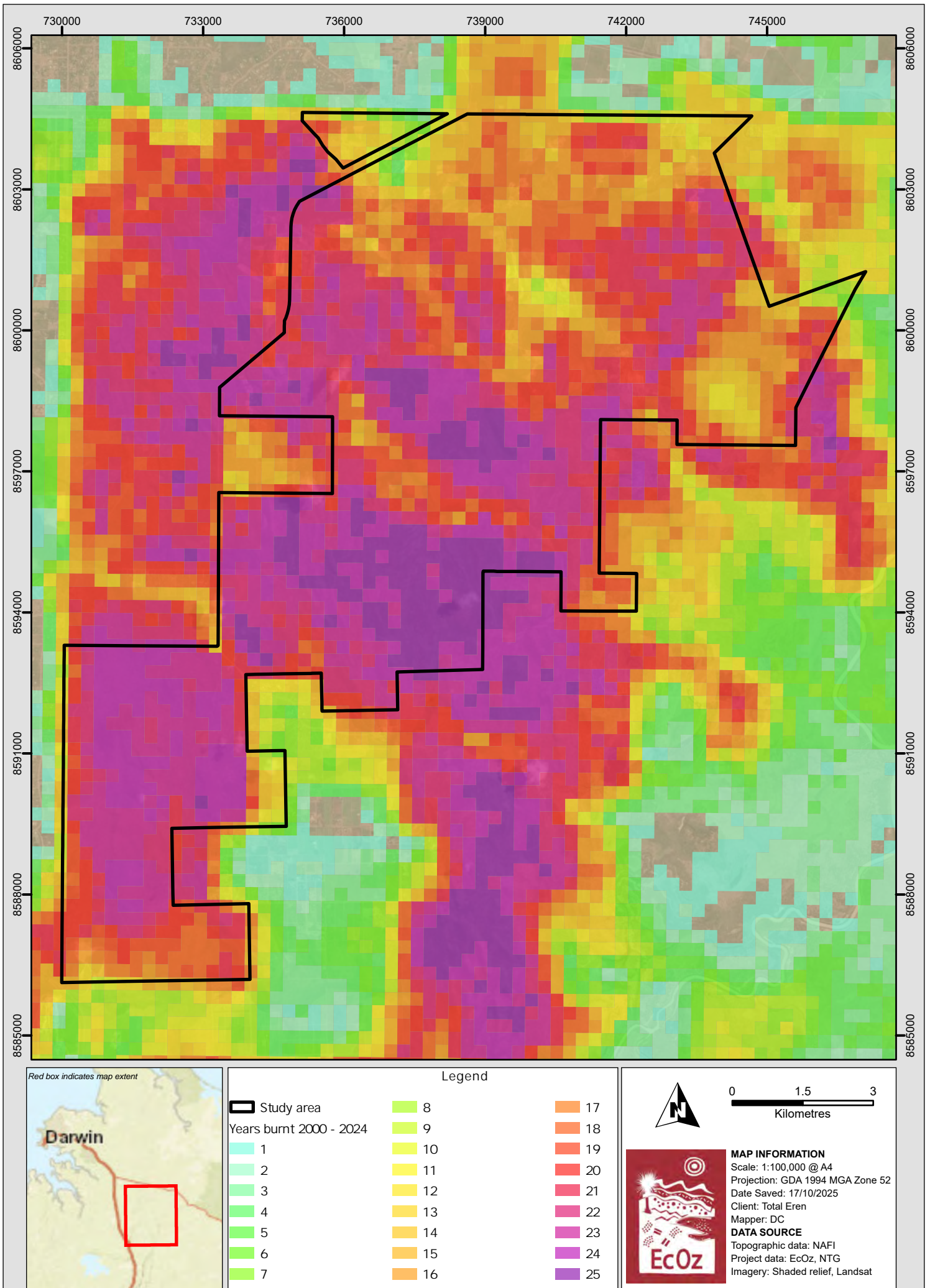
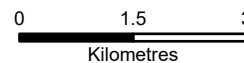
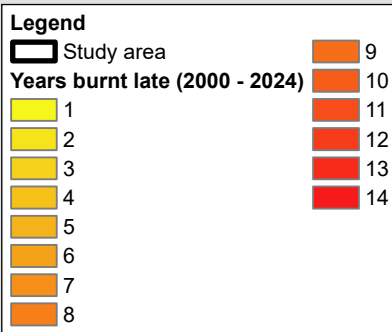
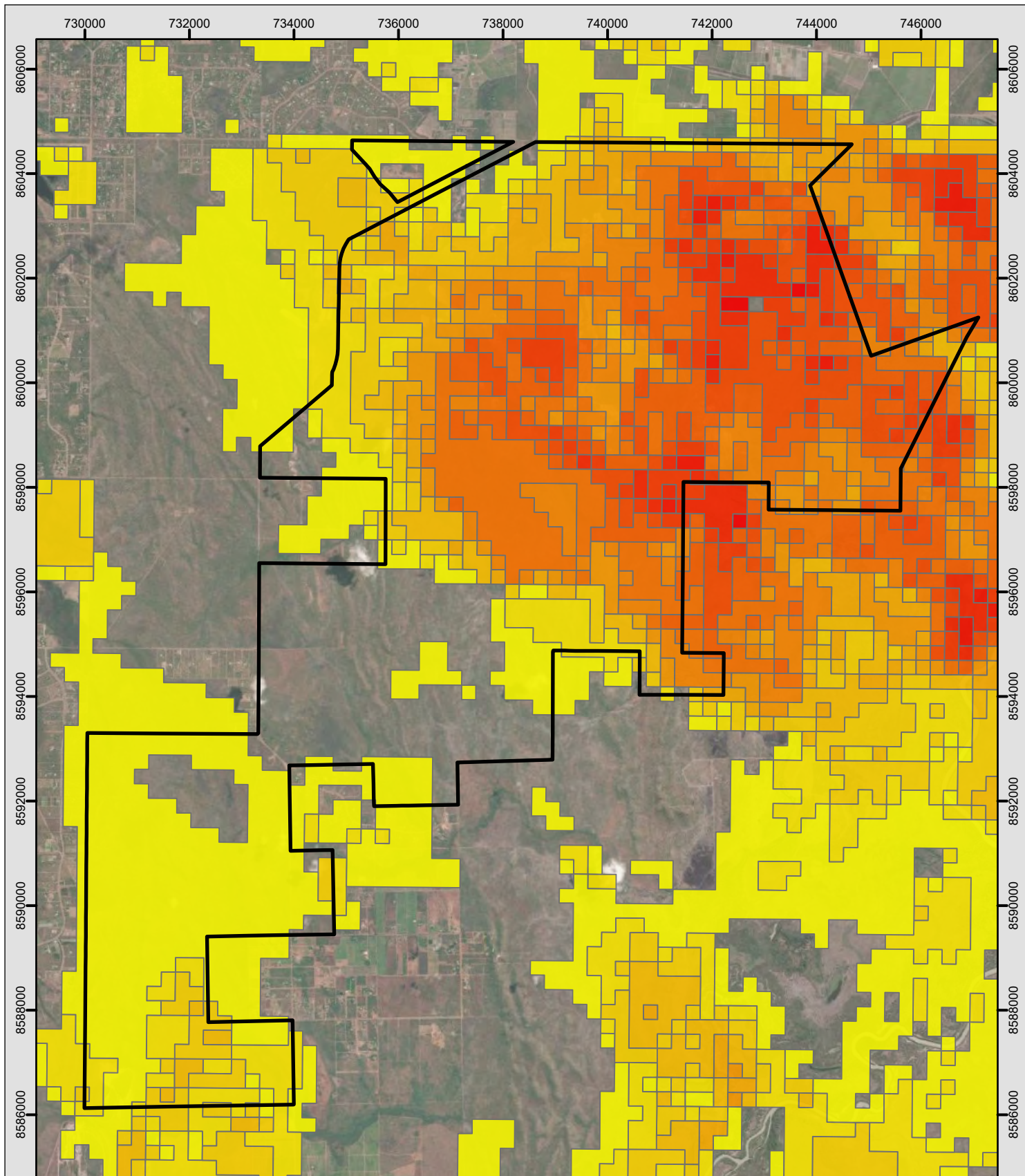


Figure 2-3. Map of fire history relevant to the study area



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA2020 MGA Zone 52
 Date Saved: 17/10/2025
 Client: Total Eren Australia H2 Pty Ltd
 Mapper: ED

DATA SOURCE
 Topographic data: OSM
 Project data: EcOz, NTG
 Imagery: NTLIS

Figure 2-4. Map showing late burn fire frequency

2.5 Threatened species

The International Union for the Conservation of Nature nominates a set of criteria used to identify species at risk of extinction. These criteria are used to define categories of risk which are used by the NT Government to determine which threatened species are listed under the *TPWC Act*, and by the Commonwealth Government to determine which threatened species are listed under the *EPBC Act*. This report focusses on terrestrial species that are listed as Vulnerable, Endangered or Critically Endangered under either Act.

To inform targeted surveys, the following procedure was used to determine which terrestrial threatened species have a reasonable (i.e. high or medium) likelihood of occurring in the study area:

- Species records from the latest version of the [NT Atlas](#) were clipped to the bioregions intersected by the study area – the Darwin Coastal and Pine Creek bioregions. Bioregions give a broad area with largely similar habitat characteristics and species assemblages. Clipping data to them ensures all potential species are captured in order to undertake a project-specific 'likelihood of occurrence' assessment.
- [EPBC Protected Matters Search Tool](#) (PMST) was used to generate a report using a 10 km buffer from the study area. This PMST is an online enquiry tool managed by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) which interrogates a range of existing flora and fauna data, as well as predictive modelling to speculate on the presence of species within a search area. The PMST uses a grid system to determine which protected matters it encapsulates for a particular search. The PMST report (see Appendix A) was generated on 24 February 2025.
- For each terrestrial threatened species, the likelihood of it occurring within the study area was then assessed based on desktop information that relates to habitat requirements, distribution, number and dates of proximate records (obtained from NT Atlas and/or [Atlas of Living Australia](#)), and the ecological information described above. Likelihood ratings are defined in Table 2-1.

Table 2-1. Ratings for the desktop threatened species likelihood of occurrence assessment

Rating	Definition
HIGH	It is expected that this species occurs within the study area because there is core habitat and recent (post-2000) proximate records or knowledge that the species occurs in the local area.
MEDIUM	Species may occur within the study area because there is suitable habitat; however, there is evidence that lowers its likelihood of occurrence (known range contraction of the species in the region, no recent records within or close to the study area, substantial loss of habitat within the study area since previous records, species is naturally-rare or occurs at a low density etc.).
LOW	Species may occur, as a vagrant, within the study area; only marginally-suitable habitat is expected.
NONE	There is strong evidence that this species will not occur within the study area (i.e. there is no suitable habitat and/or the species is considered to be regionally-extinct).

Table 2-2 presents the terrestrial threatened species which have a high or medium likelihood of occurrence within the study area. These are discussed in further detail in Sections 5 (flora) and 6 (fauna).

Note: The threatened species likelihood of occurrence presented in Appendix C differs from the assessment presented in Table 2-2 because it takes into account the results of the targeted surveys undertaken in this report.

Table 2-2. Desktop threatened species likelihood of occurrence assessment (high and medium likelihood species only)

Common name	Scientific name	Status		Justification
		Cth	NT	
BIRDS				
Partridge Pigeon (eastern)	<i>Geophaps smithii smithii</i>	VU	VU	HIGH Suitable Eucalyptus forests and woodlands with a structurally-patchy understorey of grasses. Recent nearby records.
Masked Owl (northern mainland)	<i>Tyto novaehollandiae kimberli</i>	VU	VU	MEDIUM Suitable Eucalyptus tall open forests, monsoon rainforests and open vegetation types, including grasslands. Few recent records in the region.
MAMMALS				
Fawn Antechinus	<i>Antechinus bellus</i>	VU	EN	MEDIUM Suitable Eucalyptus open forests and woodlands with a relatively dense shrubby understorey.
Northern Quoll	<i>Dasyurus hallucatus</i>	EN	CR	MEDIUM Suitable habitat, noting that since the arrival of Cane Toads generally restricted to rocky upland areas with numerous crevices and rock piles.
Black-footed Tree-rat (Kimberley and mainland Northern Territory)	<i>Mesembriomys gouldii gouldii</i>	EN	EN	HIGH Suitable woodlands and open forests with large trees and a moderately diverse mid-storey in near-coastal areas. Locally common in the greater Darwin region, elsewhere less commonly recorded.
Northern Brushtail Possum	<i>Trichosurus vulpecula arnhemensis</i>	VU	-	HIGH Suitable woodlands and open forests with large trees and a moderately diverse mid-storey in near-coastal areas. Locally common in the greater Darwin region, elsewhere less commonly recorded.
Pale Field-rat	<i>Rattus tunneyi</i>	-	VU	MEDIUM Suitable dense vegetation along creeks. Drastic range decline, but a few recent records in the region.
Bare-rumped Sheath-tailed Bat	<i>Saccolaimus saccolaimus nudicluniatus</i>	VU	NT	HIGH Suitable habitat present. Difficult to detect species that is seldom recorded.
Northern Brushtail Possum	<i>Trichosurus vulpecula arnhemensis</i>	VU	NT	HIGH Suitable Eucalypt open forests with large hollow-bearing trees, but also utilises surrounding habitat types such as mangrove communities, rainforests and semi-urban areas (including Darwin suburbs). Recent records in the region.
AMPHIBIANS				
Howard River Toadlet	<i>Uperoleia daviesae</i>	VU	VU	HIGH Suitable seasonally-inundated, low relief sandsheet heathland. Recent records from within the study area. Locally common within a limited range that broadly coincides with the greater Darwin region.
REPTILES				
Northern Blue-tongued Skink	<i>Tiliqua scincoides intermedia</i>	CR	-	MEDIUM Suitable habitat present. The species has been heavily impacted by Cane Toads; however, may be present at a low abundance.
Mertens' Water Monitor	<i>Varanus mertensi</i>	-	VU	HIGH Locally common along the edges of freshwater watercourses and lagoons. Suitable habitat present.
Mitchell's Water Monitor	<i>Varanus mitchelli</i>	-	VU	HIGH Locally common along the edges of freshwater swamps, watercourses and lagoons. Suitable habitat present.
Yellow-spotted Monitor	<i>Varanus panoptes</i>	-	VU	MEDIUM Suitable savanna woodlands and floodplains. Seldom recorded since the arrival of Cane Toads.
PLANTS				
-	<i>Cleome insolata</i>	-	VU	HIGH Suitable inundated sedge land growing on silty loam with coverage of laterite gravels. Recent records from region (Lloyd Creek).

Common name	Scientific name	Status		Justification
		Cth	NT	
Darwin Cycad	<i>Cycas armstrongii</i>	-	VU	HIGH Suitable open grassy woodland with adequate drainage. Common within a limited range that broadly coincides with the greater Darwin region.
-	<i>Ptychosperma macarthurii</i>	-	EN	MEDIUM Suitable dense rainforests fed from lowland springs at the edges of tropical riverine floodplains. Proximate records to the east of the study area.
-	<i>Stylidium ensatum</i>	EN	EN	HIGH Suitable margins of drainage areas in poorly-drained sandy or loamy flats that are damp well into the Dry season. Proximate records to the west.
-	<i>Typhonium praetermissum</i>	-*	VU	HIGH Suitable open woodland with relatively unshaded areas in red brown clay and shallow or gravelly lateritic soil. Records from within the study area.
-	<i>Utricularia dunstaniae</i>	-	VU	MEDIUM Suitable 'sandsheet heath' type habitats with wet sand, often in shallow water, frequently where water is percolating from the ground. No proximate records. Under surveyed.
-	<i>Utricularia singeriana</i>	-	VU	MEDIUM Suitable borders of seasonally-inundated grassland and low open woodland. No proximate records. Only known in the region from Weddell and Litchfield NP.
-	<i>Helicteres macrothrix</i>	EN	EN	MEDIUM High-likelihood habitat modelled as present within the study area. No nearby records, nor records this far north.

CR = Critically Endangered, EN = Endangered, VU = Vulnerable, * = nominated for listing under the EPBC Act as Endangered

3 LAND UNIT GROUND-TRUTHING

A land unit is a reasonably homogenous part of a land surface, distinct from surrounding terrain with consistent properties in landform, soil and vegetation (Jessop & King 1997). As such, each land unit has a characteristic pattern on aerial imagery. Their scale is useful for identifying habitat features that may support threatened species and sensitive vegetation types. The land unit mapping relevant to this project was undertaken by Lynch (1985) and Fogarty et al. (1984)¹ at a scale of 1:25,000.

As detailed in Appendix A, to ground-truth the verification of mapped land units, vegetation, soil and landform attributes were collected by EcOz between October and December 2024 across the study area. The survey indicated that land units within the study area are largely consistent with Lynch (1985) and Fogarty et al. (1984) with 87.6% of sites matching or partially matching their nominal unit. Of the 22 (12.4%) of sites that did not match their nominal land unit, 12 were characteristic of an adjacent or nearby unit, indicating an overall high level of accuracy in the source dataset, with some boundary adjustment required.

Within the study area, 175 polygons of 28 different land unit types are mapped. Most of the study area comprises plains (44%) and rises (32%), interspersed with drainage systems (10%) and low hills (10%). Alluvial plains, swamps and 'marine' (here referring to the western Adelaide River floodplain) comprise the remaining area. Areas significantly modified by human activity comprise 3% of the study area. The revised land units are summarised in Table 3-1, and mapped in Figure 3-2. Refer to Figure 3-1 for indicative photographs of each landform class.

¹ As compiled in the dataset: GTRDWN Land Resources of the Elizabeth, Darwin and Blackmore Rivers – Greater Darwin Area, Northern Territory (2010)



Low hills



Rises



Plains



Alluvial plains



Drainage systems



Swamps



Marine

Figure 3-1. Indicative photographs of each landform class

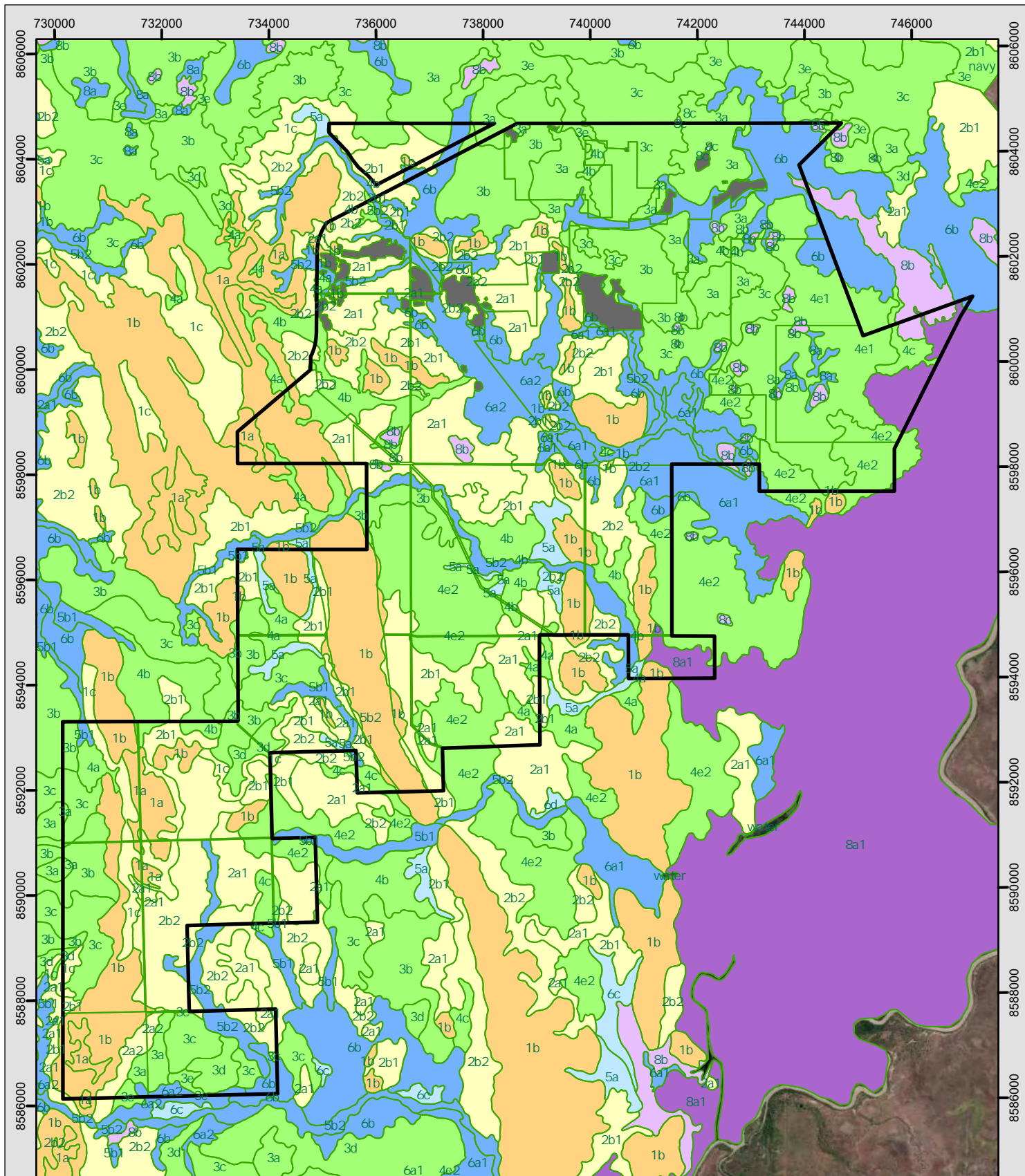
Table 3-1. Land units relevant to the study area

Land unit	Landform class	Landform	Soil	Vegetation*	No. survey sites	Area (ha)
1a	Low hills	Flat hillcrests	Rudosols	Open woodland to open forest of <i>E. tetradonta</i> , <i>E. miniata</i> over annual <i>Sorghum</i> sp., <i>Heteropogon triticeus</i>	2	127.6
1b		Steep ridges		Woodland of <i>E. miniata</i> , <i>E. tectifera</i> , <i>C. foelscheana</i> over <i>Sorghum plumosum</i>	17	716.6
1c	Rises	Rises and short steep slopes	Rudosols	Woodland of <i>E. miniata</i> , <i>C. bleeseri</i> over <i>Sorghum</i> spp.	4	248.7
2a1		Rises		Open woodland of <i>E. miniata</i> , <i>E. tetradonta</i> , or <i>C. foelscheana</i> , <i>C. confertifolia</i> , <i>E. tectifera</i> over mixed grasses	16	1,013.4
2a2		Rises (adjacent to estuarine areas)		Tall shrubland or open forest of mixed species over sparse grasses	1	12.9
2b1		Sideslopes	Kandosols	Open woodland to woodland of <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. foelscheana</i> , <i>E. tectifera</i> over <i>Sorghum</i> spp.	13	655.4
2b2				Low open to open woodland of mixed species over sparse grasses	15	915.1
3a	Plains	Flat to gently undulating upland surfaces	Kandosols	Open Forest of <i>E. tetradonta</i> , <i>E. miniata</i> over mixed grasses	8	403.5
3b				Woodland of <i>E. miniata</i> , <i>E. tetradonta</i> over <i>Sorghum</i> spp.	9	624.6
3c		Gently undulating upland surface	Kandosols	Woodland of <i>E. miniata</i> , <i>E. tetradonta</i> over <i>Sorghum</i> spp.	12	675.0
3d			Rudosols	Open woodland of <i>E. miniata</i> over <i>Sorghum</i> spp.	4	117.3
3e		Flat to gently undulating upland surface	Hydrosols	Woodland of <i>C. polycarpa</i> , <i>Erythrophleum chlorostachys</i> over mixed grasses; wet season watertable	2	28.7
4a		Gentle lower slopes	Hydrosols	Open woodland of <i>C. polycarpa</i> , <i>Lophostemon lactifluus</i> over <i>Themeda triandra</i> , <i>Eriachne burkittii</i> ; wet season watertable	4	138.6
4b				Open woodland of <i>C. polycarpa</i> over mixed grasses; wet season watertable	7	376.6
4c				Open forest of <i>Eucalyptus</i> spp. over mixed grasses; wet season watertable	2	60.5
4e1		Sloping margins to upland plateau surface	Kandosols	Woodland to open forest of mixed species including <i>E. miniata</i> , <i>Acacia auriculiformis</i> , <i>C. papuana</i> over mixed shrubs - labelled in DEPWS (2010) as monsoon vine thickets ²	4	339.9
4e2			Hydrosols	Low shrubland to low woodland of <i>Corymbia bella</i> , <i>Grevillea pteridifolia</i> , <i>Syzygium eucalyptoides</i> subsp. <i>bleeseri</i>	15	975.0

² Vegetation described as 'Monsoon vine thicket' in the GTRDW survey dataset is recorded as woodland to open forest of mixed *Eucalyptus* and *Corymbia* species in source survey 'Land Resources of the Humpty Doo Area' (Lynch 1985).

Land unit	Landform class	Landform	Soil	Vegetation*	No. survey sites	Area (ha)
5a	Alluvial plains	Narrow upland alluvial plains	Hydrosols	Grassland of <i>Sorghum stipoides</i> , <i>Eriachne burkittii</i> , <i>Paspalum scrobiculatum</i> with emergent trees	6	159.2
5b1	Drainage systems	Drainage floors within upland terrain	Hydrosols	Woodland to open forest of <i>Lophostemon lactifluus</i> , <i>C. bella</i> , <i>Melaleuca viridiflora</i> over mixed grasses	4	50.9
5b2		Incised drainage floors within upland terrain		Open shrubland to open woodland of <i>C. polycarpa</i> , <i>Melaleuca</i> spp., <i>E. alba</i> over <i>Eriachne</i> spp., <i>Sorghum</i> spp.	7	259.0
6a1		Broad lowland plains		Grassland of mixed grasses with emergent trees	2	61.1
6a2				Open woodland or woodland of <i>Lophostemon lactifluus</i> , <i>C. polycarpa</i> , <i>E. alba</i> , <i>Melaleuca viridiflora</i> over <i>Eriachne burkittii</i> , <i>Sorghum stipoides</i>	3	244.6
6b				Tall shrubland to low open woodland of <i>Grevillea</i> spp., <i>Melaleuca</i> spp., <i>Lophostemon lactifluus</i> over annual <i>Sorghum</i> sp., <i>Heteropogon triticeus</i>	9	234.7
8a				Upland depressions and floodways	Grassland of <i>Eriachne</i> spp., annual <i>Sorghum</i> sp. with scattered trees and shrubs	0
8a1	Marine	Extensive plain	Vertosols	Grassland/sedgeland with emergent trees and small patches of samphire to low closed forest of mangrove species; wet season flooding	3	66.8
8b	Swamps	Swamp depressions	Hydrosols	Open to closed forest of <i>Melaleuca</i> spp.	7	54.6
8c		Freshwater billabongs and seasonal fringes		Sedgeland, herbland and open water	2	1.2
-	Disturbed	-	-	Significantly modified by human activity.	5	255.6

*E = *Eucalyptus*, C = *Corymbia*



- Legend**
- Study area
 - Revised land units
- Landform**
- Low hills
 - Rises
 - Plains
 - Alluvial plains
 - Drainage systems
 - Swamps
 - Marine
 - Disturbance



0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GCS GDA 1994
 Date Saved: 27/06/2025
 Client: Total Eren Australia
 Mapper: Elliot.Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 3-2. Map of ground-truthed land units across the study area

4 SIGNIFICANT VEGETATION TYPES

This section provides background to the five significant vegetation types identified within the study area. It explains why the vegetation is considered significant under the *NT Land Clearing Guidelines* (DEPWS 2024), describes any current modelling of these significant vegetation types, and details the surveys undertaken to verify presence and habitat quality of these significant vegetation types. Assessing the quality of the significant vegetation types is essential for undertaking significant impact assessments and identifying appropriate disturbance buffers.

4.1 Reconnaissance survey

Because the study area is very large, a reconnaissance survey was first undertaken to inform targeted survey planning. The NT Government has modelled and mapped high-likelihood habitats for some threatened flora species and for both rainforest and sandsheet heath – to various degrees of resolution. These were assessed prior to fieldwork via examination of aerial imagery to rule out areas that have been disturbed (primarily for sand extraction) to such an extent that the modelled values are unlikely to be present. The remaining habitats were ear-marked for field verification.

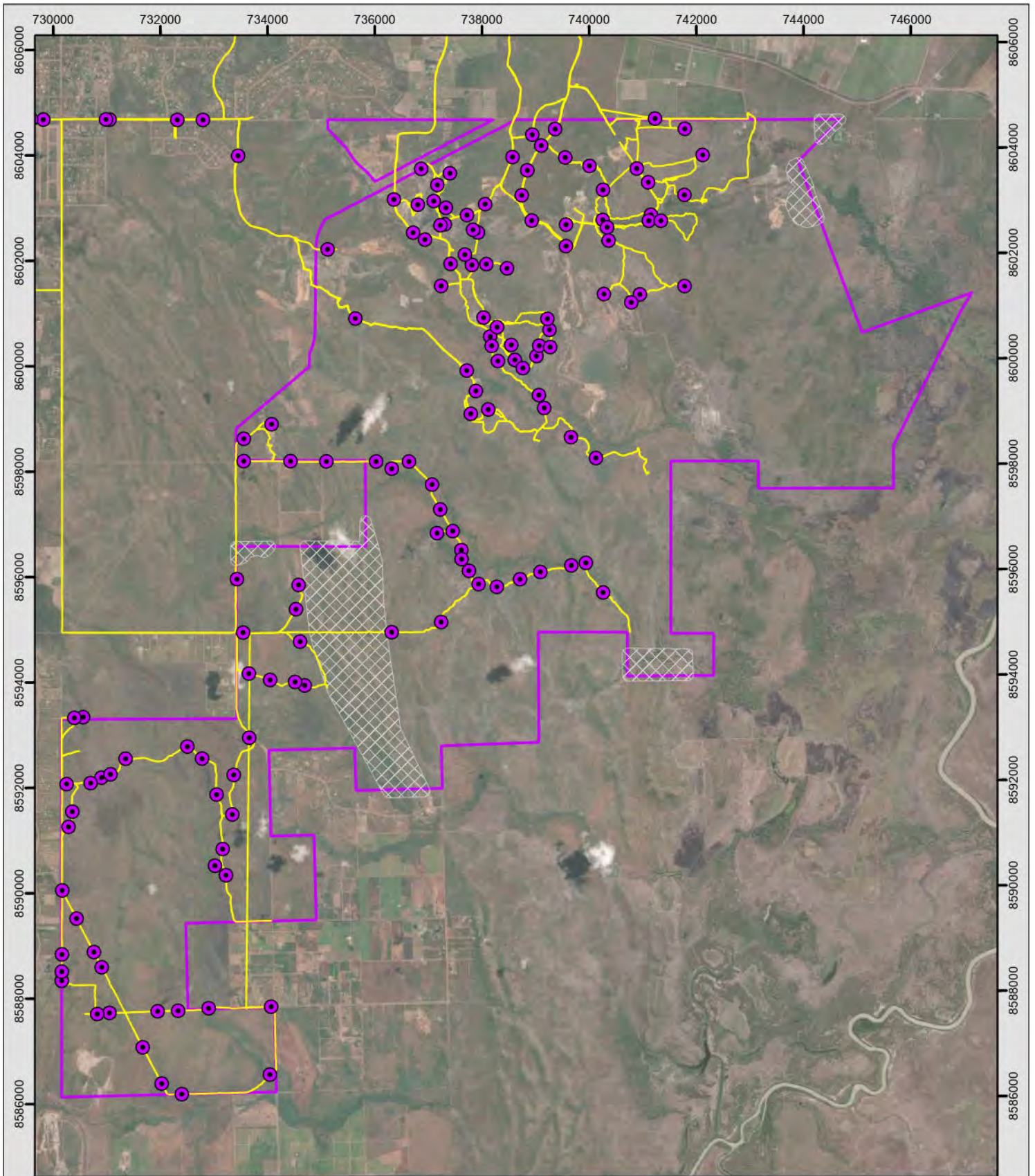
The goals of the reconnaissance survey were to:

- Determine presence and extent of the significant vegetation types.
- Verify presence and extent of modelled, high-likelihood threatened species habitat for threatened flora species.
- Obtain a good appreciation of site accessibility and limitations.

Modelled habitats for significant vegetation types and threatened flora species were assessed in the field by botanist Anna Lemon and ecologist Sara Maxsted from 23 to 31 January 2023, and on 2 and 24 February 2023. Follow-up surveys to verify modelled sandsheet heath were also undertaken on 1 and 2 March 2023. Sites within the study area were accessed mostly via existing tracks, using a combination of 4WD vehicles (car, side-by-side and quad-bikes) and on foot.

Sites were pre-selected across modelled habitats and watercourses. They were placed along existing unsealed roads and tracks where possible, to maximise survey efficiency over a large area, and accessibility in the wet season conditions. Assessments of habitat suitability within these areas involved noting the presence of indicator species, suitable substrate and other habitat features (i.e. gravel for *Typhonium praetermissum*, worm mounds for sandsheet heath etc). Observations including surface water presence/absence and disturbance indicators for sandsheet heath were also made. These assessments were then used to determine presence and suitability of modelled habitats for significant vegetation types and threatened flora species.

In total, 166 sites were assessed across the study area – see Figure 4-1. The timing of the surveys coincided with the wet season, and so some tracks within the site were too wet to be traversed and/or watercourses were too high to cross. As a result, several patches of modelled habitat were unable to be assessed.



- Legend**
- Reconnaissance survey site
 - Reconnaissance survey track
 - Sacred site (known)
 - Study area



0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GCS GDA 1994
 Date Saved: 27/06/2025
 Client: Total Eren Australia
 Mapper: Elliot Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 4-1. Map of reconnaissance survey effort

4.2 Sandsheet heath

Sandsheet heath occurs in seasonally-inundated infertile sandy soils overlaying an impermeable deposit of clay or laterite (DEPWS 2018a). There are several types of sandsheet heath, with typical upper and mid stratum species including *Grevillea pteridifolia*, *Banksia dentata*, *Melaleuca nervosa*, *Lophostemon lactifluus*, and *Verticordia cunninghamii* (Liddle et al. 2013). Ground species are generally a mix of herbs (including carnivorous *Utricularia spp.*) and sedges including *Dapsilanthus spathaceus*.

Sandsheet heath is regarded as a significant vegetation type because it covers a small land area (56 km²) and is known to support a range of threatened and specialised species, including EPBC-listed species such as Howard River Toadlet and *Typhonium taylori*, and a high diversity of bladderworts (*Utricularia spp.*). The Howard River catchment has a high proportion of the sandsheet heath in the region, with other smaller areas within the Elizabeth River and Adelaide River catchments.

4.2.1 Presence survey

A sandsheet heath mapping dataset compiled by the NT Government (Hempel 2003) indicated the presence of 29 mapped patches of sandsheet heath within the study area. The level of disturbance to these from sand mining was assessed using aerial imagery, followed by assessing habitat at the patches that warranted further investigation. As a result:

- Fifteen mapped patches were confirmed during surveys as supporting intact sandsheet heath vegetation within NT Portion 4477 (see Figure 4-2).
- At the request of TEH2, four patches in the north-east section of the study area were excluded from further study because two (patch 31 and 33) are near government mineral reserves and two (patch 24 and 32) occur within a sacred site.
- Using satellite imagery, eight patches were identified as completely disturbed because of sand mining activities. Three of these were checked and confirmed as disturbed during field surveys.
- Two un-mapped sandsheet heath patches were recorded – one near Townend Road (patch 34) and one in the north of the study area (patch 9).
- Two patches (4 and 18) are not considered to be sandsheet heath, because very few key characteristics associated with that habitat type were present. These patches of modelled sandsheet heath both form part of broader drainage systems, with habitat features consistent with that of billabongs, swamps and other floodplain habitat types.

In total, the survey determined that 198.6 ha of the mapped sandsheet heath patches³ are intact.

4.2.2 Habitat quality assessment

A habitat quality survey was undertaken between 8 and 15 March 2023 by botanist Anna Lemon and ecologist Sara Maxsted. Sites within the study area were accessed by driving along existing tracks using 4WD vehicles (car or quad bikes) and walking into patches where appropriate. To inform habitat suitability for threatened species, eight sandsheet heath reference sites supporting threatened flora were visited.

Method – field survey

Data were collected at survey sites within a 20 x 20 m quadrat based on methods used by Brocklehurst et al. (2008). The following data were collected: landform, soil type (surface examination only), vegetation structure, vegetation description, and dominant flora species within each stratum (including estimated height range and

³ The shapes of the patches depicted in Figure 4-2 are those from the NT Government sandsheet heath mapping dataset (Hempel 2003). The actual extent of sandsheet heath patches relevant to the project footprint will be refined when finer scale land type mapping is undertaken.

projected canopy cover). The presence of surface water, *Utricularia* spp., and nearby Eucalypt woodland were also documented, as these are typical features of sandsheet heath vegetation. Counts of *Utricularia* spp. Richness were made at each site and incidental species were recorded for each patch. Threatening processes were also documented – namely presence of weeds and feral animals, fire history, and other disturbances such as nearby mining and roads.

Available desktop information and results from the reconnaissance surveys indicated that 12 patches (patches 22 to 33, totalling 90.85 ha) were either highly modified due to extractive activities in the area or outside the project's refined study area boundary. These patches were excluded from the floristic and threatened flora surveys. A total of 27 sites (Appendix D) were assessed across 19 patches supporting intact vegetation within the study area.

Method – threatened species likelihood of occurrence and habitat quality assessment

To determine the presence of threatened species within sandsheet heath habitats, each patch was assigned a 'map unit', based on similarities in vegetation structure and species composition to the sandsheet heath vegetation communities outlined in Liddle et al. (2013). Patches were also compared to reference sites supporting each of the target flora species. Patches sharing similarities with habitat types known to support the threatened plants *Cleome insolata* and *Utricularia dunstaniae* were prioritised for targeted surveys (Sections 5.5 and 5.6).

Sandsheet habitat quality was then determined for each patch based on the diversity of *Utricularia* spp., presence of threatened species' habitat (or individuals) and disturbance levels. The number of *Utricularia* species observed at individual sites was collated for each patch and assigned a diversity rank according to those described in Liddle et al. (2013). These are very high (seven or more species), high (5 to 6 species), moderate (3 to 4 species), low (1 to 2 species) or none. Using all this information, each patch was assigned a habitat quality rank – very high, high, moderate and low. This method was adopted on the advice of DLPE because it is similar to that used by DLPE (as DENR) when assessing sandsheet heath patch quality at Middle Arm Peninsula (Hill 2020).

Results

The survey identified four types of sandsheet heath – as per Liddle et al. (2013) – occurring within the intact sandsheet heath patches present within the study area. Individual site data for each intact sandsheet patch are presented in Appendix D. The vegetation communities are:

- 3a – *Melaleuca nervosa* +/- *Pandanus spiralis* low open woodland with a *Sorghum intrans*, *Eriachne trisetata* mid tussock grassland understorey.
- 3b – *Melaleuca nervosa*, *Grevillea pteridifolia* low open woodland with *Dapsilanthus spathaceus* low open sedgeland ground layer.
- 4b – *Grevillea pteridifolia* +/- *Melaleuca nervosa* low open woodland with or without a mid layer of *Pandanus spiralis* and *Verticordia cunninghamii* low isolated trees or heath shrubs, and a *Dapsilanthus spathaceus* mid open sedgeland understorey.
- 4c – *Grevillea pteridifolia* +/- *Melaleuca viridiflora* +/- *Melaleuca nervosa* low open woodland with a mid layer of *Banksia dentata* +/- *Pandanus spiralis* and/or *Verticordia cunninghamii* tall sparse heathland and a *Dapsilanthus spathaceus* mid sedgeland understorey.

As detailed in Table 4-1, vegetation communities 3a and 3b are the most widespread, occurring across 12 patches and covering approximately 128.2 ha. This is followed by 4c which occurs in two patches (46.5 ha) and 4b also occurring in two patches (23.9 ha). One patch comprises of vegetation similar to community 6 (9.2 ha) and the edge of another patch comprised of vegetation similar to community 2a. Six of the patches are partially disturbed, with disturbance accounting for 30.8 ha and intact sections totalling 51.2 ha across these patches. Other threatening processes observed across patches were Feral Pig damage and occasional test pits (extractives).

Three patches from within the study area support a very high diversity of *Utricularia* spp. (7, 12, 14) and seven patches support a high diversity (3, 6, 8, 10, 15, 16 and 34). Four patches have a moderate diversity (5, 9, 13 and 17) and three patches support a low diversity (4, 11 and 18) of *Utricularia*. Of note, three patches (6, 7 and 8) support the Near Threatened species *Utricularia subulata*, one patch (7) supports the Vulnerable species *Utricularia dunstaniae*, and one other patch (14) supports the Vulnerable species *Cleome insolata* (all classifications are under the *TPWC Act*). Patch 3 is moderately disturbed, but there is a 2011 record of Howard River Toadlet (Vulnerable under the *EPBC* and *TWPC Acts*) adjacent upstream.

The quality assessment of each patch indicates that three patches are very high value, three patches are high value, seven patches are moderate value, and four patches are low value (Figure 4-2). By default, patches supporting threatened fauna or flora species are categorised as very high value. Patches with no threatened species – but a high *Utricularia* diversity – are categorised as high value.

Table 4-1. Summary of sandsheet heath communities within the study area

Patch ID	Vegetation site (SS)	Vegetation community	Size (ha)*	Threatened species survey	Threatened species recorded	Utricularia diversity	Disturbance	Habitat quality
1	28	4d	1.62	<i>Cleome insolata</i>	-	-	Moderate	Low
2	29	3a	2.28	<i>Cleome insolata</i>	-	-	Moderate	Low
3	17	3a	17.29	<i>Cleome insolata</i>	Howard River Toadlet	5	Moderate	Very High
5	01, 02, 14	3b, 3a	9.43	-	-	4	Moderate	Moderate
6	15	3b	2.8	<i>Utricularia dunstaniae</i> <i>Cleome insolata</i>	-	6	None	High
7	16	4b	4.75	<i>Utricularia dunstaniae</i> <i>Cleome insolata</i>	<i>Utricularia dunstaniae</i> Howard River Toadlet	7	None	Very High
8	03, 04	4b	19.17	<i>Utricularia dunstaniae</i> <i>Cleome insolata</i>	-	6	Low	High
9	12	3b	3.19	<i>Cleome insolata</i>	-	3	Moderate	Low
10	05, 06	3b, 3a	14.64	<i>Cleome insolata</i>	-	6	Moderate	Moderate
11	07, 08	3a	7.17	<i>Cleome insolata</i>	-	2	None	Moderate
12	09, 10	3a	14.24	<i>Cleome insolata</i>	-	8	Low	High
13	11	3b	7.88	<i>Cleome insolata</i>	-	4	Moderate	Low
14	18, 19	3b, 3a	25.54	<i>Cleome insolata</i>	<i>Cleome insolata</i>	7	Moderate	Very High
15	20	4c	16.69	<i>Cleome insolata</i>	-	5	Low	Moderate
16	21	3b	22.62	<i>Cleome insolata</i>	-	5	Low	Moderate
17	23	4c	28.18	-	Howard River Toadlet	4	None	Very High
34	22	3b	1.09	-	-	5	Low	Moderate

* Area of patch supporting intact sandsheet vegetation

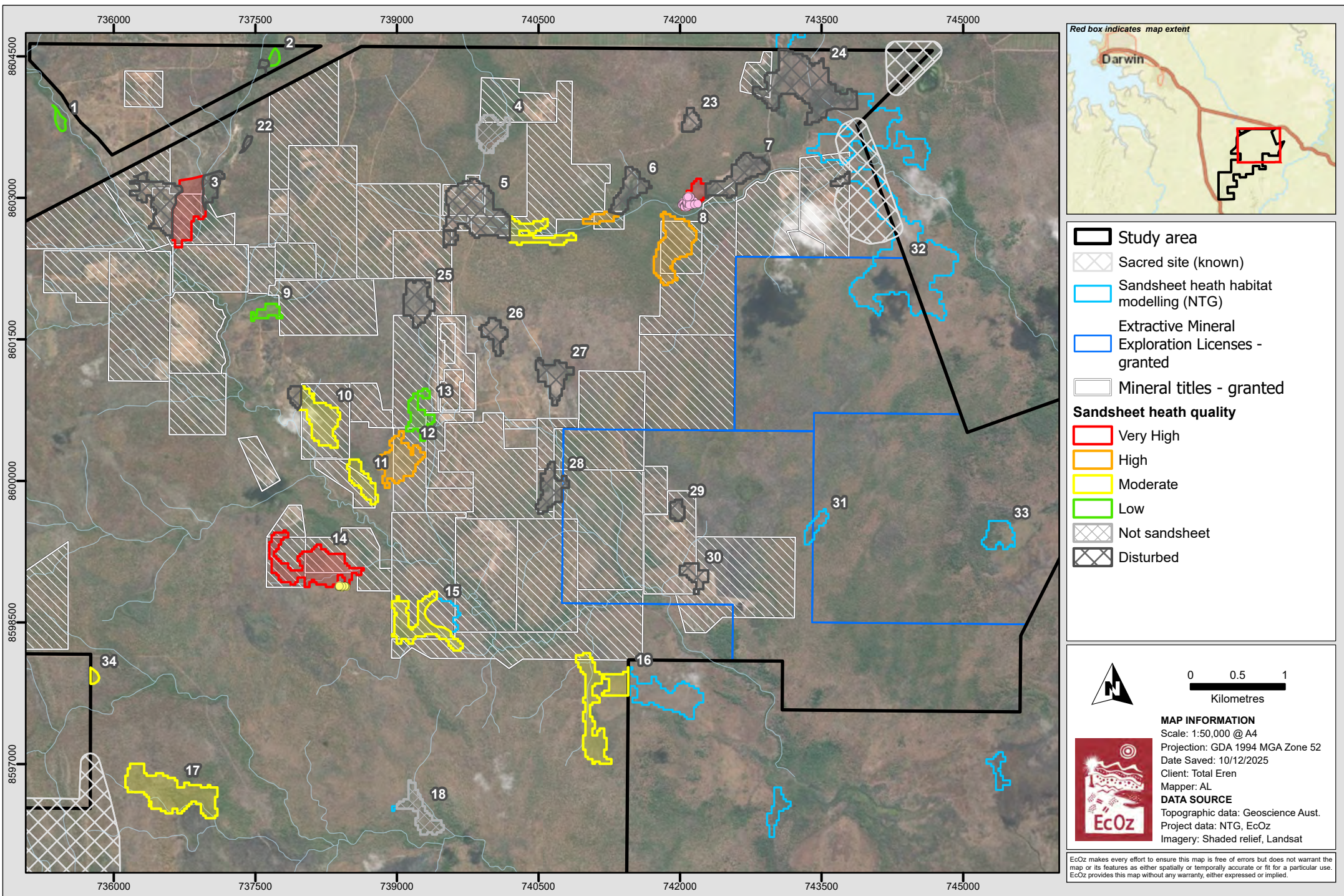


Figure 4-2. Map showing sandsheet heath vegetation occurring within the study area

4.3 Rainforest

Various types of monsoon and spring-fed rainforest, vine forest and vine thicket – collectively referred to as rainforest – occur in the NT over a broad range of landforms throughout the region of summer (i.e. monsoonal) rainfall – essentially north of 18°S (Russell-Smith 1991). Although only covering 0.2 % of the NT, these vegetation types contain 13 % of NT flora species, making them highly diverse and significant vegetation communities. The total rainforest estate in the NT is divided into 15,000 patches (ranging between 1 ha and 4,000 ha, with a median size of 3.6 ha) that are scattered within a vast expanse of mostly Eucalypt-dominated savanna (DENR 2018b).

A rainforest mapping dataset compiled by the NT Government (Russell-Smith 2000) indicates that the study area potentially supports approximately 256 ha of rainforest habitat (spring-fed, riparian and dry rainforests), across 42 patches of modelled habitat – see Figure 4-5. The largest proportion (by area) are described as spring-fed (9 patches); followed by dry rainforest (15 patches), then riparian (18 patches). This section presents results of analysis of the mapped ‘spring’ and ‘dry’ rainforests; ‘riparian’ vegetation is discussed in detail in Section 5.

An examination of satellite imagery identified eight additional patches of potential rainforest habitat, but also indicated that 21 of the patches mapped as ‘spring’ or ‘dry’ rainforest patches are not likely to support rainforest vegetation because they clearly lack the dense canopy vegetation associated with rainforest. In total, 12 patches of potential ‘spring’ or ‘dry’ rainforest habitat were identified. Due to access constraints in the wet season, only one of these patches was able to be verified during the reconnaissance surveys.

The study area was refined prior to undertaking surveys in the dry season. From the 12 potential patches identified in the reconnaissance and desktop surveys, nine occur within, or proximate to, the refined study area. Two of the patches were previously verified – one during the reconnaissance surveys and one by NT Government – and were not surveyed in the dry season. Six of the remaining patches of potential rainforest (RF01 to RF06) were visited and verified by botanist Anna Lemon, and ecologists Isabel Anderson and Nerida Liddle in June and August 2023. The final patch was surveyed during land unit ground-truthing (site 151) in November 2024, and is not a rainforest. The following rainforest patches were observed within, or proximate to, the refined study area:

- RF01 – supporting an open forest habitat with *Lophostemon grandiflora*, *Terminalia microcarpa*, *Acacia auriculiformis* and *Melaleuca dealbata* (see Figure 4-3).
- RF02 – supporting open forest habitat with *Alstonia actinophylla*, *Lophostemon lactifluus* and *Carallia brachiata* along a dry creek line.
- RF03 – supporting open forest habitat with *Terminalia microcarpa* and *Syzygium nervosum*.
- RF04 – supporting an open forest community with *Lophostemon lactifluus* open forest with *Acacia auriculiformis*, *Alstonia actinophylla*, *Erythrophleum chlorostachys* and a suite of rainforest species in the mid stratum.
- RF05 – an ephemeral creek line supporting rainforest species, including *Maranthes corymbosa* and *Carallia brachiata* (see Figure 4-3).
- RF06 – identified during the reconnaissance surveys, an ephemeral creek line supporting *Lophostemon lactifluus* open forest interspersed with rainforest species.



Figure 4-3. Photographs showing rainforest habitat at RF01 (left) and RF05 (right)

4.4 Wetlands

According to the *Land Clearing Guidelines* (DEPWS 2024), wetlands 'encompass a wide range of habitats that permanently or intermittently support plants or animals dependent upon wet conditions to complete their lifecycles'. This includes (but is not restricted to) swamps, marshes, billabongs, lakes, salt marshes, mudflats and mangroves. Wetlands support distinct vegetation communities that rely on either permanent or seasonal surface water supply (Brock 1993) and can often support a shallow water-table. They are considered a significant vegetation type because they provide essential habitat for a diverse range of flora and fauna – including endemic, threatened and migratory species – and can be easily impacted upon by poor land management and planning (Duguid et al. 2005).

The *Land Clearing Guidelines* state that valuing a wetland should consider:

- Wetland type and complexity.
- Size – larger wetland systems are generally considered to support a more diverse range of habitats.
- Aggregation – the occurrence of a wetland within a discrete aggregation may increase its value.
- The known or likely presence of significant plants or animals, or key resources or habitat for such species.
- Permanence and context in landscape – especially in arid zones.
- Listed importance or recognised special value.

Based on this guidance, this report focuses on the types of wetlands occurring within the study area that are most likely to be considered significant – namely swamps. Existing land unit mapping indicates the presence of other broader, poorly-draining habitat types within the study area – see Section 3.

The north-eastern corner of the study area intersects the Adelaide River floodplain system – see Figure 4-6. Field surveys confirmed that this system supports watercourses with riparian vegetation, sandsheet heath vegetation and *Melaleuca* swamps. This system also supports rainforest to the east, just outside the study area. Apart from sandsheet heath patches (see Section 4.1) and riparian areas (see Section 4.5), 24 swamp systems (land unit 8b) were also noted during desktop assessments, with all patches occurring within the northern portion of the study area. Typically, these are seasonally-inundated systems supporting *Melaleuca* spp., on waterlogged dark grey loamy clay soils.

The study area was refined prior to undertaking surveys in the dry season. All swamp systems within, or proximate to, the refined study area were visited in June and July 2023 by Anna Lemon, Laura Zaharie and

Isabel Anderson during targeted surveys for the threatened plant *Stylidium ensatum* (see Section 5.2). This survey confirmed the presence of three swamp systems (Figure 4-4) within the refined study area and another 10 patches outside of the refined study area to the north-east. The remaining 11 patches were not assessed because they occur well beyond the refined study area to the north-east. The swamps that were recorded were open forests dominated by *Melaleuca leucadendra* (e.g. land unit site VS-49 – see Figure 4-4), *Melaleuca viridiflora*, *Melaleuca cajaputi* (e.g. land unit site VS-114 – see Figure 4-4), or *Lophostemon lactifluus*. Land unit ground-truthing also assessed areas mapped as land unit 8b within the refined study area.



VS-49



VS-114

Figure 4-4. Photographs showing *Melaleuca* spp. wetland habitat in the centre of the refined study area

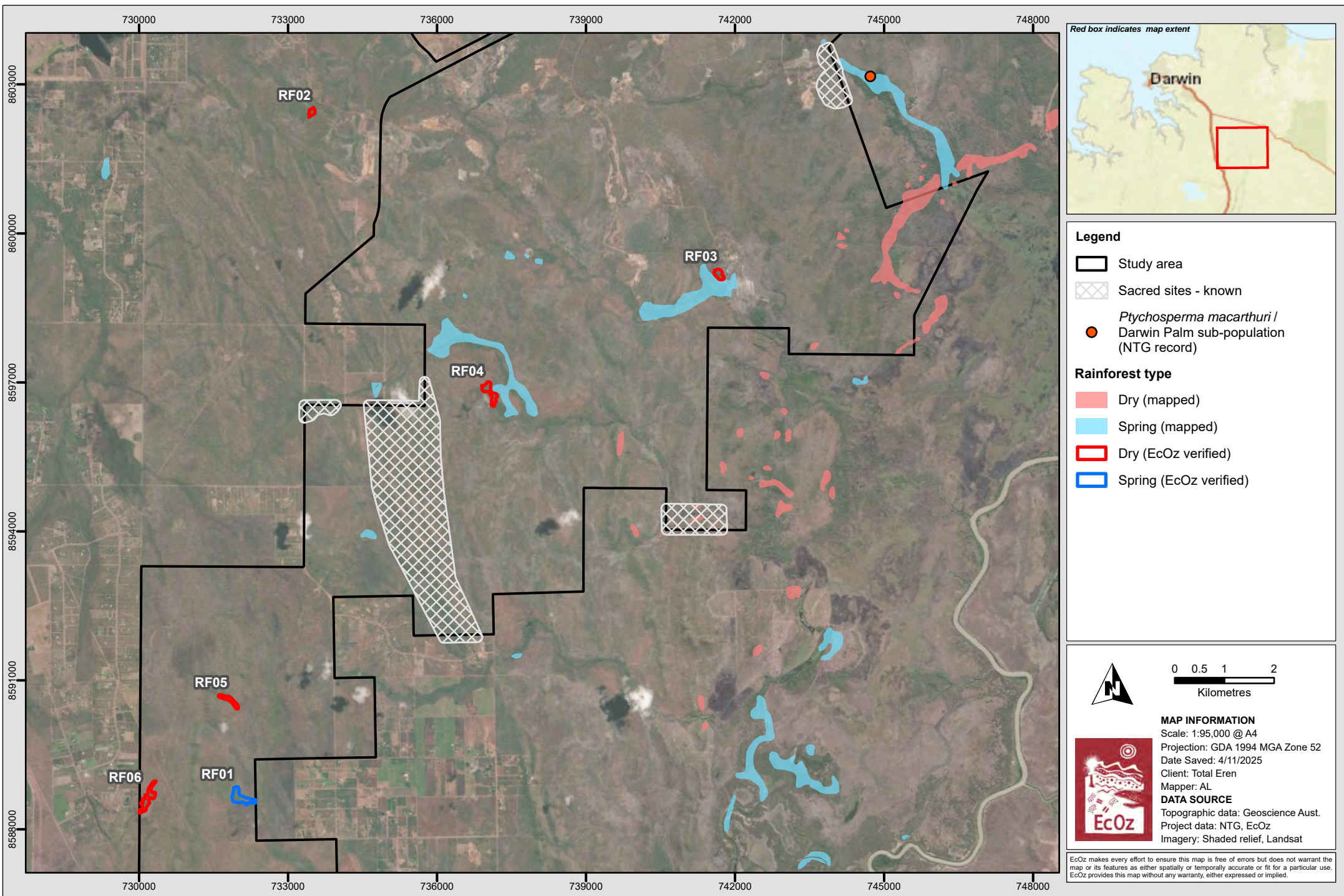
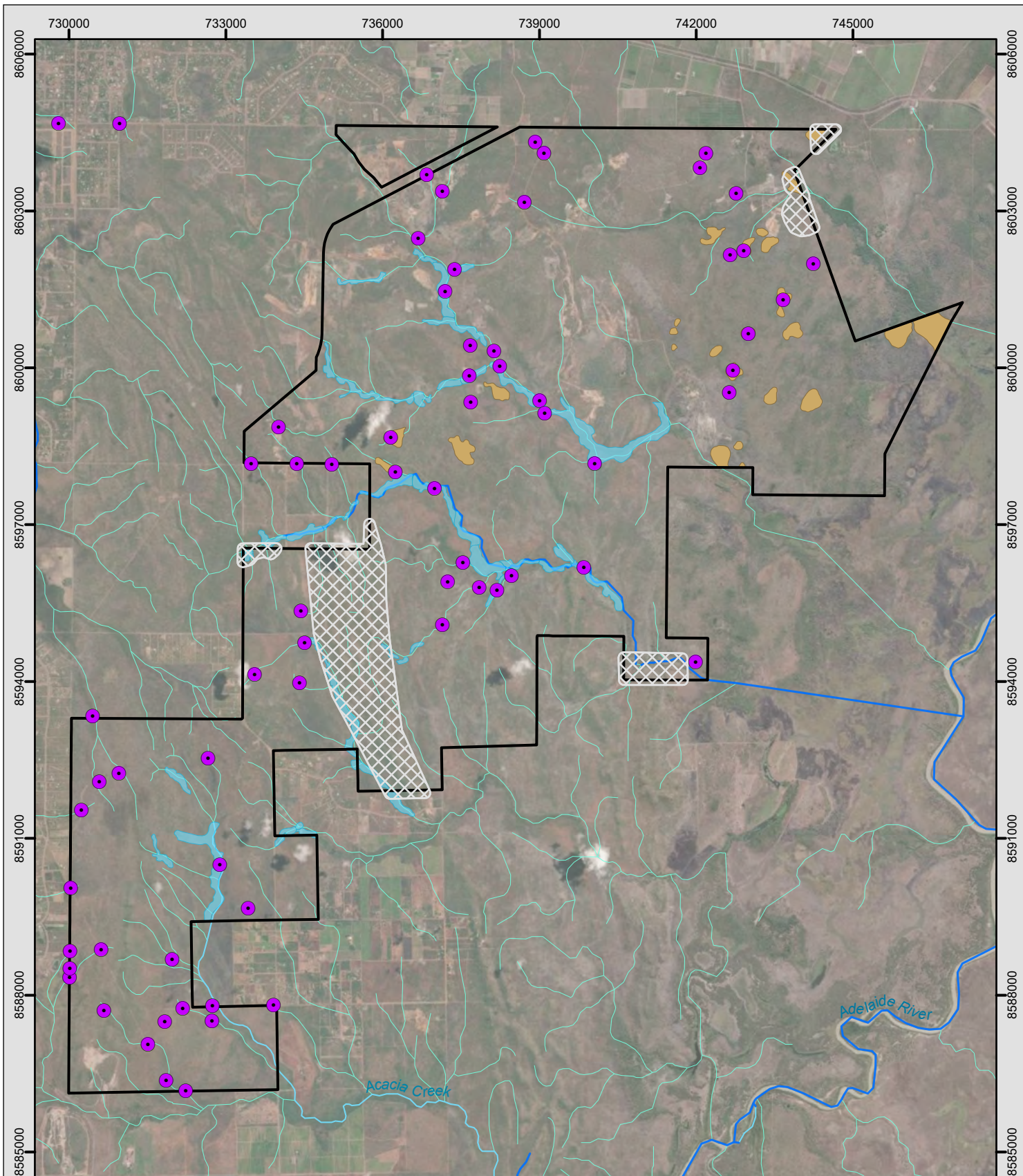


Figure 4-5. Map showing rainforest vegetation across the study area



Legend

- Study area
- Sacred sites - known
- Watercourse assessment site
- Riparian vegetation
- Melaleuca* spp. swamps (land unit 8b)
- Major Drainage
- Minor Drainage
- Streams



0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 24/06/2025
 Client: Total Eren
 Mapper: AL

DATA SOURCE
 Topographic data: Geoscience Aust.
 Project data: NTG, EcOz
 Imagery: Shaded relief, Landsat

Figure 4-6. Map showing riparian habitats and wetlands across the study area

4.5 Riparian vegetation

According to the *Land Clearing Guidelines* (DEPWS 2024), riparian vegetation is any native vegetation within, and immediately surrounding, a waterway, and is not restricted to a distinct vegetation community immediately adjacent to waterways. This broad definition identifies that all riparian vegetation provides a critical role in maintaining ecological processes. Riparian vegetation that is distinct from the surrounding vegetation often has additional values – including supporting unique biodiversity, and providing refuge habitat and habitat corridors.

Because of the large study area, remote sensing was primarily used to identify riparian vegetation. Sentinel-2 imagery from September 2022 of Band B3 (green band, 560nm) at 10 m resolution was clipped to the extent of the study area. A 100 m buffer was created for each drainage line reach (i.e. each segment of a drainage line between two tributaries) mapped in the Darwin surface water mapping layer (1:100,000), and mean pixel values for the green band were calculated within the buffer. Visual observation of the results indicated that a stream reach with green pixel values below 110 had a visible riparian edge. These stream reaches were included in the final map presented in Figure 4-6.

In the field, a total of 47 sites were assessed during the reconnaissance survey along mapped watercourses across the study area (see Figure 4-6), identifying a range of riparian vegetation types. Watercourses supporting this riparian vegetation ranged from drainage lines to creeks with incised channels, and comprised a range of associated plant assemblages – i.e. *Melaleuca* open forests, *Eucalypt* woodland and open forest containing rainforest species (see Figure 4-7 and Figure 4-8).

One un-named waterway classed as a ‘major drainage’ passes across the centre of the study area. Further to the south, *Acacia Creek* which is classed as a ‘minor drainage’ passes across the study area, supporting *Melaleuca* spp., *Pandanus spiralis* and *Eucalyptus alba*. Two additional creeks (both classed as ‘streams’) supporting riparian vegetation were also observed in the north of the study area. The northernmost creek supports vegetation that is similar to that observed along *Acacia Creek*. The other creek contains *Melaleuca* spp. vegetation and also supports rainforest species. All waterways flow to the south-east towards the *Adelaide River* catchment.



Figure 4-7. Photographs of riparian habitat supporting rainforest vegetation within the study area



Figure 4-8. Photographs of riparian habitat dominated with *Melaleuca* spp. within the study area

4.6 Old-growth forest

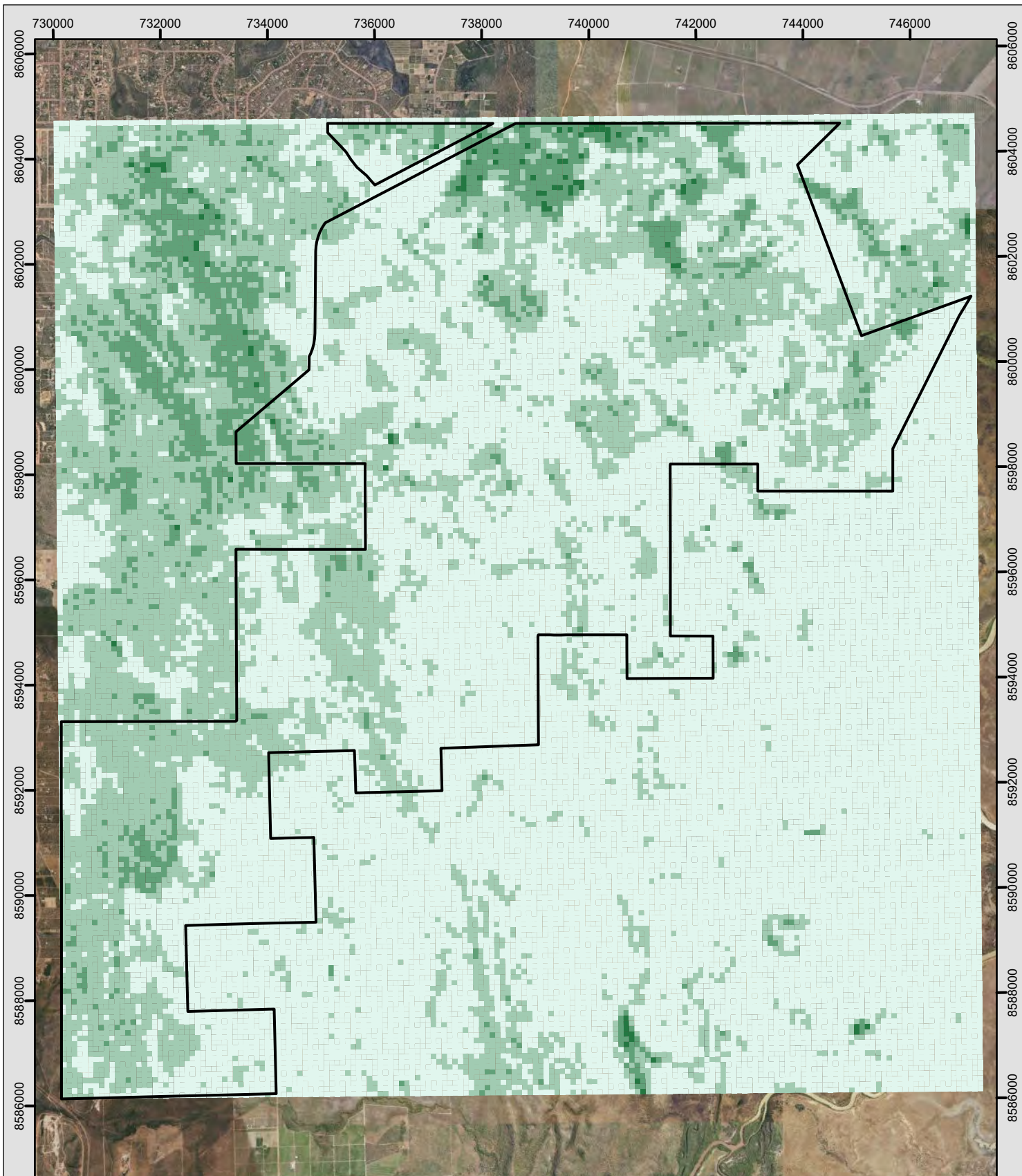
The size of a tree (height and diameter at breast height) is linked to its age and the potential for that tree to support hollows critical for hollow-dependant fauna species. The *Land Clearing Guidelines* (DEPWS 2024) acknowledge the critical resource that large old trees with hollows provide through the identification of significant patches of large old hollow-bearing trees. Hollow-bearing trees occur in a wide range of vegetation; however, they are more likely to occur within older *Eucalyptus* forests and woodlands, with a lower fire frequency. Since the development of tree hollows is associated with the age of vegetation, a forest with many tree hollows is referred to as *old-growth forest* (DENR 2018).

While all tree hollows provide valuable habitat for fauna, in the NT, a *Eucalypt* forest that has either five or more *Eucalypt* stems growing greater than 50 cm in diameter at breast height (dbh) per hectare, and/or 30 or more *Eucalypt* stems greater than 40 cm dbh per ha is considered to be of high value for biodiversity (DENR 2018).

A canopy height model derived from an airborne LiDAR data collection was provided by TEH2 (for details, see Appendix A). The Flora and Fauna Division of the DLPE indicates that trees over 17 m tall have a higher propensity of containing hollows; as a result, the number of trees taller than 17 m in each 1-ha grid cell was tallied from across the study area (see Figure 4-9).

Canopy height is strongly correlated with the abundance of tree hollows, because hollows are more likely to occur in large diameter trees. Many of the threatened woodland fauna recorded in the study area (see Section 7) are known to be strongly associated with tall stands of *Eucalyptus miniata* and *E. tetradonta*-dominated woodlands that produce tree hollows.

The model shows that tall tree density is higher on the ridgelines in the south-west and centre of the study area, and highest in the far north interspersed amongst the extractive areas.

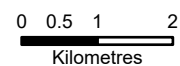


Legend

Study area

Tall tree count (>17m) / ha

Lightest Green	0 - 4
Light Green	5 - 30
Medium Green	31 - 50
Dark Green	51 - 100



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GCS GDA 1994
 Date Saved: 4/11/2025
 Client: Total Eren Australia
 Mapper: Elliot.Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 4-9. Map of tall tree densities across the study area

5 THREATENED FLORA

This section outlines the desktop and field assessments undertaken for the seven threatened flora species that were assessed in Section 2.5 as having a medium or high likelihood of being present within the study area. It presents the methods and results of threatened species habitat assessments and targeted surveys. Surveys are summarised in Table 5-1, with background information, survey methods and results for each species detailed in the following sections.

Table 5-1. Summary of threatened flora surveys conducted

Value	Survey effort
<i>Typhonium praetermissum</i>	61 habitat assessments to refine high-likelihood habitat mapping (reconnaissance survey) 91 quadrat surveys within high-likelihood habitat
<i>Stylidium ensatum</i>	29 habitat assessments within high-likelihood habitat (reconnaissance survey) Habitat verification of 25 patches (dry season) Targeted meander surveys within confirmed high-likelihood habitat
<i>Ptychosperma macarthurii</i>	10 habitat assessments within high-likelihood modelled habitat (reconnaissance surveys) 8 habitat assessments within new rainforest patches (dry season surveys)
<i>Helicteres macrothrix</i>	3 habitat assessments within modelled high-likelihood habitat (reconnaissance surveys) 20 habitat assessments within modelled high-likelihood habitat (dry season surveys) Targeted surveys within confirmed high-likelihood habitat
<i>Utricularia dunstaniae</i>	3 patches identified during floristic surveys supporting suitable habitat Targeted parallel transect surveys at three high/very high value patches (6, 7 and 8)
<i>Cleome insolata</i>	14 patches identified during floristic surveys supporting suitable habitat Targeted meander surveys at 13 patches supporting suitable habitat

All threatened flora surveys were undertaken using the methodology outlined in the *Northern Territory Guidelines for targeted surveys of threatened and significant plant species* (Cuff et al. 2020). Prior to undertaking the surveys, a visit to a suitable reference population was made to ensure the target species was readily detectable at the time of survey, and for surveyors to familiarise with the species morphology and habitat. Surveyors each used a handheld GPS to record tracks and species presence.

5.1 *Typhonium praetermissum*

5.1.1 Ecology

Typhonium praetermissum is a small perennial herb with above-ground parts present during the annual wet season, usually between December and April – see Figure 5-3 for a photograph. The species is listed as Vulnerable under the *TPWC Act* and has been nominated for listing as Endangered under the *EPBC Act*. The outcome of that nomination is expected in late November 2025. *Typhonium praetermissum* occurs in open woodland and favours relatively unshaded areas in red brown clay and shallow gravelly soils (Cowie and Westaway 2012b). Plants are typically found in small, relatively open patches of gravel or gravelly sandy

substrate supporting less than 20% vegetation ground cover and on the edge of lateritic plateaux (NTG 2013a) – see Figure 5-2.

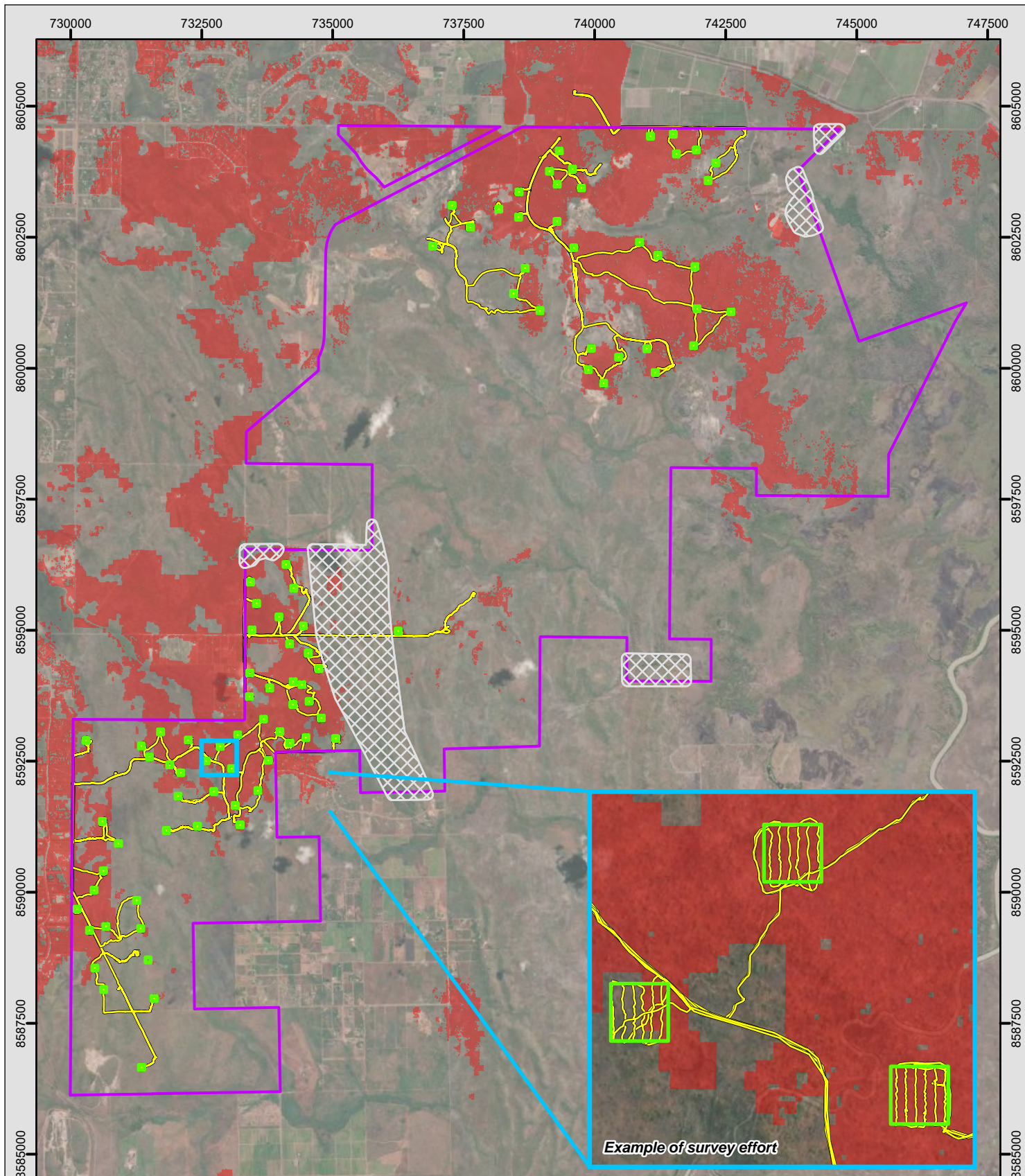
5.1.2 Methods

Government modelling (Cuff and Green 2019) indicates that the study area potentially supports ~4,200 ha of high-likelihood habitat for the species *Typhonium praetermissum*. These areas were adjusted following the abovementioned reconnaissance surveys by EcOz staff. Advice received from the Flora and Fauna Division of the Department of Environment, Parks and Water Security (DEPWS) about surveying for this species was to prioritise high-likelihood habitat in areas not previously surveyed.

As a result, 119 quadrats were randomly assigned across the high-likelihood habitat areas, each a 100 m by 100 m square made up of six 100 m transect lines (Figure 5-1). This meant that each transect line within the quadrat was almost 17 m apart, with an effective transect width of approximately 4 m (i.e. the distance from the transect at which a *Typhonium* can be reliably detected). The aim of these preliminary surveys was to detect the presence and extent of *Typhonium praetermissum*, rather than to record their abundance. Where a plant was detected, it was recorded as an individual waypoint on a hand-held GPS device. In a few instances, clusters of *Typhonium praetermissum* recorded in the same area were also recorded as a single waypoint. It is standard when surveying areas in which there are few existing *Typhonium praetermissum* records to undertake genetic sampling to inform regional variation of the species. Genetic sampling of 30 plants was undertaken during the survey to capture a spatially- and morphologically-representative sample of each occurrence within the study area.

New habitat modelling for *Typhonium praetermissum* was released by the NT Government after the survey was completed, which further refined the high-likelihood areas for this species across its extent. A review of the survey results showed that the quadrats used still represented a significant cover of the updated model's high-likelihood habitat in the study area.

All survey methods – including genetic sampling guidelines – were in accordance with the survey method described in the *Northern Territory guidelines for targeted surveys of threatened and significant plant species* (Cuff et al. 2020), as well as supplementary survey guidelines (Bickerton et al. 2020).



Legend

- Study area
- Sacred sites - known
- Typhonium praetermissum* high-likelihood modelled habitat (NTG)
- Surveyed quadrat
- Survey track

MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 5/11/2025
 Client: Total Eren
 Mapper: AL

DATA SOURCE
 Topographic data: Geoscience Aust.
 Project data: NTG, EcOz
 Imagery: Shaded relief, Landsat

Figure 5-1. Map of *Typhonium praetermissum* survey effort within the study area

5.1.3 Results

During the reconnaissance survey, 61 habitat assessments were undertaken to refine the extent of *Typhonium praetermissum* high-likelihood habitat. At the time, 27 *Typhonium praetermissum* plants were incidentally observed across the study area.

During the targeted field surveys, large areas of *Typhonium praetermissum* habitat were observed in the north and south-west of the study area, which was reasonably consistent with the NT Government habitat modelling for the species (Cuff and Green 2019) (Figure 5-2). Some patches were excluded from further survey because field observations determined the habitat was unsuitable.

Of the 119 quadrats selected, 91 were surveyed by EcOz staff during the survey window (Figure 5-1). The remaining quadrats were unable to be assessed either due to inaccessibility (because of difficult terrain or inundation) or time constraints caused by deteriorating environmental conditions for surveys. In the latter case, surveys were prioritised in areas which had not been previously assessed, particularly in the south and eastern periphery of the study area.

In total, 671 individual plants (or clusters of plants within a small area) were recorded, from which 30 genetic samples were taken. In quadrats with *Typhonium praetermissum*, surveys typically recorded less than 20 plants, with some quadrats only recording one specimen. The highest number of *Typhonium praetermissum* plants within a quadrat was approximately 50 plants in the north-east of the study area. Of the 91 quadrats assessed, *Typhonium* plants were present in 73 quadrats (80%) and absent in 18 quadrats (20%).

Figure 5-4 shows the location of the records within the study area, as well as NT Atlas records collected in previous surveys for other projects. The majority of *Typhonium praetermissum* were recorded in the north-east and south-west of the study area. These are also the areas where most of the quadrat surveys were placed because of the concentration of high-likelihood habitat.

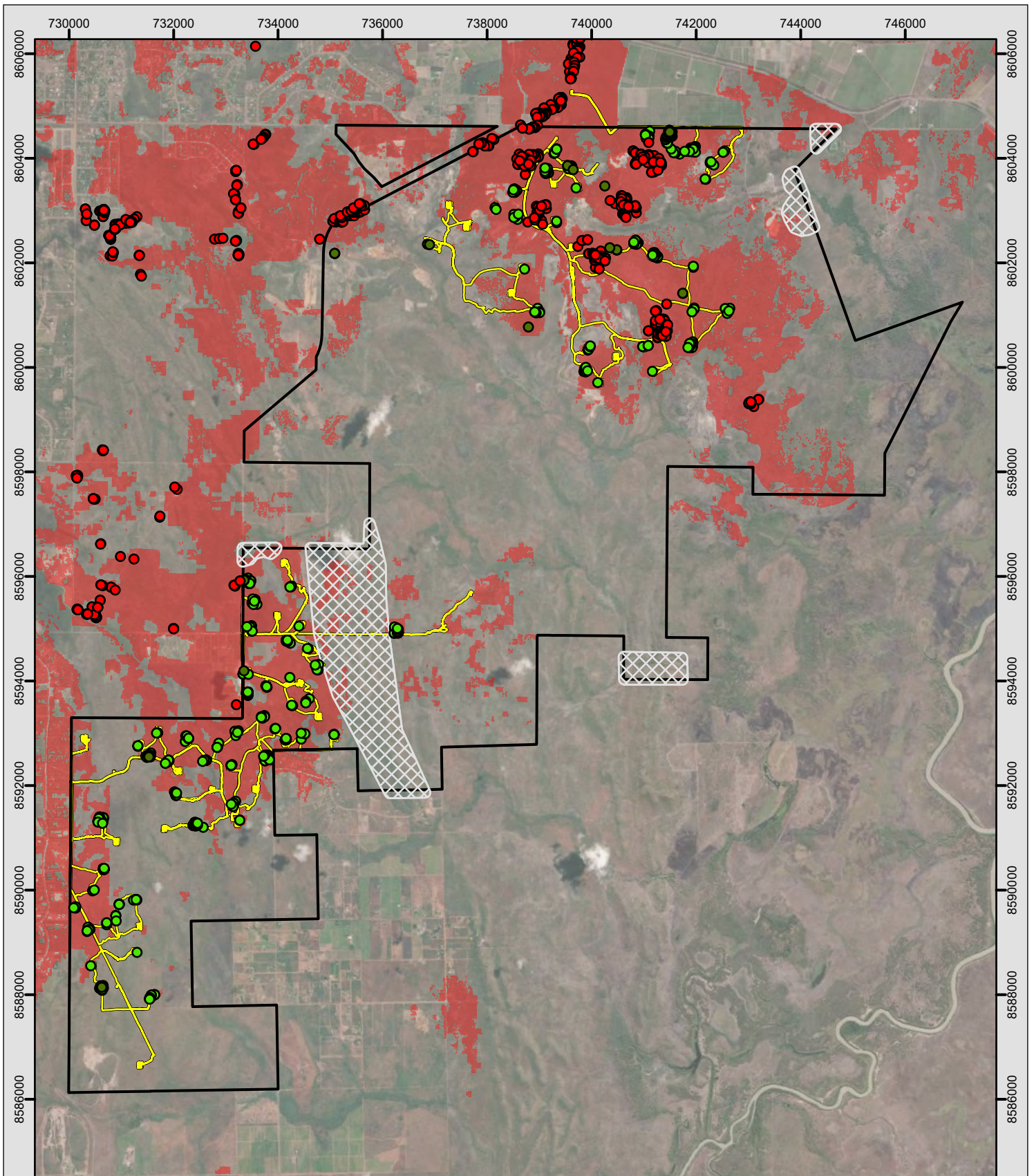
The genetic analysis confirmed that all sampled plants were *Typhonium praetermissum*.



Figure 5-2. Photographs of *Typhonium praetermissum* habitat



Figure 5-3. Photograph of a *Typhonium praetermissum* plant recorded during the survey



Legend

- Study area
- Sacred sites - known
- Typhonium praetermissum* high-likelihood modelled habitat (NTG)
- Survey tracks

***T. praetermissum* record**

- EcOz record - reccie survey
- EcOz record - targeted survey
- NTG record

0 0.5 1 2
Kilometres

MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 5/11/2025
 Client: Total Eren Australia
 Mapper: Elliot, Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 5-4. Map of *Typhonium praetermissum* survey results within the study area

5.2 *Stylidium ensatum*

5.2.1 Ecology

The trigger plant, *Stylidium ensatum*, is endemic to the NT and is listed as Endangered under the *TPWC* and *EPBC Acts*. *Stylidium ensatum* (Figure 5-5) inhabits margins of drainage areas in damp, heavy clay or peaty soil (Cowie and Westaway 2012a, NTG 2013b), although it may prefer sandier or loamy soils (Ian Cowie, NT Herbarium, pers. comm. 2017). Suitable areas for *Stylidium ensatum* tend to be adjacent to *Lophostemon* swamps, where surface moisture is maintained into the early to mid-dry season (Nick Cuff, NT Herbarium, pers. comm. 2017). The preferred habitat for *Stylidium ensatum* generally supports *Melaleuca viridiflora*, *Eucalyptus alba* and *Lophostemon lactifluus*, but also perennial grasses (such as *Eriachne burkittii*), *Pandanus spiralis*, *Osbeckia australiana* and scattered *Banksia dentata* (Donna Lewis, NT Herbarium, pers. comm. 2020).



Figure 5-5. Photographs of *Stylidium ensatum* leaves and flower

5.2.2 Habitat presence survey

The NT Government has modelled potential high-likelihood habitat for the species (Cuff and Green 2016a). The modelling is at a coarser scale compared with the *Typhonium praetermissum* modelling – meaning that surveys of such areas less often result in records of the species. This modelling indicates that the study area potentially supports ~987 ha of high-likelihood habitat for the species *Stylidium ensatum* across 12 patches.

During the reconnaissance surveys, habitat assessments were undertaken at 22 sites within potential *Stylidium ensatum* habitat across the study area. Of these, 17 assessments were undertaken across six patches of *Stylidium ensatum* high-likelihood modelled habitat and five assessments identified potential habitat outside modelled areas. In total, four assessments confirmed the presence of medium or high-likelihood habitat at three patches of modelled habitat, and five new patches (four creeks and one swamp) were confirmed supporting suitable habitat outside of modelled areas. Patches classed as high-likelihood were typically associated with swamp systems and drainage depressions containing *Melaleuca viridiflora* and *Eucalyptus alba* over *Eriachne* spp. grassland (see, e.g., Figure 5-6) with suitable soils, whereas areas classed as moderate only partially satisfied these habitat requirements.

The results from the reconnaissance and desktop surveys suggest that the study area is likely to support ~18 ha of high-likelihood habitat, ~103 ha of medium likelihood habitat, and ~613 ha of low likelihood habitat

(see Figure 5-9). All of the high-likelihood habitat observed during the reconnaissance surveys is situated in the north-eastern corner of the study area.



Figure 5-6. Photograph of suitable *Stylidium ensatum* habitat within the study area

5.2.3 Targeted survey

A refined version of the study area became available prior to undertaking surveys for *Stylidium ensatum* in the dry season, and was used for targeted surveys for *Stylidium ensatum* undertaken by botanist Anna Lemon, and ecologists Laura Zaharie, Isabel Anderson and Nerida Liddle from June-August 2023. Potential habitat within the refined study area was accessed by driving along existing tracks using 4WD vehicles (car, quad bikes, side by side) and walking into patches where appropriate, to undertake targeted searches for the species.

Method

A total of 25 patches were identified as potential *Stylidium ensatum* habitat within, or proximate to, the refined study area. Prior to undertaking targeted surveys for *Stylidium ensatum*, habitat modelling for the species was further revised to reflect the presence of all potentially-suitable habitat within the refined study area. This identified select portions from five patches of modelled habitat (two verified and three unverified patches), 12 *Melaleuca* spp. swamp habitats and four new patches observed during the reconnaissance surveys. In addition to the new patches, another four patches were observed during field surveys targeting sandsheet heath and rainforest habitats. All 25 patches were visited, assessed for suitability, and subsequently searched if suitable habitat was present.

The following habitat features are preferred by *Stylidium ensatum* and were used to verify and re-assess habitat suitability in line with appropriate survey timing (NTG 2013b):

- Margins of drainage systems; areas that are poorly drained with seasonal inundation or waterlogging and have hydrosols soils – i.e. they are saturated with water for extended periods, are generally a greyish colour and have a high organic content.
- Shallow inundation or saturated soils in the mid dry season.
- Overstorey consisting of *Melaleuca viridiflora*, *Lophostemon lactifluus* and/or *Pandanus spiralis*.
- Ground layer incorporating grasses and herbs that occur in poorly-drained habitats – i.e. *Eriachne* spp., *Fimbristylis* spp.
- Relatively open overstorey.

To determine the presence of suitable habitat, each patch was categorised as having a high, moderate, or low likelihood of supporting the species, based on similarities in vegetation structure and species composition to the reference sites. Suitable habitats were defined using the same approach described previously in Section 5.2.2, with the addition of a low likelihood category – habitat supporting few indicator species and/or showing evidence of habitat modification. Habitats considered to have a low likelihood of supporting the species were not included in targeted searches.

If suitable habitat was present, two surveyors conducted a targeted meander to search for *Stylidium ensatum* in line with Cuff et al. (2020). This survey approach was selected for this species because the study area supports between 100 and 500 ha of high-likelihood habitat, and the species also occurs within relatively linear habitat types – i.e. the edges of drainage line vegetation and swamp systems. Surveyors aimed to maintain the recommended separation width while traversing within suitable habitat, which is 5 m apart in closed habitats for herbs such as *Stylidium ensatum* (Cuff et al. 2020).

Results

Visits to several reference sites (Girraween, Gunn Point, and Alverly Roads) confirmed the detectability of *Stylidium ensatum* prior to undertaking surveys (Appendix E). The plants at the reference sites were detectable during each visit. Habitat features were consistent among all three locations, and with those described above. No *Stylidium ensatum* plants were observed within the study area during the targeted surveys. A summary of the habitats observed within the study area are detailed below and are presented on Figure 5-9. Habitat assessments undertaken during the targeted surveys are presented in (Appendix E).



Figure 5-7. Photographs showing *Stylidium ensatum* reference site and specimen on Gunn Point Road

Four patches of *Melaleuca viridiflora* swamps and one drainage depression had a high likelihood of supporting the species. All four swamps are located approximately 1.1 to 1.3 km beyond the north-east corner of the refined study area. The drainage depression forms part of the sacred site identified approximately 1.6 km north of Townend and Mocatto Roads and so was excluded from search efforts. Ten patches comprised of partially-suitable habitat had a moderate likelihood of supporting the species. The remaining 22 patches were considered have a low likelihood because they were largely comprised of other habitat types and were not typically associated with swamp systems. A large portion of habitat classed as low likelihood were also highly modified by mineral extractive activities.

Desktop assessment for the species indicates that all publicly-available *Styloidium ensatum* records are located within, or proximate to, swamp systems or drainage depressions – typically those belonging to land unit 8b⁴ (Fogarty et al. 1984). The habitat modelling for the species is consistent with drainage systems belonging to land unit 6b⁵ (Cuff and Green 2016a; Fogarty et al. 1984). While it has been observed that these records are usually present within the habitat modelling (land unit 6b), they are typically observed abutting land units supporting the species preferred habitat (land unit 8b). Given that searches for *Styloidium ensatum* were undertaken at all patches supporting high and moderate likelihood habitat (excluding the sacred site) – and that no plants were detected during the surveys – the likelihood for this species occurring within the study area is low.

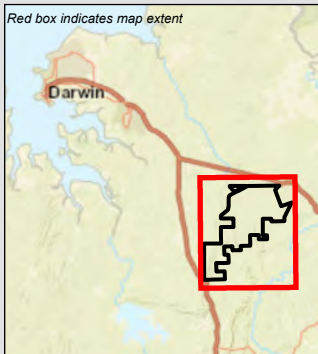
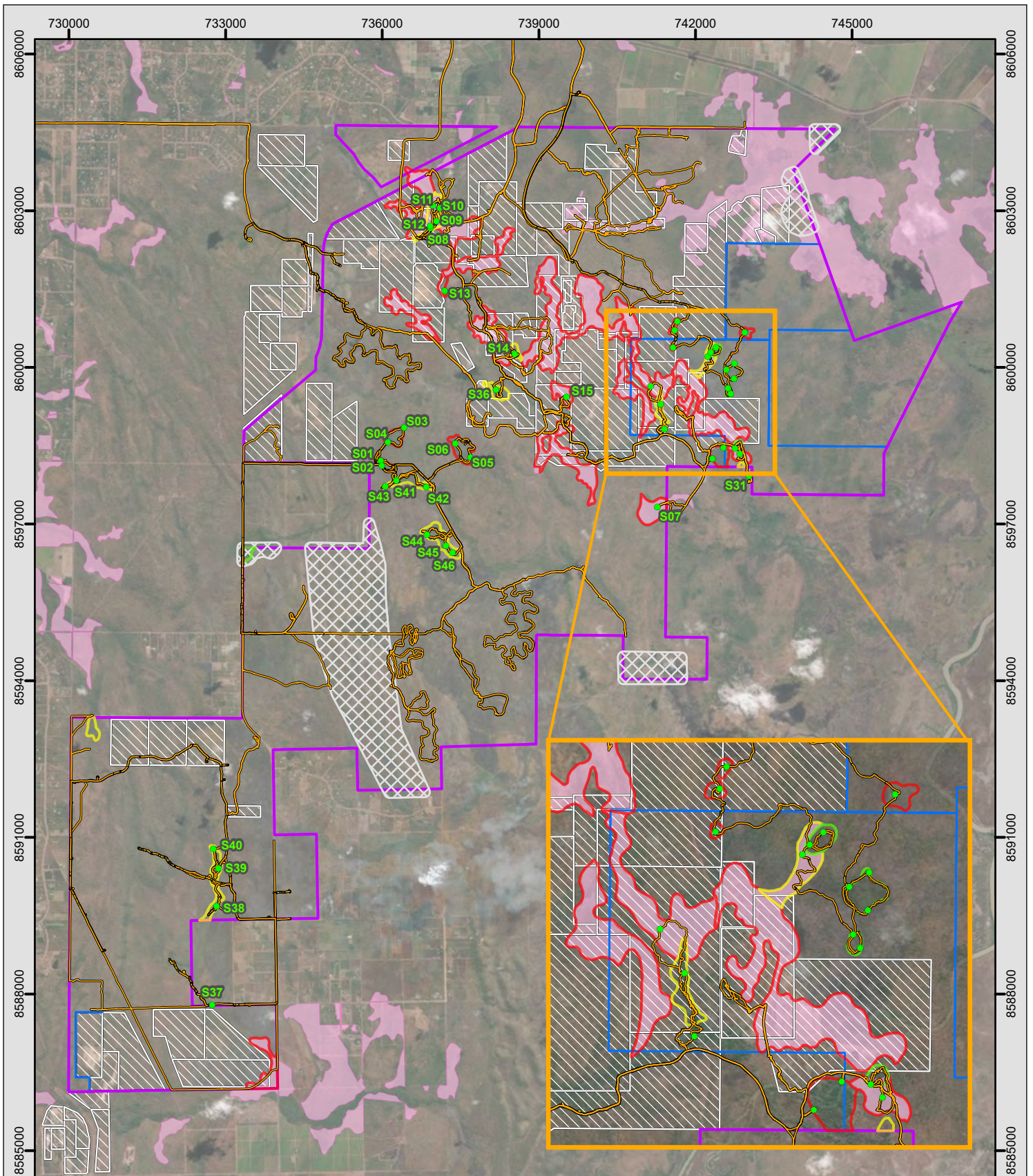
Two modelled patches were not verified or surveyed during reconnaissance and targeted surveys. It is unlikely that these patches support *Styloidium ensatum* because the modelling does not abut the species' preferred habitat (land unit 8b); no records for the species exist within the catchment or were collected in recent surveys within nearby habitats; and satellite imagery suggests that these patches do not support the species' preferred habitat.



Figure 5-8. Photographs showing example of modelled, high-likelihood *Styloidium ensatum* habitat (S23) within the study area

⁴ Land unit 8b typically comprises of swamp depressions supporting open to closed forest with *Melaleuca* spp. on soils with high clay and organic matter which are usually damp until the mid-late dry season.

⁵ Land unit 6b typically comprises of broad lowland plains supporting tall shrubland to low open woodland with *Grevillea* spp., *Melaleuca* spp. and *Lophostemon lactifluus* on sandy clay soils which are usually damp until the early-mid dry season.



Legend

- Study area
- Sacred sites - known
- Extractive Mineral Exploration Licenses - granted
- Mineral titles - granted
- Survey tracks
- Styliidium ensatum* habitat modelling (NTG)
- *Styliidium ensatum* habitat assessment (dry season)
- Habitat suitability**
- High
- Moderate
- Low

0 0.5 1 2
Kilometres

MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 10/12/2025
 Client: Total Eren
 Mapper: AL

DATA SOURCE
 Topographic data: Geoscience Aust.
 Project data: NTG, EcOz
 Imagery: Shaded relief, Landsat

Figure 5-9. Map of habitat suitability and survey effort for *Styliidium ensatum* within the study area

5.3 *Ptychosperma macarthurii*

Ptychosperma macarthurii is listed as Endangered under the *TPWC Act*. In the NT, the Darwin Palm occurs in dense wet rainforests associated with lowland springs near the margins of riverine floodplains (NTG 2013c). The soils typically comprise deep organic clay loams without humus development. The species is known from eight populations. The Black Jungle sub-population is by far the largest, with Crocodile Creek containing 70% of the NT population (Liddle et al. 2006). The next largest Darwin Palm occurrence – the Daminmin Jungle sub-population – is located to the north-east of the study area, supporting over 1,000 individuals.

Coarse-scale government modelling indicates that the study area potentially supports ~256 ha of high-likelihood habitat for *Ptychosperma macarthurii* (Cuff and Green 2016b). During the rainforest survey, each patch of rainforest – identified in Section 4.3 – was also assessed for its potential to support the Darwin Palm. Based on the results presented in Section 4.3, no suitable habitat for the Darwin Palm was observed within the study area, because the habitat was either too dry or the vegetation structure was too open – see Appendix G for details. Therefore, the likelihood of the Darwin Palm occurring within the study area is low. Refer to Section 4.3 and Figure 4-5 for a detailed presentation of survey results regarding the presence of rainforest vegetation within the study area.

5.4 *Helicteres macrothrix*

5.4.1 Ecology

Helicteres macrothrix is listed as Endangered under the *TPWC* and *EPBC Acts*. It is a multi-stemmed subshrub, one of approximately 13 species of the genus *Helicteres* from the NT (Cowie 2011). The species grows to 50 cm tall with ascending to erect branches, pink to purple flowers, and fruits, leaves and branches that are green and woolly-hairy (NTG 2013d; DEPWS 2021b) (Figure 5-10). The aerial parts of the plant are annual, with perennial root stock. The plant is known to re-sprout from root stock, often vigorously, after fire. *Helicteres macrothrix* has been recorded from three populations – near Mt Bundey, near Batchelor and in the Lake Bennett area (Cuff and Green 2016c). *Helicteres macrothrix* flowers from November to March, and fruits from January to March (DEPWS 2021b). This species is associated with *Eucalyptus tectifica*, *E. miniata* and/or *E. tetradonta* woodland on clayey soils derived from siltstone or sandier soils derived from the granite-like rock syenite (NTG 2013d).



Figure 5-10. Photographs of *Helicteres macrothrix* leaves and flowers.

Images I. D. Cowie

5.4.2 Habitat presence survey

Coarse-scale government modelling indicates that the study area potentially supports ~440 ha of high-likelihood habitat for *Helicteres macrothrix* (Cuff and Green 2016c). There were ten patches of modelled, high-likelihood habitat for *Helicteres macrothrix* within the study area (Figure 5-13). Five habitat assessments were undertaken during the reconnaissance survey across four patches of modelled habitat. The remaining patches were assessed during the dry season surveys because they were inaccessible in the wet season. Two patches were assessed as being highly suitable and the other two were considered moderately suitable. Habitats were considered highly suitable if indicator species and suitable substrate were present, and if the landform was mid or foot-slopes of nearby rises (Figure 5-11). Moderate habitat contained only indicator species and suitable substrate. All patches of high-likelihood habitat were verified and searched during the dry season surveys (see Section 5.4.3).



Figure 5-11. Photographs of modelled, high-likelihood *Helicteres macrothrix* habitat

5.4.3 Targeted survey

Methods

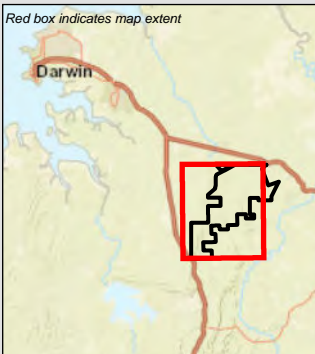
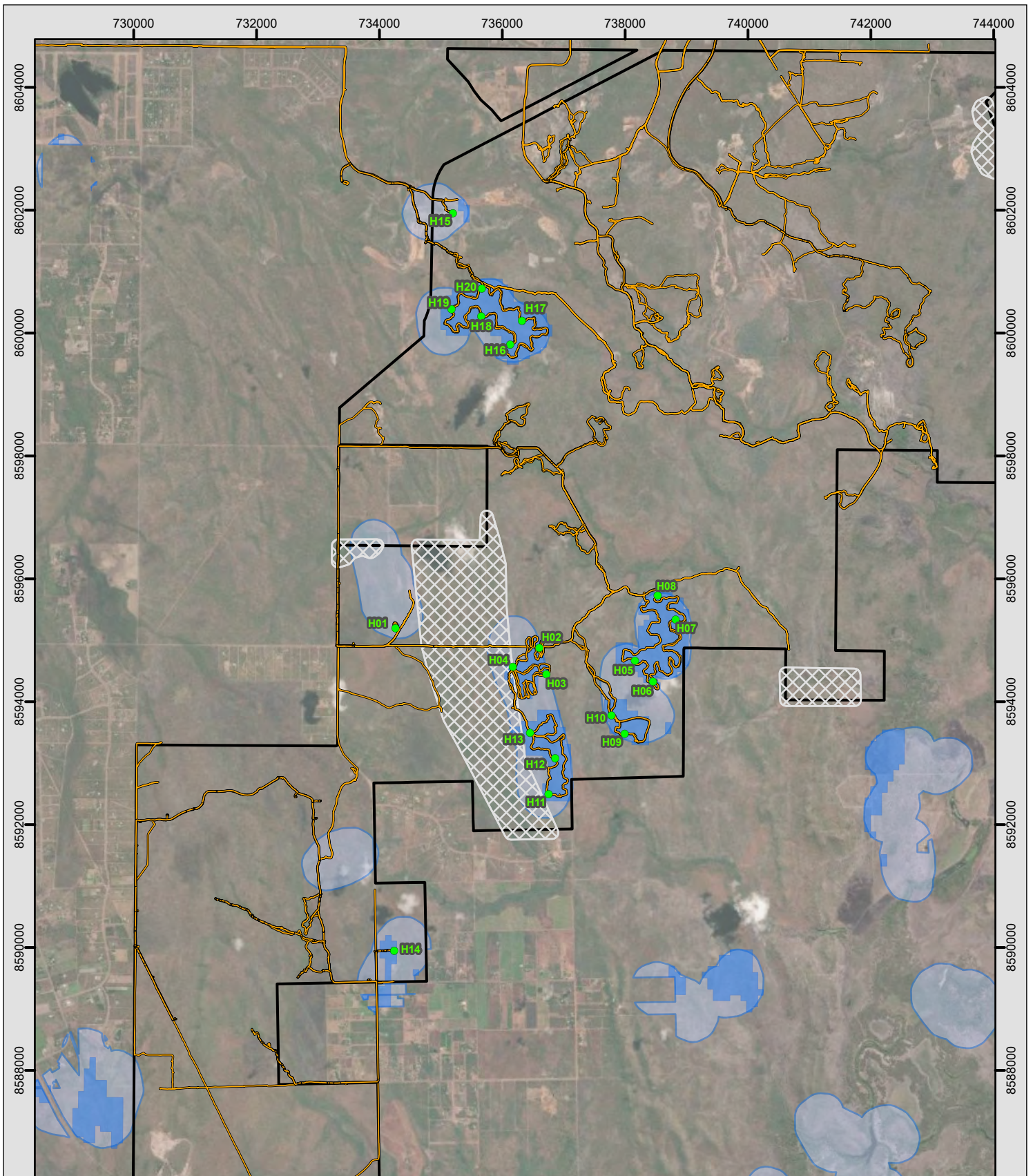
Because the study area supports a large area of high-likelihood modelled habitat, targeted meander traverses were used to survey for the presence of *Helicteres macrothrix* in accordance with Cuff et al. (2020). This involved traversing at least 10% of the recommended lengths required when applying field transects to areas containing modelled/suitable habitat. For shrubs such as *Helicteres macrothrix*, the recommended separation of field traverses is 15 m apart in open habitats. On that basis, the total length of traverses was estimated to be 292 km long within high likelihood modelled habitat. Therefore, 29.2 km was required at a minimum to effectively cover target areas, with surveyors traversing approximately 60 km in total across patches of high likelihood modelled habitat. Targeted surveys were undertaken during the dry season by botanists Anna Lemon and Nicole Clark, and ecologists Laura Zaharie and Isabel Anderson in June and July 2023.

Results

Visits to three reference sites (Mt Bundey and Lake Bennett) confirmed the detectability of *Helicteres macrothrix* during the survey times (Figure 5-12). The plants were visible, although material had deteriorated. No *Helicteres macrothrix* plants were observed during surveys within the study area. Although most of the study area had been burnt in May/June, regrowth and persistent material of ground species was present in sufficient amounts to identify presence of *Helicteres macrothrix* (Appendix F). A similar species, *Helicteres darwinensis* was detected at several sites across the study area, this species has a prostrate form and grows closer to the ground. Distribution mapping for this species indicates that previous surveys have also confirmed its absence east of Townend Road and at patches near Mocatto Road (Cuff and Geen 2016c). Individual site data is presented in Appendix F.



Figure 5-12. Photographs of a *Helicteres macrothrix* reference site and specimen at Mt Bunday



Legend

- Study area
- Sacred sites - known
- Survey tracks
- *Helicteres macrothrix* habitat assessment (dry season)

Habitat model (NTG)

- Helicteres macrothrix* high-likelihood habitat
- Helicteres macrothrix* potential habitat

0 0.5 1 2

Kilometres

MAP INFORMATION
 Scale: 1:85,000 @ A4
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 5/11/2025
 Client: Total Eren Australia
 Mapper: Elliot.Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 5-13. Map of habitat model and survey effort for *Helicteres macrothrix* within the study area

5.5 *Cleome insolata*

5.5.1 Ecology

Cleome insolata is a small herb with a conspicuous flower – see, e.g., Figure 5-14 – currently listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*. The species is known to occur in low, open woodlands associated with *Grevillea pteridifolia*, *Melaleuca viridiflora*, *Melaleuca nervosa*, *Verticordia cunninghamii* and *Pandanus* species over *Dapsilanthus*, *Eriachne burkittii*; *Sorghum* and *Alloteropsis*, on seasonally-waterlogged sandy soils (NTG 2013e) – often in association with sandsheet heath. This species is endemic to the NT (and possibly the Darwin region), where it is known from the Noonamah / Amys Creek area, Wishart Road and near Shoal Bay (Westaway and Cowie 2012c).

5.5.2 Methods

Targeted surveys for *Cleome insolata* were undertaken in the study area between 4 and 17 May 2023 by Anna Lemon, Sara Maxsted, Harry Owen and Isabel Anderson. Patch 16 could not be accessed during the 2023 surveys due to time and access constraints. That patch was surveyed on 11 April 2024 by Anna Lemon and Harry Owen.

A targeted meander between two surveyors was undertaken along the edges of sandsheet patches identified as suitable for supporting the species. If the species was observed, a zigzag pattern was employed across the ecotone to map the extent of the population. In accordance with the guidelines for surveying herbs in closed habitats (Cuff et al. 2020), surveyors aimed to maintain a separation width of 5 m while traversing within suitable habitat. Sandsheet heath patches (as detailed in Section 4.1) with the following characteristics were prioritised for survey:

- Presence of laterite gravel or rocky outcropping along patch edges
- Presence of Eucalypt open woodland upslope from patch
- Proximity of patches to *Cleome insolata* records detected during floristic surveys.

5.5.3 Results

Thirteen patches of modelled sandsheet heath were surveyed for *Cleome insolata* across the study area. One patch was observed supporting the species, with a total 17 records collected at patch 14 from an area spanning less than 100 m, along the south-eastern edge (Figure 5-14 and Figure 5-15). Fourteen of those records were collected during the targeted survey on 4 May 2023. Prior to this, three records were collected in the same patch on 14 March 2023 during the floristic surveys, including a plant specimen. The specimen was lodged with the Darwin Herbarium. No plants were observed at Patch 16 during the 2024 survey.



Figure 5-14. Photographs of *Cleome insolata* plants observed at Patch 14

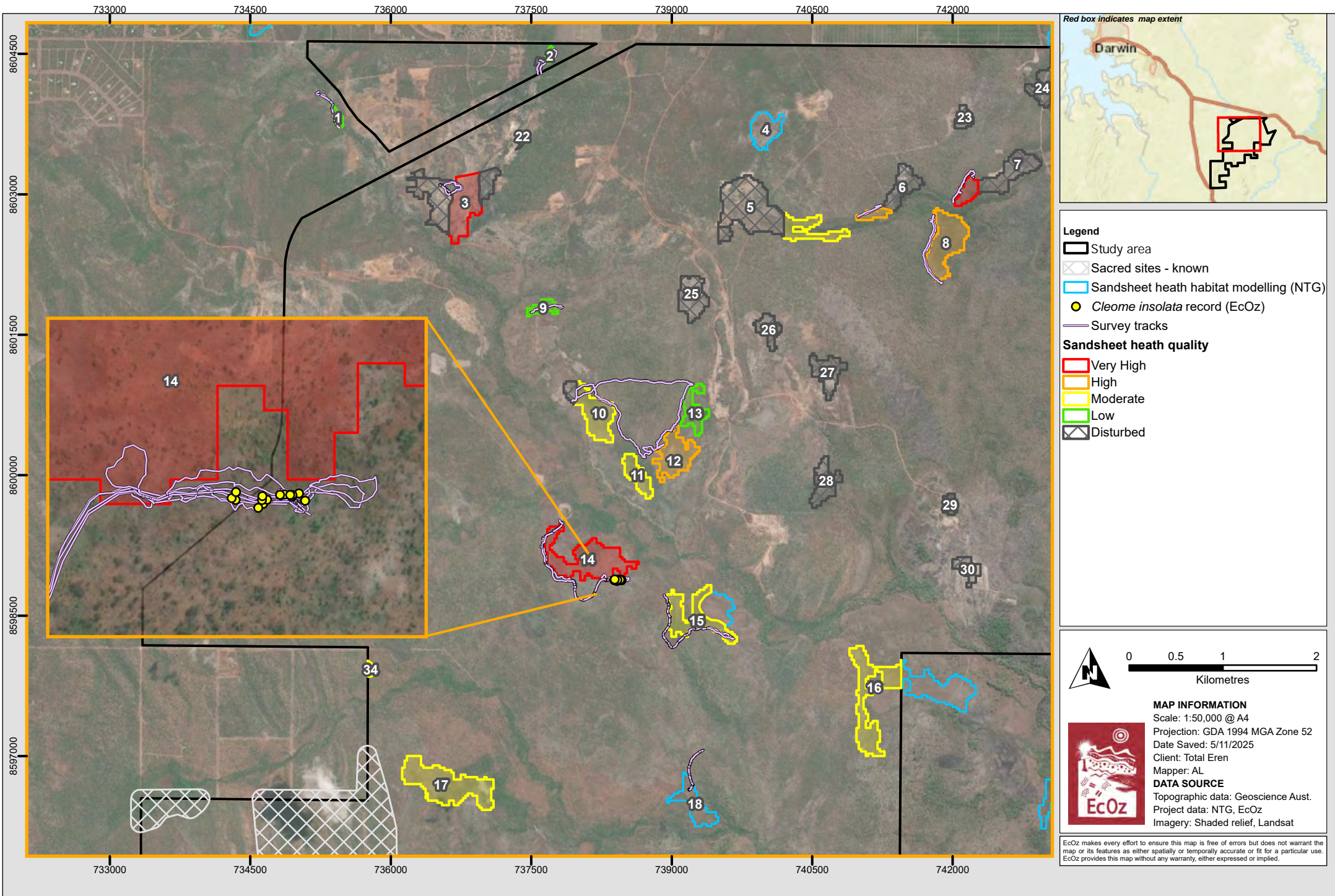


Figure 5-15. Map of survey effort and *Cleome insolata* records within the study area

5.6 *Utricularia dunstaniae*

5.6.1 Ecology

Utricularia dunstaniae is listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*. *Utricularia dunstaniae* is a small, annual, terrestrial bladderwort, flowering between March and May. In the NT, it is associated with 'sandsheet heath' type habitats such as *Melaleuca nervosa* woodland or *Melaleuca verticordia* shrubland in wet sand – often in shallow water, frequently where water is percolating from the ground. The species tends to occur in slightly wetter micro-habitats than other sympatric *Utricularia* species (Kerrigan and Cowie 2015). *Utricularia dunstaniae* has a scattered distribution across north-western NT and is known to occur in the Darwin area (particularly the Howard Springs region), Kakadu National Park and Cobourg Peninsula.

5.6.2 Methods

There is no habitat modelling for *Utricularia dunstaniae*. Three sandsheet heath patches (6, 7 and 8 – as detailed in Section 4.1) in the north-eastern section of the study area were deemed highly suitable for supporting the species. This determination was based on floristic data collected across all intact patches, data collected at three reference sites (Figure 5-16) known to support the species, and proximity of patches to the detected *Utricularia dunstaniae* records. A total of 17 sandsheet heath patches were identified as unsuitable for supporting *Utricularia dunstaniae* – based on habitat modification, lack of surface water and seepage from nearby source, and unsuitable vegetation composition, soil type and colour. Only patches that were deemed highly suitable were prioritised within study area, due to access and time constraints.

Targeted surveys for *Utricularia dunstaniae* were undertaken from 15 to 19 May 2023 by Anna Lemon and Isabel Anderson at sandsheet patches 6, 7 and 8 within the study area. Surveyors searched along parallel traverses across three patches identified from the wet season surveys to determine the location of any new populations within these areas. Although the ideal separation width for field traverses is 5 m or less for *Utricularia* spp. as per Cuff et al. (2020), transects were spaced 15 m apart to determine presence/absence of the species over a large survey area before the end of the season.



Figure 5-16. Photographs showing *Utricularia dunstaniae* habitat at the Girraween Road reference site

5.6.3 Results

A total of 63 new *Utricularia dunstaniae* records were collected within the study area on 15 May 2023 (see, e.g., (Figure 5-17). This is in addition to the four records collected during the sandsheet floristic surveys on 13 March 2023, bringing the total number of records to 67. Only one patch (7) was found to support the species, with all plants located in the south-western portion of the patch (Figure 5-18). The northern portion of patch 7 was dry from the centre of the patch, so it could not be determined if the local population extended beyond that observed during the surveys. No plants were detected at patches 6 and 8 during the targeted surveys for this species.



Figure 5-17. Photographs showing *Utricularia dunstaniae* habitat and plant at patch 7

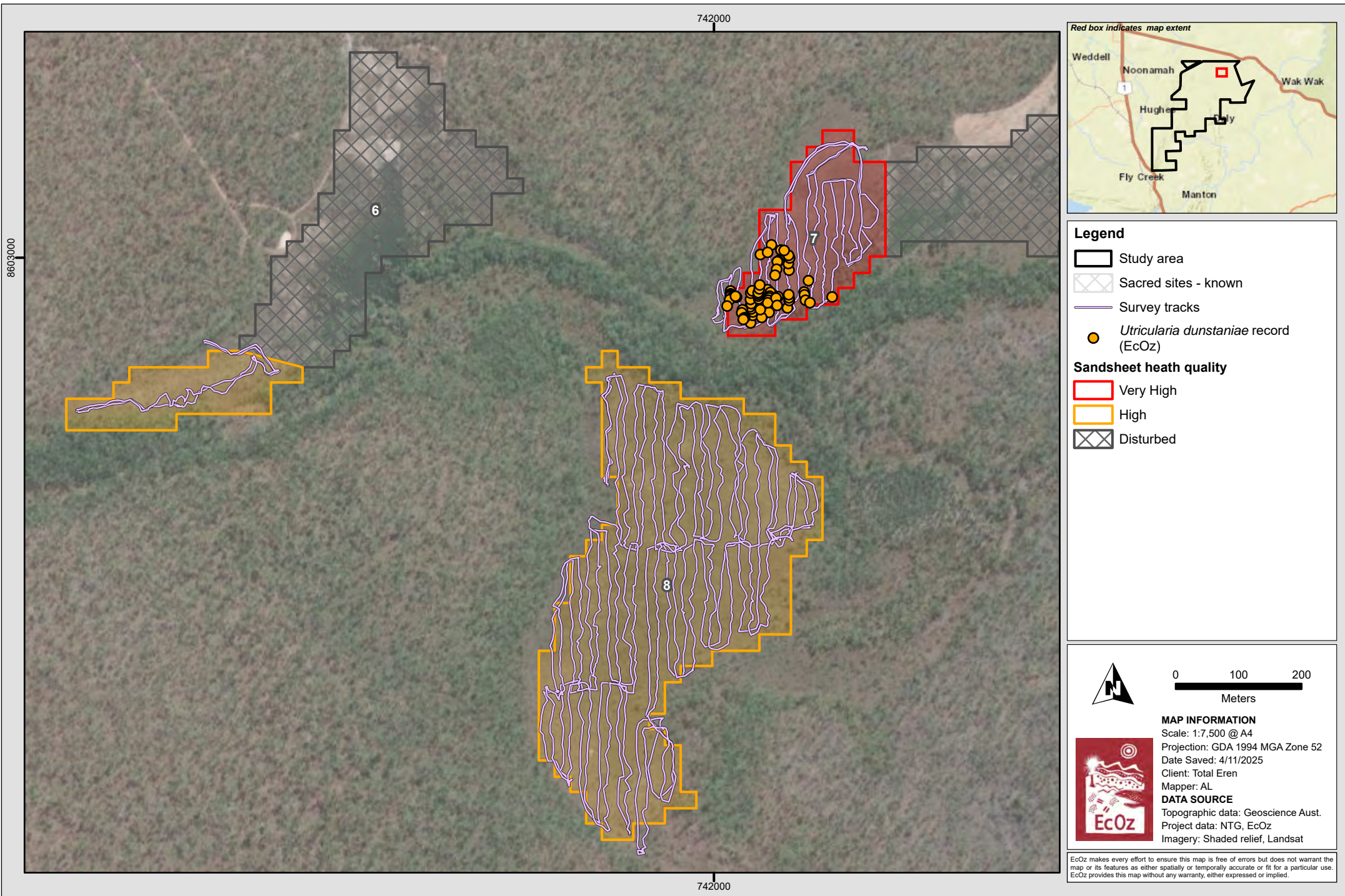


Figure 5-18. Map of survey effort and *Utricularia dunstaniae* records within the study area

5.7 Darwin Cycad (*Cycas armstrongii*)

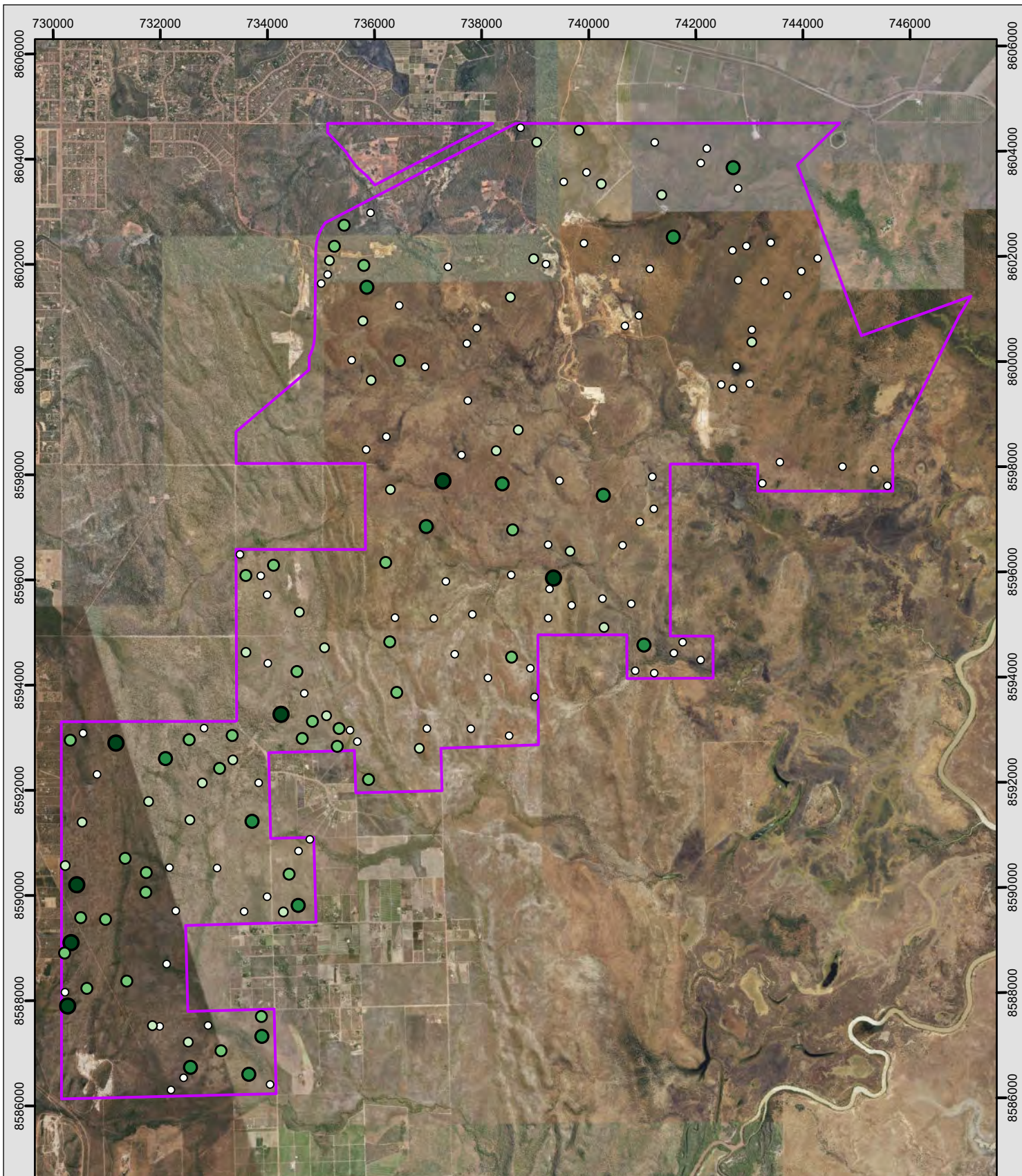
The Darwin Cycad (*Cycas armstrongii*) is a small to medium-sized cycad with a slender trunk listed as Vulnerable under NT legislation. The Darwin Cycad occurs in open grassy woodlands where adequate drainage appears to be a limiting factor (Liddle 2009). It also occurs on rocky outcrops, undulating hills and plains (DEPWS 2021d). Prime cycad habitat has deep loamy, well-drained soil and the species is frequently associated with *Eucalyptus miniata* and *Eucalyptus tetradonta* (Liddle 2009).

The NT Government considers Darwin Cycad densities of 400 to 700 mature stems per hectare to be high density, and more than 700 mature stems per hectare to be very high density. High and very high density stands of cycads are important for maintaining the species' diversity and function (Stokeld et al. 2020).

To obtain a preliminary understanding of Darwin Cycad presence and extent within the study area, the number of mature cycad stems (> 50 cm tall) was recorded within 178 vegetation check sites during the land unit ground-truthing (see Section 3). The species was present at 81 of the 178 vegetation check sites (Table 5-2, Figure 5-19). Most of the sites (61 of 81) had a low or moderate density of cycads, 13 sites had a high density, and 7 sites had a very high density. High and very high-density sites occurred more frequently in the south-west of the study area; however, they were still recorded in the centre and north of the site. Land unit 3b was the most frequently occurring land unit within the high and very high-density cycad sites; however, the species was present throughout the plains and rises landform classes, and otherwise not strongly associated with any one land unit.

Table 5-2. Darwin Cycad density survey results

Density classification	Cycad density (no. per hectare)	No. of sites
Absent	0	97
Low	1 to 99	29
Moderate	100 to 399	32
High	400 to 699	13
Very High	Greater than 700	7



Legend

- Study area
- Cycad density (ha)**
- Absent
- Low (1 to 99)
- Moderate (100 to 399)
- High (400 to 699)
- Very High (700+)



0 0.5 1 2
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GCS GDA 1994
 Date Saved: 5/11/2025
 Client: Total Eren Australia
 Mapper: Elliot Day
DATA SOURCE
 Topographic data: OSM
 Project data:
 Imagery: NTLIS

Figure 5-19. Map of Cycad densities across the study area

6 WEEDS

Some species of introduced flora are declared to be weeds under the NT *Weeds Management Act* because of the environmental and/or economic harm they can cause. Class A weeds are to be eradicated by landowners and occupiers. Class B weeds must have their growth and spread controlled by landowners and occupiers. The remaining introduced flora species are referred to as *environmental weeds*. The Commonwealth Government has also categorised some species as Weeds of National Significance (WoNS).

Weed distribution is often related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds are most prevalent on land under pastoral lease, with infestations generally concentrated around infrastructure such as water points, fence lines and tracks, as well as along the banks of watercourses where cattle and feral animals tend to congregate.

The study area lies within the *Darwin Regional Weeds Strategy 2021-2026* (DEPWS 2021a). That plan focusses on weeds that are most important to the region, categorising them as:

- Category 1 – Priority weeds (present in the region, widely considered feasible to eradicate from the Region, typically evaluated as very high risk and have isolated and restricted distributions).
- Category 2 – Priority weeds or strategic control – including the eradication of outliers (species warranting strategic control across the landscape due to the high impact they have on land managers and on broader economic and environmental values).
- Category 3 – Weeds of concern (assessed by the weed risk management system as a medium to high risk, or have not been assessed, but have been identified by stakeholders as posing a threat to the values of the Region).
- Category 4 – Hygiene and biosecurity weeds (species for which it is important for landholders to implement weed hygiene and other biosecurity measures to prevent their spread into clean areas, and to control these species where the opportunity arises).
- Category 5 – Alert weeds (have the potential to have a high level of impact to the region should it become established, the likelihood of the species naturalising and spreading in the region is perceived to be high).

Due to the large size of the study area, a comprehensive weed survey was not undertaken to systematically record weed species across the study area. However, during all the ecological surveys undertaken for this report (including land unit and habitat mapping), incidental weed records were collected within the study area. The target was priority species, as outlined within the *Darwin Regional Weed Strategy 2021-2026* (DEPWS 2021a).

An aerial survey by the NT Government in 2023 identified that Gamba Grass (*Andropogon gayanus*) is widespread across most of the study area, particularly in proximity to extractive activities – see Figure 6-1. During field surveys for this report, 14 weed species were observed occurring in the study area, three of which are WoNS – Gamba Grass, Mimosa (*Mimosa pigra*) and Olive Hymenachne (*Hymenachne amplexicaulis*). Of the remaining, two species are class A/B weeds, six species are class B weeds, and the remaining are environmental weeds – see Table 6-1.

Gamba Grass was the most commonly observed and widespread species occurring throughout the study area and refined study area, with densities typically highest near tracks and near mining areas (see Figure 6-1). Hyptis (*Mesosphaerum suaveolens*) was also common and widespread throughout both the study area and refined study area. Mimosa, Olive Hymenachne, and Calopo (*Calopogonium mucunoides*) were all observed occurring within swamp systems or watercourses near the north-eastern section of the study area – of these species, only two records of Olive Hymenachne and three records of Calopo were recorded in the refined

study area. Snakeweed (*Stachytarpheta* sp.) was generally observed along watercourses, with most records collected along a watercourse running through the centre of the refined study area.

Mission Grass (*Cenchrus* sp.), *Sida* species and Stylo (*Stylosanthes* sp.) were also observed from the study area and refined study area. Most records of Stinking Passionfruit (*Passiflora foetida*) were observed in the south-west of the refined study area.

Two observations of Neem (*Azadirachta indica*) were recorded in the south-west section of the refined study area and a single patch of Guinea Grass (*Megathyrsus maximus*) was observed on the western boundary along a creek line.

Table 6-1. Weed species observed within the study area

Common name	Scientific name	WoNS	NT Class	Category in regional strategy
Gamba Grass*	<i>Andropogon gayanus</i>	Yes	A/B#	2
Mimosa*	<i>Mimosa pigra</i>	Yes	A/B#	2
Olive Hymenachne	<i>Hymenachne amplexicaulis</i>	Yes	B	2
Mission Grass – perennial	<i>Cenchrus polystachios</i>	-	B	2
Neem*	<i>Azadirachta indica</i>	-	B	3
Mission Grass – annual	<i>Cenchrus pedicellatus</i>	-	-	3
Hyptis	<i>Mesosphaerum suaveolens</i>	-	B	4
<i>Sida</i> spp. (two species)	<i>Sida acuta</i> , <i>Sida</i> sp.	-	B	4
Snakeweed	<i>Stachytarpheta</i> spp.	-	B	4
Guinea Grass	<i>Megathyrsus maximus</i>	-	-	4
Stylo	<i>Stylosanthes</i> spp.	-	-	-
Calopo	<i>Calopogonium mucunoides</i>	-	-	-
Stinking Passionfruit	<i>Passiflora foetida</i>	-	-	-

* Species must be eradicated or managed as directed by its Statutory Weed Management Plan

The study area is located within the greater Darwin region, where Gamba Grass and Mimosa are declared NT Class B



Figure 6-1. Photograph showing Gamba Grass infestations within the study area

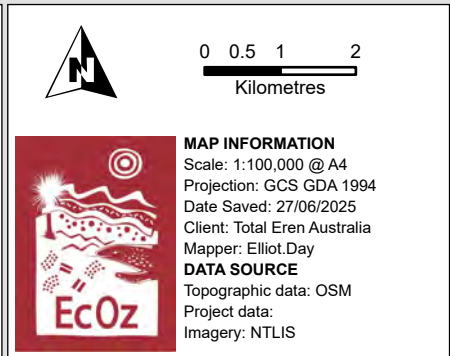
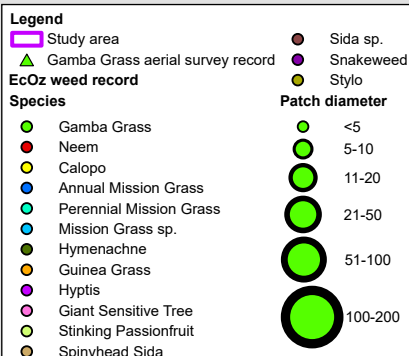
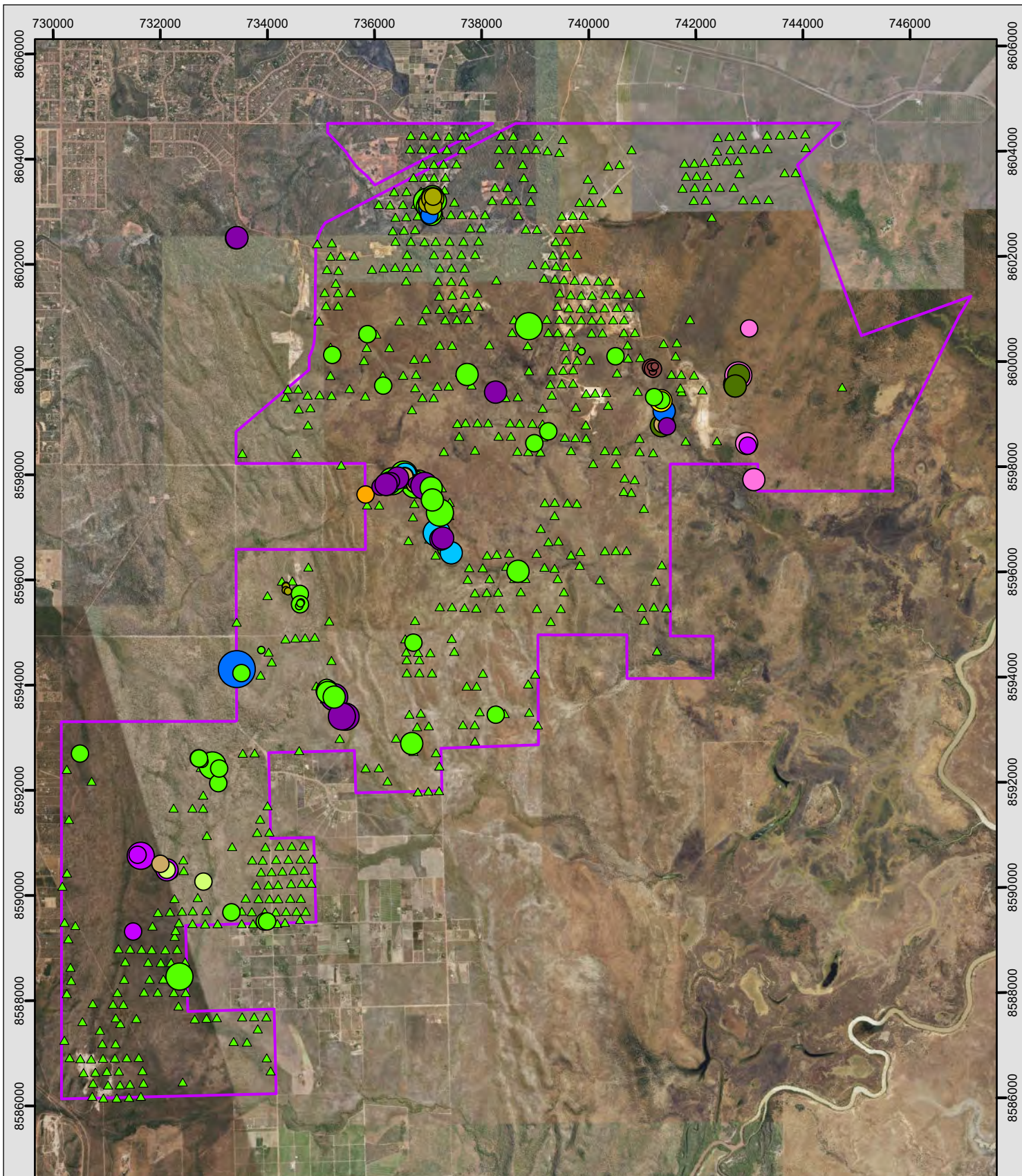


Figure 6-2. Map of weeds recorded across the study area

7 THREATENED FAUNA

This section outlines the desktop and field assessments that were undertaken for the threatened fauna species that were assessed in Section 2.5 as having a medium or high likelihood of being present within the study area. It presents the methods and results of threatened species' habitat assessments and targeted surveys.

Due to the large size of the study area and the variety of species being targeted, a multi-faceted approach was adopted. Many factors were taken into consideration – such as the variety of habitat requirements, foraging and hunting behaviour, seasonal detectability, site access and environmental constraints. In summary:

- A remote-sensing camera survey was used to target mammals (with reptiles also possibly detected). The Partridge Pigeon was also targeted (for the portion of surveys that were set to capture images during the day).
- The Bare-rumped Sheath-tailed Bat was targeted using passive ultra-sonic acoustic recorders.
- The Masked Owl was targeted using passive acoustic recorders and call playback.
- The Howard River Toadlet was targeted using passive acoustic monitoring informed by eDNA surveys.
- A supplementary survey using Elliott traps was conducted to identify to species' level some small mammals photographed during the camera survey.

Moreover, as detailed in Table 7-1, ecologists spent more than 20 weeks in the field over the course of the surveys undertaken for this report, during which they recorded all incidental observations of target species.

The high- and medium-likelihood threatened fauna species targeted by surveys are presented in Table 7-1.

Table 7-1. Threatened fauna species targeted by surveys

Target species	Surveys
Fawn Antechinus (<i>Antechinus bellus</i>)	6,027 active camera nights across 183 cameras 900 Elliot trap nights
Northern Quoll (<i>Dasyurus hallucatus</i>)	
Black-footed Tree-rat (<i>Mesembriomys gouldii gouldii</i>)	
Pale Field Rat (<i>Rattus tunneyi</i>)	
Northern Blue-tongued Skink (<i>Tiliqua scincoides intermedia</i>)	
Northern Brushtail Possum (<i>Trichosurus vulpecula arnhemensis</i>)	
Bare-rumped Sheath-tailed Bat (<i>Saccolaimus saccolaimus nudicluniatus</i>)	258 passive acoustic recorder nights
Mertens' Water Monitor (<i>Varanus mertensi</i>)	Incidental field observations (at least 144 people days)*
Mitchells' Water Monitor (<i>Varanus mitchelli</i>)	
Yellow-spotted Monitor (<i>Varanus panoptes</i>)	
Partridge Pigeon (<i>Geophaps smithii smithii</i>)	1,420 active camera days across 51 cameras Incidental field observations (at least 144 people days)
Masked Owl (<i>Tyto novaehollandiae kimberli</i>)	117 passive recorder nights Playback acoustic surveys
Gouldian Finch (<i>Chloebia (Erythrura) gouldiae</i>)	1,420 active camera days across 51 cameras Incidental field observations (at least 144 people days)
Howard River Toadlet (<i>Uperoleia daviesae</i>)	124 passive acoustic recorder nights across 3 sites eDNA sampling of relevant catchments

* The project design intends to avoid and buffer riparian habitats; hence, these species were not targeted.

All surveys were conducted in accordance with the relevant licences and permits held by EcOz:

- Animal Ethics Project A24004
- NT Parks and Wildlife Permit 74225
- NT Animal Welfare Licence 038.

7.1 Habitat assessment

A habitat assessment was undertaken within each survey site where cameras and acoustic recorders were deployed. In the instances where an acoustic recorder was deployed within 50 m of a camera site, a single habitat assessment was completed. A summary table of each assessment conducted is included in Appendix H. The data were collected in general accordance with the data requirements to identify vegetation communities/land types in the NT *Land Clearing Guidelines* (DEPWS 2024) and considered habitat features in accordance with the *NT EPA Guidelines for Assessment of Impacts on Terrestrial Biodiversity* (NT EPA 2013). Data collected broadly included:

- GIS coordinates using hand-held GPS unit.
- Landform and slope.
- Broad vegetation description for characterisation to a standard that is equivalent to Level 5 in the National Vegetation Information System, and in accordance with the *NT Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst et al. 2007) and the *NT Land Clearing Guidelines* (DEPWS 2024). Within each stratum (upper, mid and ground), the three dominant species were recorded, as well as general structure.
- General notes on habitat features such as large old trees and observations of hollows, presence of Pandanus and other midstory tree and shrub resources, proximity to water and ground layer characteristics (e.g. type and cover of understorey, leaf litter cover etc.).
- Disturbance – fire history, weeds and signs of feral animals.
- Photographs of surface soil and vegetation and other key habitat features where relevant. Four cardinal point photos were collected at each data point for documentation of vegetation/habitat.
- Incidental records of threatened species.

7.2 Mammals and reptiles

Based on desktop assessment of historic records and habitat types, six threatened mammals and four threatened reptiles were targeted for survey.

7.2.1 Ecology

Fawn Antechinus

The Fawn Antechinus (*Antechinus bellus*) is listed as Vulnerable under the *EPBC Act* and Endangered under the *TPWC Act*. This species is found in savanna woodlands and tall open forests of the Top End. It shelters in tree hollows and logs, and appears to prefer areas exposed to less frequent and cooler fires. The decline of the Fawn Antechinus is likely due to predation by cats and inappropriate fire regimes affecting habitat quality. Weeds and grazing by livestock and feral animals may have reduced the availability of preferred food (DEPWS 2021h).

Northern Quoll

The Northern Quoll (*Dasyurus hallucatus*) is a nocturnal carnivorous marsupial listed as Endangered under the *EPBC Act* and Critically Endangered under the *TPWC Act*. Its range is across much of northern Australia, in savanna woodland across the Top End from south-eastern Queensland to the south-west Kimberley, with a

disjunct population in the Pilbara (Woinarski et al. 2007). The Northern Quoll can live in a range of habitats, but prefers rocky areas and Eucalypt forests with high structural diversity, where hollow logs, hollow trees, rock crevices and caves provide shelter (DEPWS 2021f).

The Northern Quoll has suffered a catastrophic decline in northern Australia over the last 50 years. Predation by cats is a major threat to Northern Quolls, and this is exacerbated by hot fires and grazing which reduce ground cover and shelter for small mammals. The more recent sharp decline in Northern Quoll numbers is primarily due to the arrival of Cane Toads. However, there is evidence that some populations of Northern Quolls have persisted in toad-invaded areas, with remnant populations being associated with rocky areas (Woinarski et al. 2007). Loss of habitat due to agricultural and urban development is also a threat to this species (DEPWS 2021f).

Black-footed Tree-rat

The Kimberley and mainland Northern Territory sub-species of the Black-footed Tree-rat (*Mesembriomys gouldii gouldii*) is listed as Endangered under both the *EPBC Act* and the *TPWC Act*. It is a medium-sized nocturnal rodent that is largely arboreal, but also forages on the ground. The Black-footed Tree-rat predominantly occurs in woodlands and lowland open forests with large trees dominated by *Eucalyptus miniata* and/or *E. tetradonta* and a moderately dense and diverse mid-storey of small trees and shrubs where the subspecies dens mostly in tree hollows but may also use clumps of *Pandanus spiralis* (DEPWS 2021c). The Black-footed Tree-rat generally requires fruit and seed resources including Pandanus fruits, fruiting trees and shrubs (Rankmore 2006). Black-footed Tree-rats have a large home range (~67 ha) (Rankmore and Friend 2008).

The sub-species is thought to be more prevalent in woodlands with infrequent and low intensity fires (Price and Baker 2005) with greater fruiting species diversity to support a greater abundance of Black-footed Tree-rat individuals (Rankmore 2006). Frequently burnt landscapes may contain fewer larger hollow-bearing trees which is an important resource for the species, whilst natural events such as cyclones may also reduce the number of trees and hence hollow availability (Woinarski and Westaway 2008). This sub-species does not use highly-modified habitat and requires forested corridors connecting remnant patches of intact woodland larger than 1 ha in size (Rankmore and Price 2004).

Inappropriate fire regimes and habitat fragmentation caused by land clearing appear to be the main drivers of this sub-species' decline, as well as predation by feral cats (DEPWS 2021c). The continuing decline of this sub-species means that all known populations and habitat supporting them are considered important and should be protected wherever possible (Stokeld et al. 2020).

Pale Field-rat

Listed as Vulnerable under the *TPWC Act*, the Pale Field-rat (*Rattus tunneyi*) is a medium-sized rodent that was once a widespread species in the Top End (DEPWS 2021). Historically, the species occurred in lowland *Eucalyptus* open forests and grasslands that have sandy surface soil characteristics, but the Pale Field-rat is now recorded primarily in dense vegetation along creeks (Aplin et al. 2008). An area's fire regime seems to have little effect on population numbers (Braithwaite and Griffiths 1996); instead, the level of groundwater irrigating the riparian system and, to a lesser extent, current rainfall have a much stronger influence (Braithwaite and Griffiths 1996). Due to a combination of threats, the overall population of the species was estimated in 2014 to have declined by up to 30% in the previous ten years (Woinarski et al. 2014).

Bare-rumped Sheath-tailed Bat

The Bare-rumped Sheath-tail Bat (*Saccolaimus saccolaimus nudiclunatus*) is listed as Vulnerable under the *EPBC Act*. A large, high-flying insectivorous bat, this species occurs across two ranges in northern Australia: a north-eastern Queensland population and a western population which extends along coastal areas of the western portion of the Gulf of Carpentaria, north-western portions of the Top End NT, the Victoria Bonaparte

IBRA7 biogeographic region, and all five bioregions of the Kimberley Administrative Region (WA) (Armstrong et al. 2021; McKenzie and Bullen 2018).

There have been relatively few records of Bare-rumped Sheath-tail Bats across this broad distribution, suggesting a fragmented distribution. This information is difficult to interpret as Bare-rumped Sheath-tail Bats are difficult to capture because of their high flight, and echolocation studies have reported constraints in distinguishing records with closely related species (Armstrong et al. 2021; McKenzie and Bullen 2018; Woinarski et al. 2014). In the NT, Bare-rumped Sheath-tail Bat specimens have been collected from *Pandanus* woodland fringing the sedgelands of the South Alligator River, and Eucalyptus tall open forests (Churchill 2008; Friend and Braithwaite 1986), with more recent records from Howard Springs (Milne et al. 2009). Bare-rumped Sheath-tail Bats have been detected at 11 locations within the NT, and most records occur within near-coastal or lowland (woodland, forest, open environment) habitats with one recent exception 150 km inland (McKenzie et al. 2018; Woinarski et al. 2014).

Bare-rumped Sheath-tail Bats forage above open and edge canopies (McKenzie and Bullen 2018), and roost in groups of 10 – 100 individuals in large trees (*E. miniata*, *E. tetradonta* and *Melaleuca leucadendra*) generally characterised by broken tree trunks, large branches (Armstrong et al. 2021; Murphy 2001; Schulz and Thomson 2007) and deep hollow pipes > 18 cm in diameter with hollow entrances > 6 m from the ground (Churchill 2008; Milne pers. comm.). The most severe threat to Bare-rumped Sheath-tail Bats is habitat loss and fragmentation – in particular the loss of roost trees (Woinarski et al. 2014).

Northern Blue-tongued Skink

The Northern Blue-tongued Skink (*Tiliqua scincoides intermedia*) is listed as Critically Endangered in the *EPBC Act*. The species is a large, heavy-bodied, ground-dwelling lizard that can grow up to 40 cm in length. It is distinguished by a bright blue tongue that is visible during threat displays (Shea 1998). The northern sub-species is found in savanna woodlands and open forests with a high proportion of grass and leaf litter as ground cover in home ranges of 2 to 12 ha (Price-Rees et al. 2013) where it may spend significant time in thermal refugia during the day. The species is omnivorous (Shine 2017).

This sub-species is highly vulnerable to the impacts of toxic ingestions of Cane Toads (*Rhinella marina*), with significant population declines commencing with the arrival of Cane Toads in the Top End (Price-Rees et al. 2010) and a 95% reduction in population numbers predicted as Cane Toads are to envelope the entire range of the sub-species (Shine 2017).

Northern Brushtail Possum

The north-western sub-species of the Brushtail Possum (*Trichosurus vulpecula arnhemensis*) is listed as Vulnerable in the *EPBC Act*. A nocturnal semi-arboreal marsupial, this sub-species occurs discontinuously from the Gulf of Carpentaria hinterland near Borroloola, in the NT, to the Kimberley, in Western Australia (Morris et al. 2016). The Northern Brushtail Possum mainly inhabits tall eucalypt open forests and woodlands with large hollow-bearing trees, particularly where the understorey contains shrubs that bear fleshy fruits, but also occurs in mangrove communities (especially where these contain hollow-bearing trees), rainforests and semi-urban areas (notably around Darwin) (TSSC 2021b). Northern Brushtail Possum abundance is associated with high shrub density (Stobo-Wilson et al. 2019).

The broadscale decline of the sub-species' populations in Australia's Top End and reduction of its distribution across the NT – an estimated 72 % decrease in the species' historical geographic range in north-western Australia between 1993 and 2019 – is largely attributed to frequent extensive fires, which reduces shelter sites and shrub density, thereby increasing risk of feral cat predation, as well as habitat modification from invasive grasses, namely the Gamba Grass and Mission Grass (Stobo-Wilson et al. 2019; TSSC 2021b).

Mertens' Water Monitor

The Mertens' Water Monitor (*Varanus mertensi*) is listed as Vulnerable under the *TPWC Act* and Endangered under the *EPBC Act*. A moderately large, semi-aquatic and arboreal monitor (up to 1.1 m), this species forages

extensively in freshwater, primarily feeding on fish, frogs, carrion, insects, and small terrestrial vertebrates, as well as opportunistic feeding of other groups (Christian et al. 1996; Christian 2004; Cogger 2014). This flexible diet enables the species to adapt to seasonal and spatial differences in prey availability throughout its broad distribution, occurring in coastal and inland waters across northern Australia, from the Kimberley, in Western Australia, to the western side of Cape York Peninsula in Queensland. (Christian 2004; DEPWS 2024b). Within the NT, records span across most of the Top End and Gulf Region (DEPWS 2024b).

A strong swimmer seldom seen far from waterbodies, Merten's Water Monitor occupies a range of natural and unnatural freshwater bodies (Mayes et al. 2005; Wilson & Swan 2017). Species movement patterns revolve around the shape of local waterbodies (Mayes 2006).

Cane Toads, the greatest threat to this species, are now present across its entire NT distribution. Merten's Water Monitor is highly vulnerable to Cane Toad toxin (DEPWS 2024b). Given the inability to prevent localised declines once Cane Toads establish, conservation effort is best directed to maintaining Merten's Water Monitor numbers in toad-invaded areas (DEPWS 2024b).

Mitchells' Water Monitor

Mitchell's Water Monitor (*Varanus mitchelli*) is a diurnal, semi-aquatic and arboreal medium-sized monitor listed as Vulnerable under the *TPWC Act* and Critically Endangered under the *EPBC Act*. In the NT, the distribution of the species includes the catchments of all northern river systems flowing into the Timor Sea, Arafura Sea and the Gulf of Carpentaria (DEPWS 2024).

Mitchell's Water Monitor shelters in tree hollows or under bark and inhabits margins of *Pandanus*-lined watercourses, swamps and lagoons in Northern Australia (DEPWS 2024). Found close to watercourses, this species basks on overhanging vegetation and submerges into water when approached (Swanson 2011). In a recent paper, de Laive et al. (2021) argued that the ecological niche occupied by Mitchell's Water Monitor is broader than currently recognised and that the species should be considered as potentially occurring in most mangrove habitats across their known range.

Mitchell's Water Monitor numbers have severely declined because of the spread of Cane Toads and their high susceptibility of monitors to Cane Toad toxin, as well as Cane Toad depletion of potential prey for monitors. However, there does not appear to be a range contraction for this species since there are still many recent records (post-2000) across its historic distribution, indicating species persistence (DEPWS 2024).

Yellow-spotted Monitor

The Yellow-spotted or Floodplain Monitor (*Varanus panoptes*) is a large terrestrial monitor that can grow up to 1.4m. Listed as Vulnerable under the *TPWC Act*, it is a robust ground-dwelling monitor occupying a variety of habitats, including coastal beaches, floodplains, grasslands and woodlands. It feeds primarily on small terrestrial vertebrates and insects, and lays a clutch of eggs in a burrow, usually in the Wet season (Ward et al. 2012).

The species once occupied a variety of habitats, including coastal beaches, floodplains, grasslands and woodlands, across the extent of northern Australia. However, its propensity to eat Cane Toads and die from the ingested toxins has caused a significant decline in the population (Ward et al. 2012).

7.2.2 Methods

Surveys for threatened mammals and reptiles involved a combination of camera trapping, Elliott (live) trapping and passive acoustic recorders.

Camera trapping

Survey design

The Australian Government *Survey Guidelines for Australia's Threatened Mammals* (DSEWPC 2011) mention camera trapping in general as a methodology to detect various mammal species. However, these guidelines are old and do not include the subsequently-listed Northern Brushtail Possum and Black-footed Tree-rat. Advice on surveying those two species has been sought from the Flora and Fauna Division of DLPE, who recommend using camera traps at a minimum sampling density of two camera site per 20 ha of suitable habitat, with cameras deployed for four weeks. A third camera paired with a 4 m drift net was also employed at each site to increase the likelihood of detecting smaller reptiles and mammals.

In addition, camera trapping design and set up was guided by the following survey guidelines:

- *A Guide for the Use of Remote Cameras for Wildlife Survey in Northern Australia* (Gillespie et al. 2015)
- *Camera trapping SOP for the Top End Long-term Monitoring Program* (Gillespie et al. 2017)
- Optimising camera trap survey effort to reliably detect a threatened species, the Black-footed Tree-rat, *Mesembriomys gouldii gouldii*, in open forest and woodland of tropical savannas of the Top End, NT (Risler 2017).

The Northern Blue-tongued Skink is newly listed under the *EPBC Act* and currently has no established survey methodology. However, EcOz has had experience detecting the species using camera traps in the greater Darwin region – including on Blackmore Peninsula and in Weddell.

Mammal survey site selections were made using NT Government land unit mapping (LCU 2004) – in conjunction with aerial imagery and fire history data – to identify appropriate woodland habitat within which to place cameras across the study area.

In consideration of the Black-footed Tree-rat's ~67 ha home range, remote camera sites were deployed a minimum of 500 m apart to ensure sites were independent and to maximise geographical spread across the survey area (Hill 2020).

Camera deployment

The remote-sensing camera trapping survey was led by field ecologist Nathan Archer who has participated in several threatened fauna camera trap surveys with EcOz, including comprehensive threatened species' camera trapping project on Blackmore Peninsula in 2021. Nathan was assisted by field ecologists Laura Zaharie, Anna Lemon, Isabel Anderson, Nerida Liddle, Simon Aylott, Nick Volpe, Riley Rusu, Harry Owen, Hollie Gooden, Ruby Hatfield and Amika Mbwente. Due to the size of the survey area, the camera survey effort was undertaken in three sequential deployments, covering approximately one third of the survey area per deployment.

The remote-sensing camera surveys took place during the 2023 dry season, between June and November. This period combined the best conditions to access the entire study area with the highest potential activity and detectability of target species. The seasonal inundation of the area that occurs during the wet season months between November and April greatly restricts access to, and movement through, the site by field staff, and can have other impacts on survey results from rainfall – such as reduced image clarity and possible reduction in target species' movement due to inclement weather.

A total of 183 cameras across 61 camera trapping sites were deployed over the study area between 25 June and 30 November 2023 – see Figure 7-5.

Deployment 1 occurred in the south-western section of the study area, covering approximately 1,500 ha between Monck Rd and Mocatto Rd, and consisted of 17 camera sites with an average separation distance of 500 m between sites. Cameras were installed between 26 and 30 June 2023 and retrieved 2 and 3 August 2023. A major fire event took place on 3 July through the entirety of the first deployment area, causing extensive damage to many cameras and preventing some from recording. A supplementary installation of another 4 camera sites (12 cameras) was undertaken between 26 October and 30 November to bolster the original deployment.

Deployment 2 occurred in the central section of the study area, covering approximately 2,000 ha east of Mocatto Rd and consisted of 20 camera sites with an average separation of 1,000 m. Cameras were installed on 6, 7, 8, 11, 12 and 13 September and retrieved on 11 and 12 October.

Deployment 3 occurred in the northern and north-eastern sections of the survey area, covering approximately 2,000 ha south of the Arnhem Highway and consisted of 20 camera sites with an average separation of 1,000 m. Cameras were deployed on 19, 20, 23, 24 and 25 October and retrieved on 29 and 30 November.

Site set-up

Each site array consisted of three Reconyx Hyperfire 2 White Flash cameras positioned approximately 50 m apart. Vertical cameras were set to a height of 40 cm (measured to the top of the camera housing) and horizontal cameras were set to a height of 65 cm, with the camera focal point centred on the base of a post with a bait canister positioned at a height of 30 cm (as per Figure 7-1). The perforated bait canisters contained a universal bait mixture of rolled oats, peanut butter and honey intended to attract target species into the camera frame. Three different focal point distances from cameras were used (1.5 m, 2.5 m and 65 cm) to incorporate variation in target species captures. Focal distances for each camera site were chosen during field set-up given site-specific constraints – i.e., dense vegetation cover at sites made it difficult to clear a 2.5 m focal distance. Cameras were set vertically for the 1.5 m and 2.5 m (as per Figure 7-2), and horizontally for the 65 cm drift-fence sites.

One drift net camera with a focal distance of 65 cm was used at each site, where suitable ground cover vegetation and soils allowed for appropriate set-up design. Drift net sites employ a camera set at an angle of roughly 45° and a height of 65 cm with the bait station positioned 65 cm from the camera (as per Figure 7-3). A cork board was secured in front of the bait station and a 4 m drift fence was placed on either side of the cork board. This camera trap site design encourages ground-dwelling species such as rodents and reptiles to move along the drift fence into direct view of the camera for capture. The cork board helps with animal detection by increasing the temperature differential between the small animal and warm ground. This is especially applicable to reptiles.

For Deployment 1, cameras were set to be active for the 24-hr period, recording three still images per trigger at rapid-fire intervals between pictures, with no delay between subsequent triggers. Cameras were set at high sensitivity to maximise wildlife detection. Cameras were positioned facing southward and angled downward to prevent sun damage and glare. Cameras were attached to trees with sufficient diameters to avoid camera movement in windy conditions (see Figure 7-4). Each bait station consisted of a 50 mm PVC pipe with removable vent caps attached to a star picket via cable ties. A ball of bait was placed in each bait station. Insecticide granules were applied to the base of each star picket to deter ants.

Due to the large number of false triggers (coupled with low captures of target species) in Deployment 1 during the daylight hours, the use of a 24-hr activation period was discontinued for Deployments 2 and 3. Instead, the cameras were scheduled to be active from 18:00 – 07:00, recording three still images per trigger at rapid-fire intervals between pictures, with no delay between subsequent triggers. This significantly reduced the number of false triggers, but also meant that cameras were less likely to capture diurnal species – namely the Partridge Pigeon, Northern Blue-tongued Skink and Yellow-spotted Monitor.

All cameras had vegetation cleared from their field of view (approximately 2 m²) to minimise false triggers from the movement of vegetation, to ensure a clear view of any wildlife that moved within the range of the camera, and to protect cameras from the risk of fire damage.

The combined 6,027 active camera nights resulted in over 300,000 images across Deployments 1, 2 and 3 (see Figure 7-5). Image analysis and verification was undertaken by Isabel Anderson, Amika Mbwente and Hollie Gillespie, with quality control by Nathan Archer.

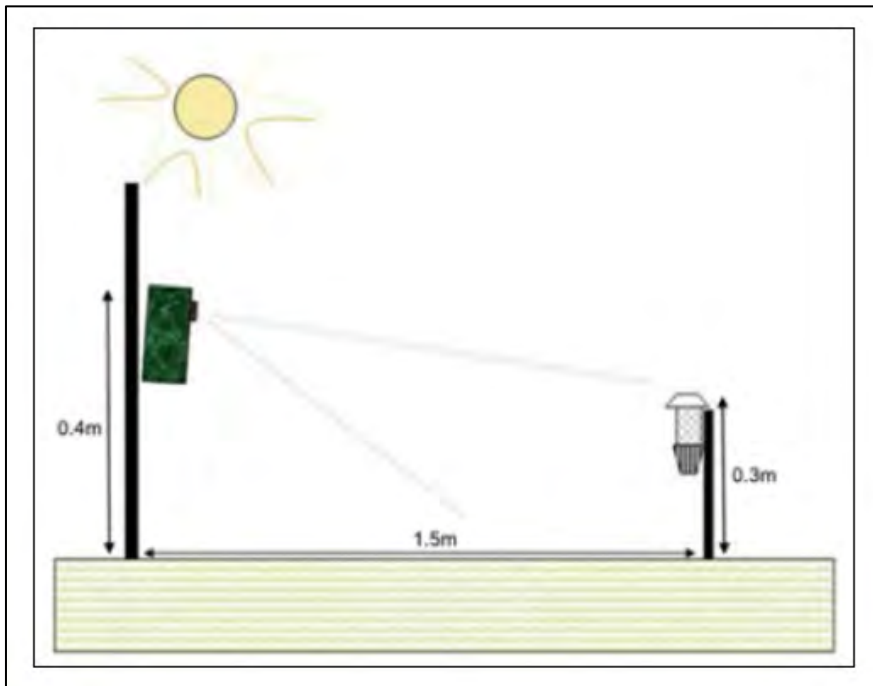


Figure 7-1. Diagram of vertical camera set-up with 1.5 m focus point



Figure 7-2. Photographs of vertical camera setups with a 2.5m and 1.5m focus point.

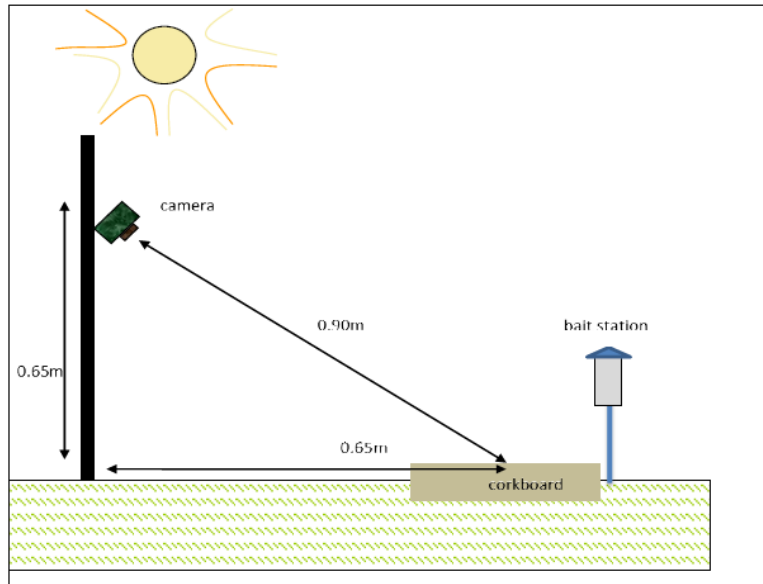


Figure 7-3. Diagram of horizontal camera set-up with drift net and .65m focus point



Figure 7-4. Photographs of a drift net camera set-up in Deployment 1 (D1CT.07-01)

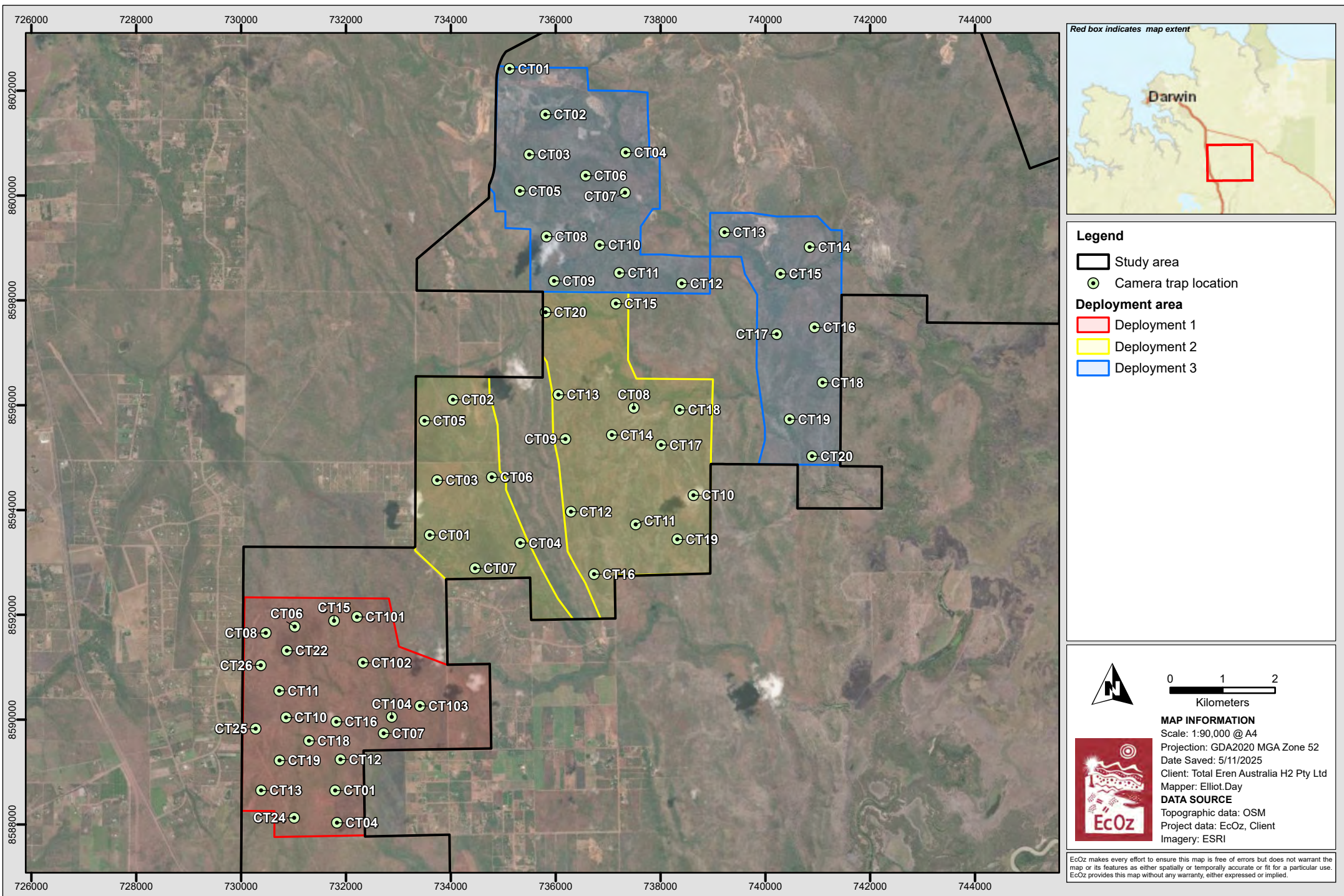


Figure 7-5. Map of camera trap sites

Live trapping

There are two small, threatened mammal species that are occasionally recorded in the Greater Darwin region – Fawn Antechinus (typically near rocky outcrops) and Pale Field-rat (typically near grassed watercourses). The Fawn Antechinus was identified in our desktop likelihood of occurrence as ‘High’, and the Pale Field Rat as ‘Medium’ due to proximate records and presence of suitable habitat within the survey area.

As detailed in the camera trapping results in Section 7.2.3, the camera survey captured some images of small (rodent-sized) mammals that had potential for being Fawn Antechinus or Pale Field Rat and were in, or adjacent to, areas of suitable habitat. Unfortunately, as is often the case with rodents, the images captured were not clear enough to identify the animals conclusively. The threatened Fawn Antechinus shares many superficial features and characteristics with the Sandstone Pseudantechinus (*Pseudantechinus bilarni*) and Red-cheeked Dunnart (*Sminthopsis virginiae*). This can make it difficult to differentiate and identify small mammals with certainty due to the size of the animals and the speed at which they can move, especially when captured in images with longer focal lengths and bait distances. The same difficulties are faced when attempting to differentiate between the Pale Field Rat, and the introduced Black Rat and other more common native small mammals such as the Grassland Melomys (*Melomys burtoni*) and Western Chestnut Mouse (*Pseudomys nanus*).

In such situations, the prudent response is to undertake live trapping in the locations where the ambiguous images were recorded, in the hope that small mammals will be captured and identified to species. This approach was confirmed as appropriate when advice was sought from the Flora and Fauna Division of DLPE.

Following the *Survey Guidelines for Australia’s Threatened Mammals* (DSEWPC 2011), and discussions with the Flora and Fauna Division of DLPE, the live trapping survey effort focused on the camera sites that captured images of small mammals likely to be target species. The survey sites covered a combination of suitable habitat types that potentially support these species. Across the entire survey area, 14 camera sites located within or adjacent to suitable habitat recorded potential Fawn Antechinus occurrences, but were unable to be identified with certainty to species level. Another site (D2CT.10) recorded images of a small mammal which may be a Pale Field-rat.

The survey was undertaken in two rounds, with the first round of traps deployed on 21 May 2024 and retrieved on 24 May 2024 and the second round deployed on 3 June 2024 and retrieved on 6 June 2024. At each of the 15 relevant sites, 20 Elliott traps were deployed for three consecutive nights (for a total effort of 900 trap nights) in a 50 x 50 m square, with traps separated by 10 m centred over the location that the camera was deployed – see Figure 7-7. Deployment location and alignment was adjusted in the field, where necessary, to maximise the likelihood of interaction with the target species. The sites were established during the first day, with all field data collected as the traps were laid out. Traps were then baited and set in the late afternoon once the conditions had cooled and were left active overnight. All traps were subsequently checked the following morning between 05.00 and 08.00 before the increasing daytime temperature put any captured animals at risk of stress or heat-related injury. This process was repeated for each of the three nights of the survey efforts.

Acoustic recorders

Acoustic recorders were deployed in conjunction with the remote-sensing cameras and, for mammals, were targeted towards the detection of the Bare-Rumped Sheath-tail Bat, following the methods laid out in the *Survey Guidelines for Australia’s Threatened Bats* (DEWHA 2010a) and recommendations from Dr Kyle Armstrong of Specialised Zoological Services, an expert on this species.

Following Dr Armstrong’s advice, Anabat Chorus units were fitted with an omni-directional, ultra-sonic microphone and attached to tree trunks at 1.5 m above the ground in likely preferred hunting locations along flyways and at the edge of clearings throughout the study area – see Figure 7-6. The units were set to record between sunset and sunrise, as informed by its integrated GPS receiver, with recording initiated by a trigger event of at least two micro-seconds between 10 kHz and 250 kHz. Once the trigger event was detected, a 20 second recording was taken.

Each unit was deployed for between 7 and 14 days, in 6 deployment rounds, from 26 June 2024 to 13 December 2024. A major fire event took place on 3 July throughout the entirety of the first deployment area, destroying or causing damage to three units, preventing them from recording. A supplementary installation of another four recorders was undertaken between 21 and 30 November to bolster the original deployment and ensure complete coverage of that section of the survey area.

Acoustic recorders were deployed successfully at a total of 28 sites across the survey area over three deployments – see Figure 7-8 – with two units destroyed by fire without recording any data. The remaining 26 sites returned a total survey effort of 258 recorder nights. After retrieval of the units, the acoustic data were sent for analysis by Dr Kyle Armstrong.



Figure 7-6. Photograph of Anabat Chorus passive acoustic recorders on tree

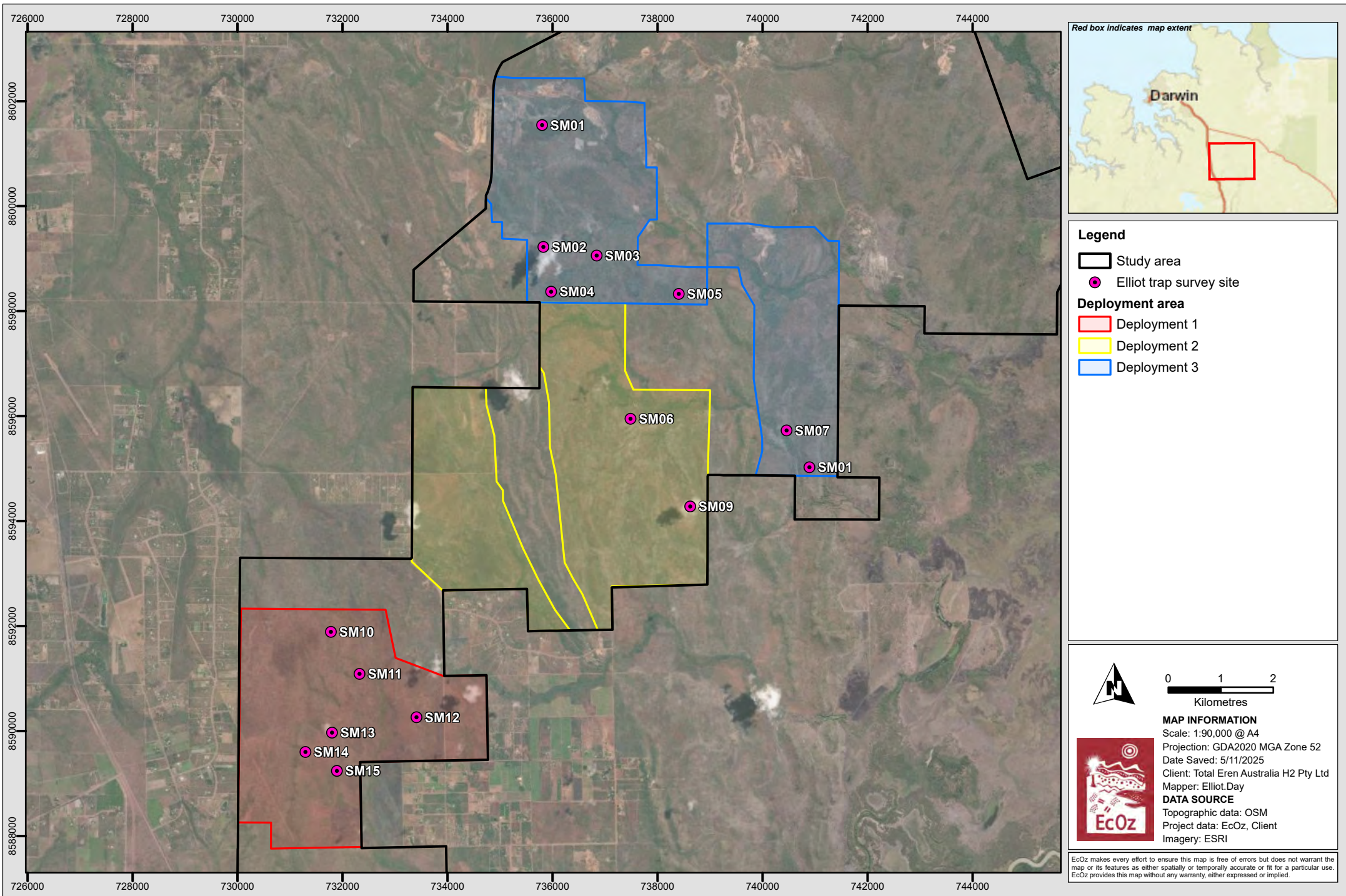


Figure 7-7. Map of Elliot trap survey sites for small mammals

7.2.3 Results

Camera trapping

A total of 50 species were recorded across the three deployments (see Figure 7-9 for some example images), of which four were target threatened species – Northern Brushtail Possum, Black-footed Tree-rat, Partridge Pigeon and Northern Blue-tongued Skink (see Figure 7-11 and Figure 7-12 for location of records). Four introduced species were detected – Feral Cat, Cane Toad, Feral Cattle and Feral Pig (see Figure 7-19). A complete list of species captured by cameras is presented in Appendix H, with threatened species-specific occurrence tables presented in Appendix I. Descriptions of the habitat at each camera site are presented in Appendix L.

The Northern Brushtail Possum were recorded at 32 of the 61 camera sites across the entire survey area (see Figure 7-11), with multiple occurrences at a majority of those 32 sites. Notably, 18 out of 21 sites in the southern section between Mocatto Rd and Monck Rd (Deployment 1) had consistent occurrences of Northern Brushtail Possums over the survey effort, with sites D1-CT.18 and D1-CT.19 recording the greatest number of occurrences (see Appendix I).

In contrast, the Black-footed Tree-rat was only recorded at one site in Deployment 2 – D2-CT.04 on 20 and 26 September 2023 (see Figure 7-11) – in a *Corymbia* and *Lophostemon* woodland adjacent to a creek line.

Three Northern Blue-tongued Skinks were recorded at sites D1-CT.16 on 23 July, D2-CT.16 on 6 October, and D3-CT.10 on 15 November 2023 (see Figure 7-12). These observations occurred in or directly adjacent to land types 2a and 2b (rises and side-slopes) in medium to high quality *Eucalyptus*-dominated woodland.

The camera survey also returned captures of another non-target significant species, the Northern Brown Bandicoot (*Isodon macrourus*). This species is listed as Near Threatened under the *TPWC Act*. Multiple occurrences were detected at 33 out of 61 camera trap sites spread across the study area – see Figure 7-13.



Black-footed Tree-rat



Northern Brushtail Possum



Partridge Pigeon (lower foreground)



Short-beaked Echidna



Red-cheeked Dunnart



Northern Blue-tongued Skink



Sand Goanna

Figure 7-9. Photographs of some of the species recorded during camera trapping

Live trapping

No small mammals were captured at any of the sites during this survey. This result is not entirely surprising given how low the density of small mammals appears to be across most of the Top End. Lack of captures does

not mean that the presence of threatened small mammal species can be ruled out, especially with recent proximate records and suitable habitat availability.

Notably, a small Olive Python (*Liasis olivaceus*) was captured at site SM12 with a bulge in its belly, suggesting that it had eaten the animal caught in that trap earlier that night – see Figure 7-10. Three captures of Cane Toads were also made.



Figure 7-10. Photographs of Olive Python captured during Elliott trapping

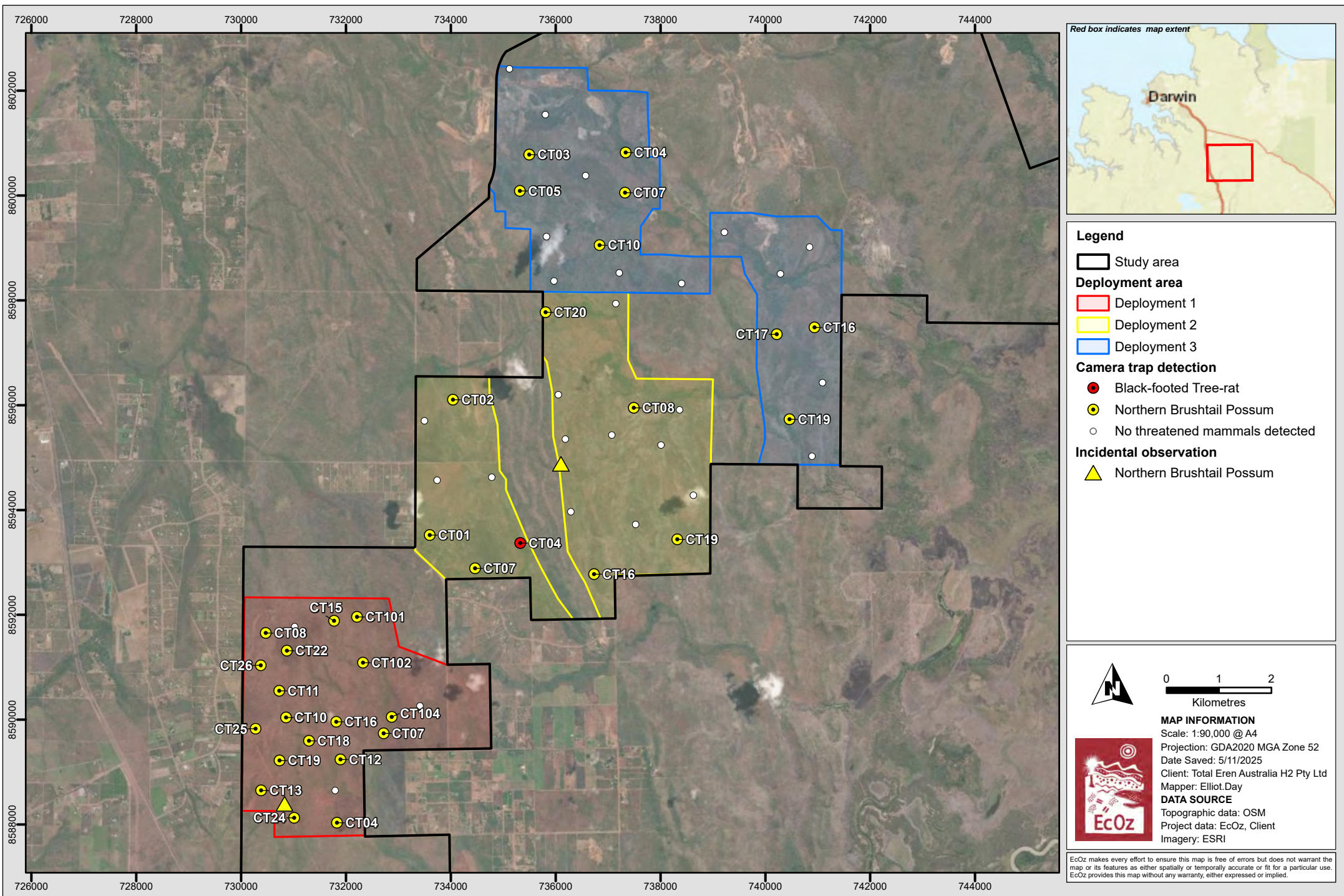
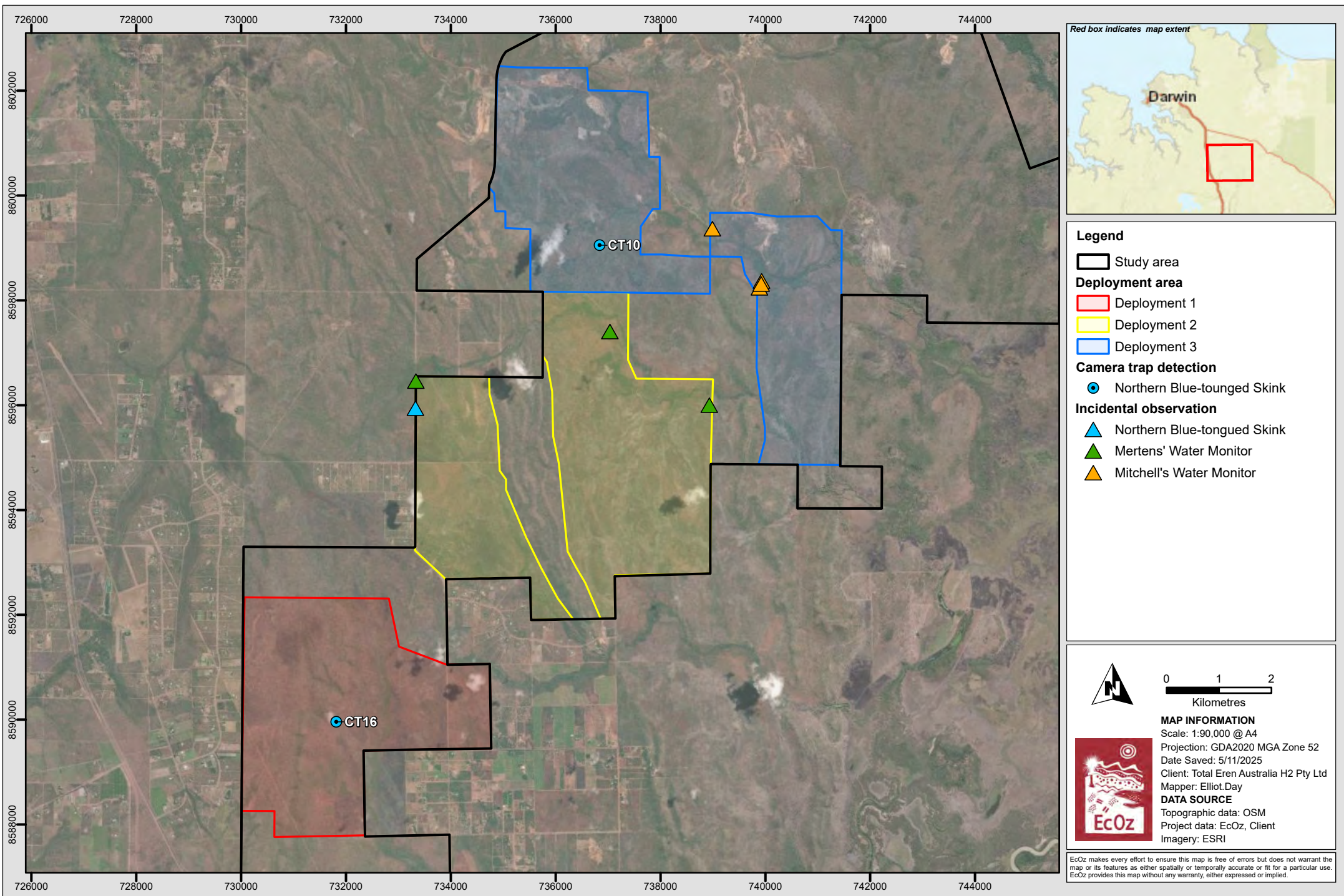


Figure 7-11. Map of location of threatened mammal records (cameras and incidental)



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ23001 - Total Eren Darwin Renewable Hydrogen Hub (Ecology)\1. Project Files\2. Report Maps\EZ23001 - Field survey results\EZ23001 - Field survey results.aprx | Figure 7-12. Map of location of threatened reptile records (cameras and incidental)

Figure 7-12. Map of location of threatened reptile records (cameras and incidental)

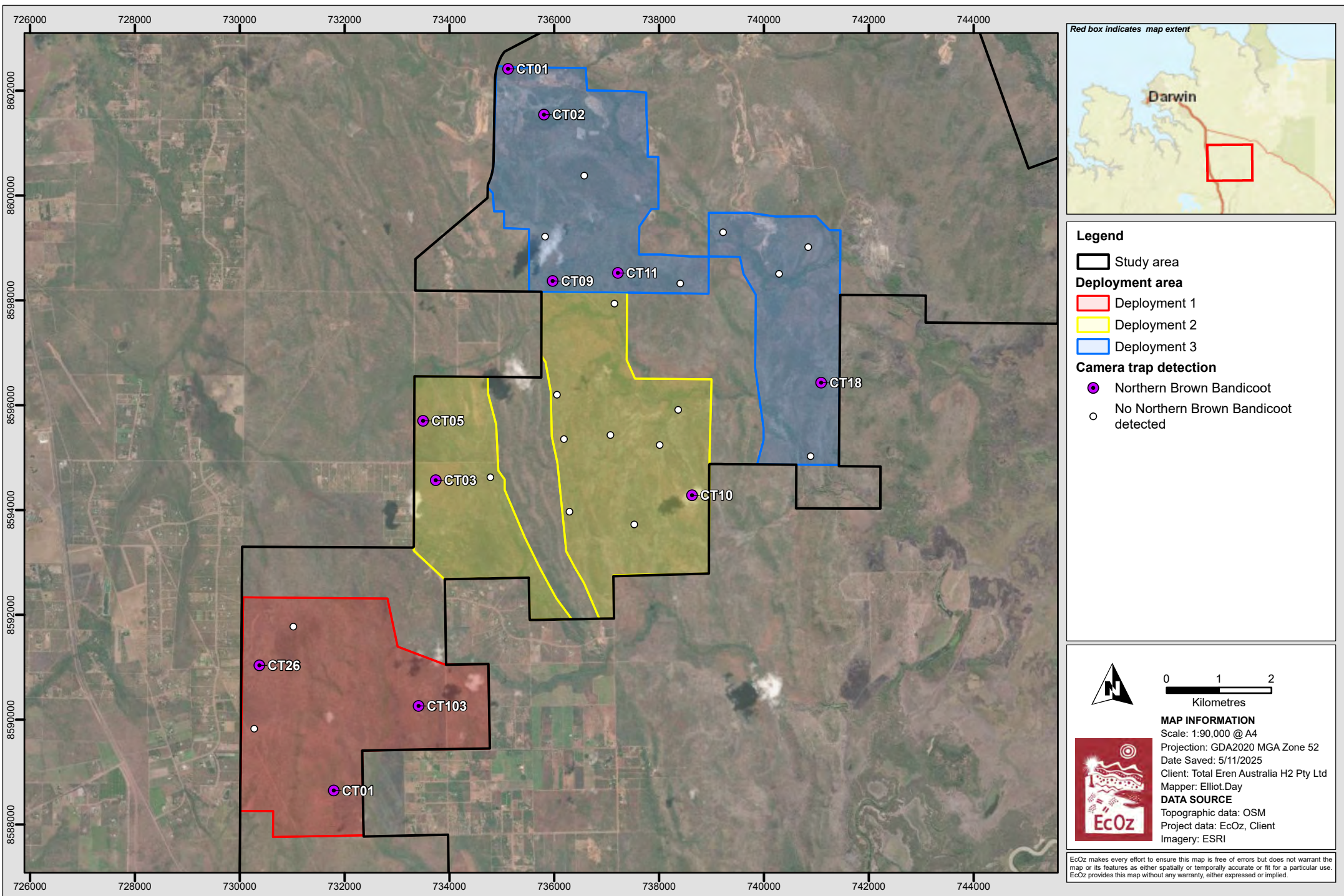


Figure 7-13. Map of location of Northern Brown Bandicoot records

Acoustic recorders

All acoustic data were analysed by Dr Kyle Armstrong from Specialised Zoological. The analysis report is presented in Appendix J and detection locations shown in Figure 7-14. Descriptions of the habitat at each acoustic site are presented in Appendix M.

There were twelve confirmed bat species, with additional ambiguous calls associated with a few other species. In particular, calls of the Bare-rumped Sheathtail Bat were confirmed at four sites, with an additional recorder capturing a call that was potentially from a Bare-rumped Sheathtail Bat, but was not able to be distinguished to a species level accuracy. Four out of these five sites were situated within land units 2a, 2b and 3c in medium to high quality Eucalypt woodland, which provides large hollow-bearing trees utilised by Bare-rumped Sheathtail Bat for roosting. The exception was Bat-7_D3 in the north, which was located on the tree line of a grassy floodplain.

Incidental observations

Two incidental observations of the Northern Brushtail Possum were made during the Masked Owl call playback survey – one at site CPB-3 on 15 November 2023 of an adult and juvenile together, and the other of an individual adult at CPB-5 on 16 November 2023.

Several incidental observations of threatened varanids were made during the deployment and retrieval effort of acoustic detectors for the survey of the Howard River Toadlet in the 2024 wet season. Three separate observations of Mertens' Water Monitor were made on 20 February 2024 and two on 26 March 2024; and four observations of Mitchell's Water Monitor were made on 20 February 2024, two on 23 February 2024, and two on 7 March 2024. The individuals were spotted on the banks of watercourses or in submerged areas close to watercourses, whilst moving through the study area along existing tracks.

A single incidental observation of Northern Blue-tongued Skink was made on 22 November 2024 on Mocatto Rd, approximately 1 km north of Townend Rd intersection on the western boundary of the study area.

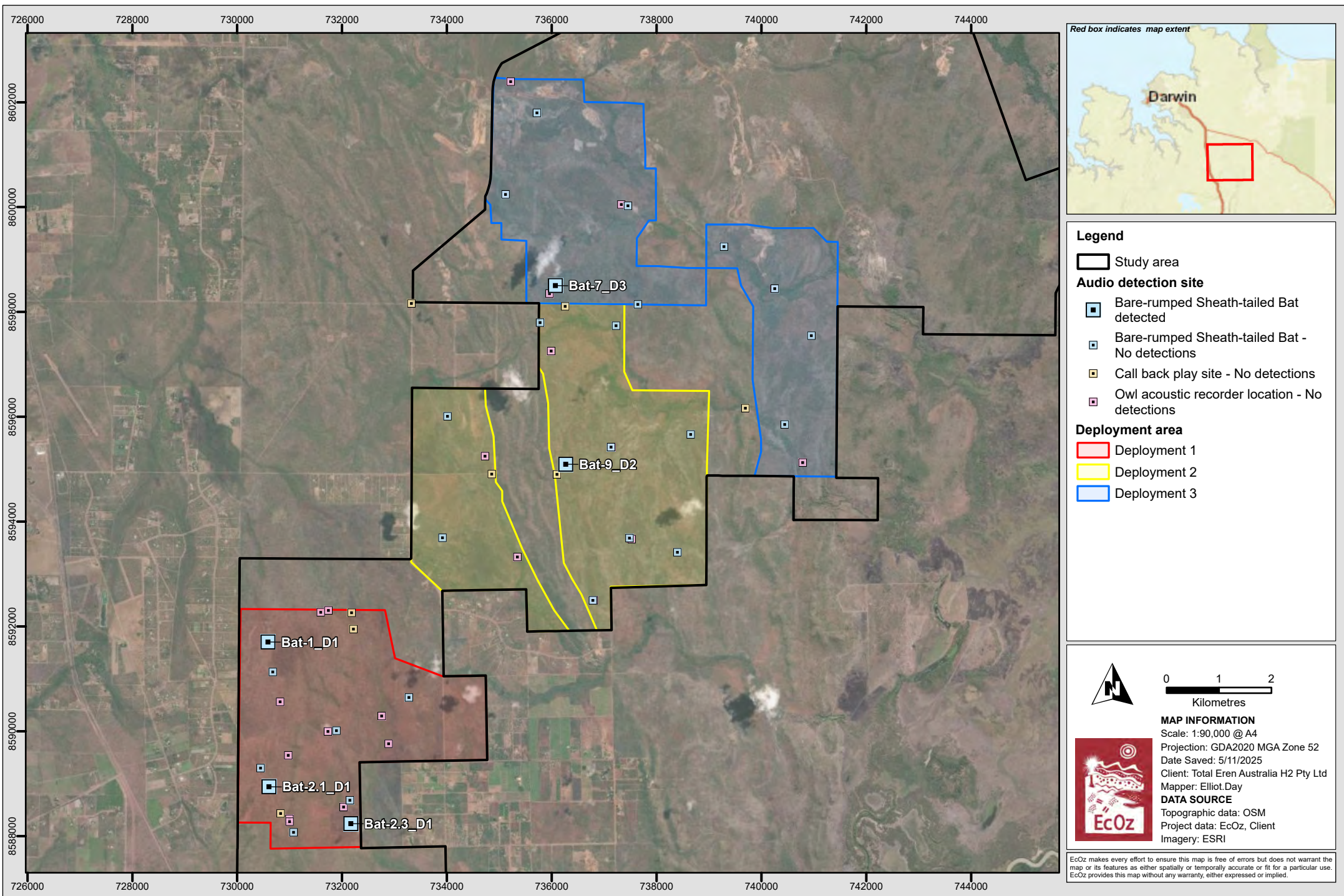


Figure 7-14. Map of acoustic survey results (passive and active)

7.3 Birds

7.3.1 Ecology

Partridge Pigeon (eastern sub-species)

The Partridge Pigeon (*Geophaps smithii smithii*) is a medium-sized ground-dwelling bird which forages entirely on the ground and rarely flies, except when flushed. The species is largely sedentary and typically occurs singly or in small family groups. Larger aggregations may occur around waterholes. The Partridge Pigeon nests on the ground, preferentially in lowland eucalypt open forests and woodlands at sites with relatively dense grass cover. This contrasts with the relatively open (often burnt) areas the species prefers for feeding, which suggests that fire regimes may significantly affect the species. Nesting occurs mostly in the early dry season (Garnett and Baker 2021).

The eastern sub-species of Partridge Pigeon occurs across the Top End and the Kimberley; however, it has declined or disappeared from much of the lower rainfall parts of this range over the last century (Woinarski 2006). The species is largely sedentary; however, individuals can travel distances of 5 to 10 km in the Wet season in search of food and water resources (Woinarski 2006). Home ranges vary seasonally between 8 and 31 hectares (Fraser 2001). It is primarily found in open forest and woodland dominated by *E. tetradonta* and *E. miniata* that has a structurally diverse understory (DEWHA 2010b). According to Garnett and Baker (2021), the Partridge Pigeon favours a structurally-patchy savanna understorey at a relatively intricate scale. In all seasons, the species prefers to feed in areas that have an open ground layer (e.g. following fire); however, they are more likely to nest at sites where there is high vegetation cover. These vegetated areas are also often used as roost sites and when retreating from disturbance.

The major threat to the Partridge Pigeon is change in fire regime to one where fires extend over large areas and the mosaic of fire ages is erased (Fraser et al. 2003; Garnett and Baker 2021). Associated with larger, more intense fires is an increase in predation pressure by feral cats following the reduction in habitat cover (DEPWS 2021g). Furthermore, the species is threatened by the invasion of exotic pasture grasses, such as Gamba Grass, which then provide greater fuel loads and promote large fires that further change the natural vegetation structure (Garnett and Baker 2021).

Masked Owl (northern sub-species)

The northern sub-species of Masked Owl (*Tyto novaehollandiae kimberli*) occurs mainly in Eucalyptus tall open forests (especially those dominated by *E. miniata* and *E. tetradonta*), but also roosts in monsoon rainforests and forages in more open vegetation types, including grasslands (Woinarski and Ward 2012). The sub-species usually nests in large tree hollows with an opening diameter of at least 20 cm, between 10 and 45 m off the ground. Pairs reside in territories of up to 3,000 hectares (Debus 2009) within patches of closed forest (Garnett and Baker 2021). DLRM (2010) notes that the sub-species is most vocal in the lead-up to nesting (typically the early dry-season)

Little is known about the distribution of the northern sub-species of Masked Owl. There are only 100 records for the Northern Territory – mostly on the Cobourg Peninsula; but also Kakadu, Groote Eylandt and scattered across the Top End. There is no reliable information on what factors may affect the status of this sub-species; however, it is thought that food resources may be diminishing, through broad-scale decline of small and medium-sized native mammals, possibly due to changed fire regimes. The current regime of more intense, frequent, and extensive fires may reduce the availability of large trees and hollows required for nesting. The greatly increased cover and height of invasive exotic grasses may cause a reduction in foraging efficiency for this owl (DEPWS 2021e).

7.3.2 Methods

Camera trapping

For the Partridge Pigeon, the Australian Government *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010b) recommend targeted searches and waterhole watches for areas greater than 50 ha. The original study area was 14,000 ha and so the approach taken was to first determine if the species was detected during camera trapping and/or incidentally by field staff. If not, the intention was to then target waterholes. Partridge Pigeons share similar habitat preferences with the Black-footed Tree-rat and Northern Brushtail Possum. They commonly forage within recently burnt/cleared areas and may be attracted to the clearing of vegetation around camera traps made during field set-up. Consequently, the species is known to be detectable using remote-sensing cameras. As explained in Section 7.3.3, Partridge Pigeons were detected during field surveys and so targeted searches were not undertaken. The camera trapping methodology is described in Section 7.2.2.

Acoustic recorders

For Masked Owl, the *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010b) only recommend the use of call playback monitoring surveys along roads – 8 hrs over 4 days (with no mention of survey area size); the use of more recent passive acoustic recorders is not mentioned. Passive acoustic monitoring is a very robust and effective survey method and is used widely for many other bird and bat species that would otherwise be unobservable or present false negatives due to their high mobility, nocturnal or cryptic nature, or large territory/range; or is present but not vocal (Gros et al. 2023).

The size of, and restrictive nature of access within, the study area limited the ability to perform a comprehensive call playback survey, and hence an alternative/supporting survey method was required. In 2020, DENR published a biodiversity survey of the nearby Gunn Point area which targeted the Masked Owl using a combination of active call playback and deployment of passive acoustic recorders at sites with key habitat features. A very similar approach was used here, using an adaptation of the NT survey guidelines for the species (DLRM 2010) based on the advice given by Luke Einoder when he worked with the NT Flora and Fauna Division.

Passive acoustic recorders targeting Masked Owl were deployed during the remote-sensing camera deployment effort in locations that were identified as being high quality hunting and nesting habitat, as well as providing thorough coverage of the study area – see Figure 7-14.

The AudioMoth from Open Acoustics was used for this component of the survey. Units were attached to trees at approximately 1.5 m above ground level and set to record between 19:00 and 06:00 for a minimum period of 7 days. Recording time was set to 55 seconds with a 5 second pause between each recording, providing effectively constant coverage while keeping the recorded files to a manageable size. Recorders were deployed at 18 sites across the refined study area over 6 deployments between 26 June and 13 December 2024, resulting in a total survey effort of 117 active recorder nights and over 700 hrs of recordings.

A major fire event took place on 3 July 2024 throughout the entirety of the first deployment area, destroying or causing damage to all units, making any recorded data inaccessible and preventing them from recording past that date. A supplementary installation of another four recorders at the highest potential sites was undertaken between 21 November and 30 November 2024 to bolster the original deployment and ensure coverage of that section of the survey area.



Figure 7-15. Photographs of Audiomoth passive acoustic recorders

Call playback monitoring

A call playback monitoring survey targeting the Masked Owl was carried out by Nathan Archer and Nick Volpe. Several locations were identified during the camera deployment as being high quality woodland hunting habitat in the vicinity of tall, hollow-bearing Eucalypts. These were refined to eight sites spread across the survey area that were deemed safe to access by ATV or 4WD at night – see Figure 7-8.

Masked Owls are most vocal, and therefore most amenable to playback-based survey techniques, in the lead-up to the nesting season, with calling most evident in NT populations in the build up to the wet season (October-December) (DLRM 2010).

Surveys began approximately 30 minutes after sunset. For each site, the following methods were used:

- 1) Arrive at site and listen in silence for 10 minutes (without torches).
- 2) Broadcast the call of the Masked Owl (a combination of screeches, hisses, and chattering – with silence in between) using a powerful portable speaker, then spend 5 minutes in silence listening for owl calls and watching (without torches) for silhouettes of owls in trees around the site. Repeat this step twice.
- 3) After third call playback, keep listening for owl calls, but also use a spotlight to scan habitat around the site for ten minutes for both owls and small mammal prey species.

This procedure was carried out for 60 minutes at each of the selected sites, over two consecutive nights in the middle of the build up to the wet season, on 15 and 16 November 2023. This resulted in a total of eight hours of focused survey effort over two days

7.3.3 Results

Camera trapping

The first camera deployment between 26 June to 3 August captured the Partridge Pigeon at two sites on four separate occurrences within the survey area, approximately 1.2 km apart – see Figure 7-16. As mentioned earlier, for the second and third deployments the camera schedule was adjusted from 24hrs to 18:00 – 07:00, limiting the likelihood that Partridge Pigeons would be detected.

Call playback monitoring

No Masked Owls were observed or heard during the call playback survey. A Barking Owl was observed flying into site CPB-4 on during the active broadcasting of the calls and remained within the area for approximately 10 minutes. A Southern Boobook was also heard calling for approximately five minutes at CPB-4 on the same night.

Incidental field observations

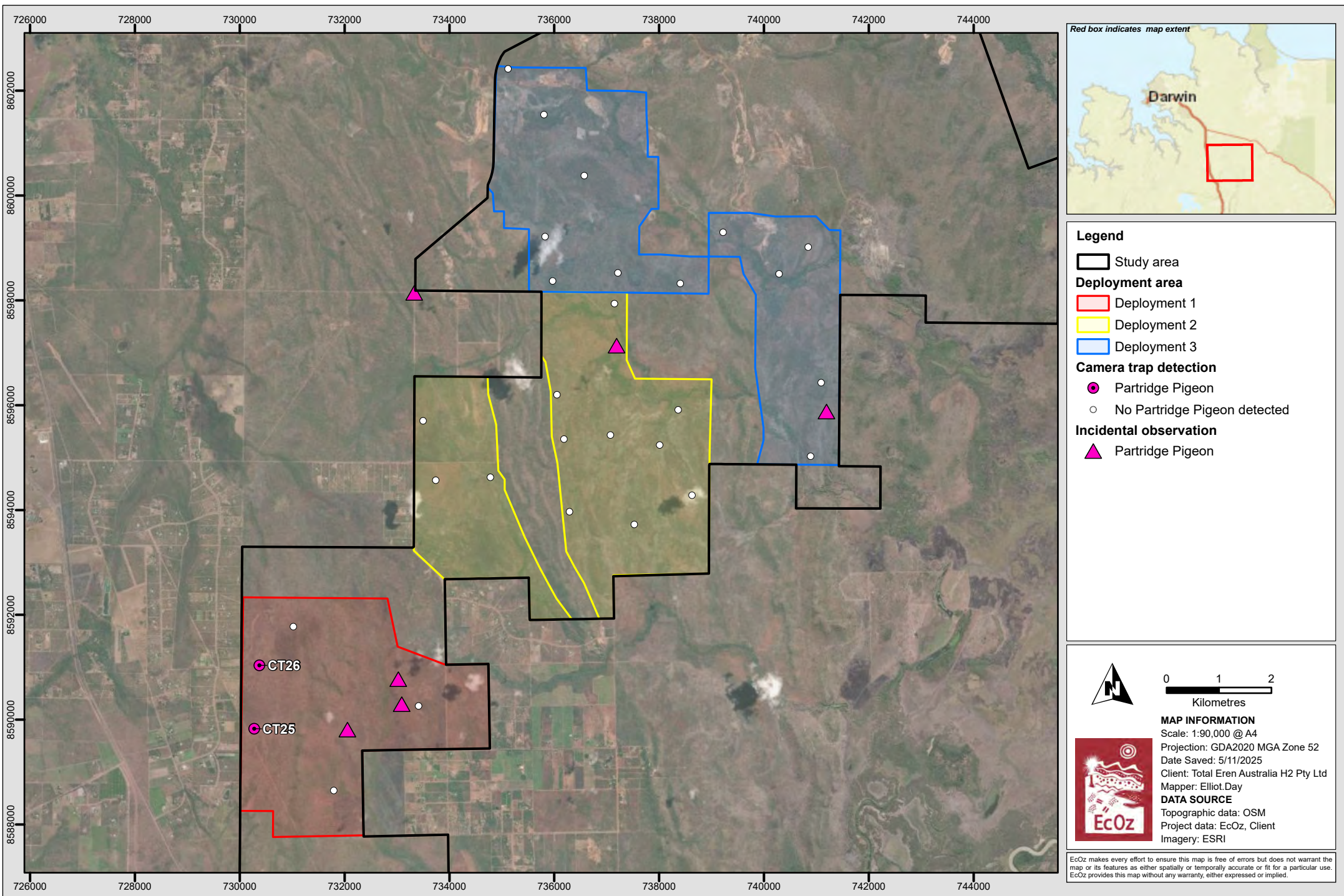
Six separate incidental observations of Partridge Pigeons were made by field staff moving along tracks during survey efforts. Three observations of individual birds were made during the camera survey effort, two observations of an individual and a pair were seen during the small mammal Elliott trap survey, and a single incidental observation was made at the field team staging area on the north end of Mocatto Rd during the deployment of acoustic recorders for Howard River Toadlet – see Figure 7-16.

Acoustic recorders

EcOz did not detect the presence of Masked Owls at any of the call playback sites within the study area.

Analysis of the 700 hrs of acoustic data collected during field surveys was performed by EcOz using a python-based call recogniser model created in JupyterLab. The model was trained using a combination of confirmed screech, chatter, and hiss calls of the northern sub-species of Masked Owl (*Tyto novaehollandiae kimberli*) with varying levels of background noise. Analysis of the field recordings detected no confirmed/potential Masked Owl calls captured during the survey. The true positive training calls were then mixed in with the field recordings and run back through the recogniser, returning 100% detection of the true positive training calls and no positive detections of Masked Owl calls in the field recordings.

Descriptions of the habitat at each acoustic site are presented in Appendix M.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ23001 - Total Eren Darwin Renewable Hydrogen Hub (Ecology)\1. Project Files\2. Report Maps\EZ23001 - Field survey results\EZ23001 - Field survey results.aprx | Figure 7-16. Map of location of Partridge Pigeon records (cameras and incidental)

Figure 7-16. Map of location of Partridge Pigeon records (cameras and incidental)

7.4 Howard River Toadlet

7.4.1 Ecology

The Howard River Toadlet (*Uperoleia daviesae*) is a small, endemic frog species that was only formally described in 2005. The species is highly-restricted to shallow drainage systems that intersect sandsheet heath habitat of the Darwin region (Young et al. 2005; Fisher et al. 2011). Known only from the Howard and Elizabeth River catchments, the Howard River Toadlet is listed as Vulnerable under the *TPWC Act* and the *EPBC Act*. This is due to its restricted distribution and reliance on sandsheet habitats that are under pressure from peri-urban development, particularly because of sand extractive industries (Doyle 2001; Price et al. 2005; Woinarski et al. 2007).

The Howard River Toadlet becomes active during the wet season when heavy monsoonal rain events inundate the low lying sandsheet heaths, triggering them to emerge from their burrows and providing suitable conditions for breeding (Clancy 2019).

The species has a highly restricted distribution, even within suitable seasonally-inundated sandsheet heathland. Key features as per the *EPBC Conservation Advice* (TSSC 2021a) for this species are:

- Predominantly sandy soil types (e.g. oxy-aquic or redoxic hydrosols).
- Micro-relief ('debil-debil' or swamp-hummock).
- Vegetation communities characterised by an open overstorey of small trees and tall shrubs including *Melaleuca nervosa*, *Grevillea pteridifolia*, *Banksia dentata* and *Verticordia cunninghamii*, and a closed to open ground layer of mixed sedges, herbs and grasses with *Dapsilanthus spathaceus* being a prominent component (short tussock structure).
- Water seepage from surrounding woodland or laminar flows of shallow water across the sandsheet heath area.

7.4.2 Methods

The draft *Survey Methodology for Uperoleia daviesae* (DEPWS, in prep) is based upon nocturnal surveys. According to the methodology, each survey site should be 1 ha. The number of sites required depends on the size of the project disturbance area and the size, suitability and configuration of the habitat patch. Surveys should be planned to coincide with the onset of wet season monsoonal rains, and surveys should only take place after a sufficient rainfall event during the species' peak activity period.

According to the methodology:

... to ensure rainfall and conditions are appropriate for U. daviesae detection, a local reference site is required. The reference site should be visited each night immediately prior to surveys to verify if U. daviesae are active and calling in the area. Site surveys should ONLY be undertaken if U. daviesae have been confirmed calling that night. Selection of the reference site should be based on a known reliable population, where local conditions are representative of the survey site.

As detailed in Section 4.1, the study area contains many patches of sandsheet heath, some of which have the characteristics of high-quality Howard River Toadlet habitat. These patches are spread across a large area and safely accessing many of them at night during a rain event – having first visited a reference site – is not possible. Faced with such logistics, it was decided that employing the draft survey methodology was not feasible.

This prompted EcOz to develop a method of surveying for Howard River Toadlet using environmental DNA (eDNA).

eDNA

Living organisms constantly shed genetic material (DNA) such as skin, mucus, urine and faeces into the environment. Detecting this eDNA is becoming an established tool for ecologists to detect species – particularly in aquatic systems – in situations where conventional methods may be ineffective, prohibitively labour- or time-intensive, or detrimental to the species (Burns et al. 2020). For the Howard River Toadlet, the method is simply to collect water samples from suitable habitat and undertake laboratory analysis of the samples to detect whether there is DNA of the toadlet in the samples.

For this to be possible, the laboratory needed to first develop species-specific genetic markers. Such an assay was developed by a company called EnviroDNA using tissue samples from Howard River Toadlet that were previously collected by EcOz and DLPE. This work was undertaken in conjunction with Dr Renee Cattullo from the University of Western Australia who is an expert on this genus of frog. The required 16S genomic data was provided for Howard River Toadlet and potential off-target species to develop and verify a targeted species assay (high confidence of primer specificity).

A total of 15 sandsheet heath sites were selected for eDNA monitoring – both within, and outside, the study area. The sites were selected based on:

- Recent and historic records of Howard River Toadlet within sandsheet patches, and/or sandsheet patches in close proximity to previous records (i.e. within 500 m).
- Moderate and high quality sandsheet patches, as determined in Section 4.2.2.

The 15 sites included three sandsheet heath patches which support a known population of Howard River Toadlet. This site was used as one of our reference sites for sampling eDNA.

Water samples were collected from reference sandsheet heath patches known to support a local occurrence of Howard River Toadlet – to confirm the veracity of the method – and then from pooling water at high-quality habitat in sandsheet heath patches within the study area. At each site, three samples were collected. The 24 survey sites within the study area are shown in Figure 7-17. The water sampling methods used were developed in conjunction with EnviroDNA (see Appendix K).

In the laboratory, each sample was screened in triplicate for Howard River Toadlet using qPCR.

Acoustic recorders

In the early wet season of 2024, a passive acoustic monitoring survey for Howard River Toadlet was undertaken in two sandsheet heath patches that were not surveyed with eDNA, and to verify ambiguous eDNA results from a third patch/site.

Two models of acoustic loggers were used in this survey to allow for greater coverage and a comparison of recording quality and detection capacity of the units. The models used were the Anabat Chorus from Titley Scientific and the AudioMoth from Open Acoustics

The three separate sandsheet heath patches within the study area were identified as having all the characteristics of high-quality habitat likely to support populations of Howard River Toadlets. Deployment of the monitors commenced once the monsoonal wet season had set in, and enough major rain events had occurred to ensure the sandsheet heaths would remain inundated for a sufficient period to allow spawning to take place and tadpoles to reach metamorphosis.

Three confirmed reference sites outside of the study area with NT Atlas historical records from previous surveys were visited to confirm that Howard River Toadlets were calling before acoustic monitors were deployed within the study area.

A mixed array of two AudioMoth and three Anabat Chorus acoustic recorders were then deployed in each of the sandsheet heath patches (patch 15, 16 and 17) and set to record every other minute between sunset and sunrise. Sites were selected by desktop analysis of aerial imagery and vegetation assessments performed by

ecologist Anna Lemon and then modified where necessary during deployment to locations with the highest quality habitat that were representative of the SSH patch

A single AudioMoth was deployed at two of the reference sites during the same period to provide context and verification of calling across the range of the Howard River Toadlet.

Audio data was analysed by ecologist Nathan Archer to assess the presence of Howard River Toadlet at each recorder location. Confirmed call recordings were verified externally by Dr Stephen Reynolds from Charles Darwin University, who is an expert on this species.

7.4.3 Results

eDNA

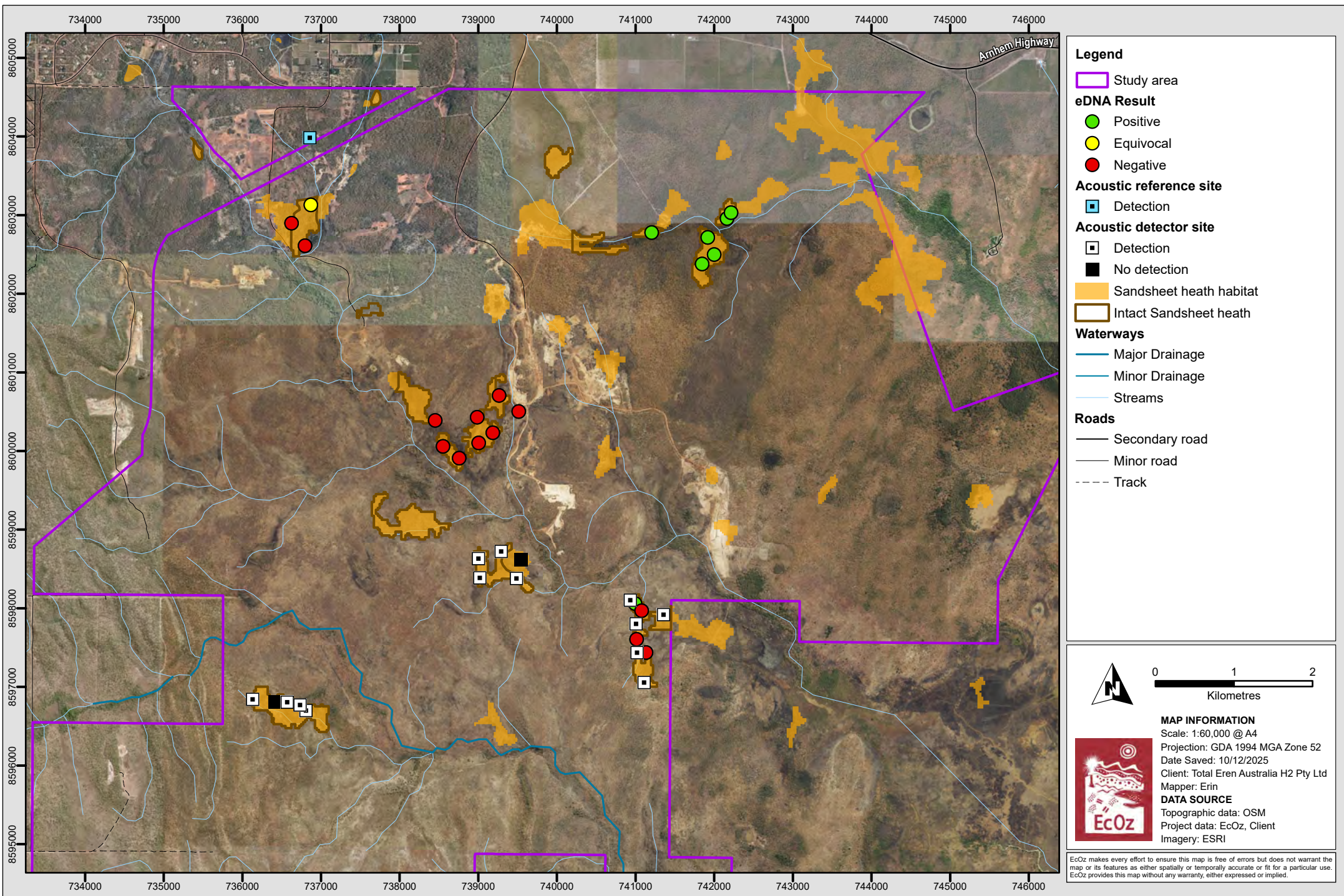
Water samples were collected from 35 sites (24 within the study area), with two replicates per site. As shown in Figure 7-17, target species' analysis identified seven sites within the study area had positive detections for Howard River Toadlet (i.e. more than 3 out of 6 detections over the two replicates) and one site returned an equivocal detection (1 to 3 out of 6 detections over the two replicates). Recording an *equivocal detection* can signal that the target species is present in low abundance or occupies a site transiently. Alternatively, low levels of target DNA may arise from sample contamination through sampling or laboratory screening processes (minimised through strict protocols and negative controls), facilitated movement of DNA between waterbodies (e.g. water birds, recreational anglers, water transfers, predator scats), or eDNA dispersal from other sites (e.g. flow, floods).

More detail is provided in see Appendix K.

Acoustic recorders

Heavy rainfall and seasonal flooding during the deployment period caused some difficulty in accessing the sites, and several attempts were made to reach the sites to install the recorders. Due to the difficulties accessing the sites, the deployment length of the recorders was not uniform across sites.

A total survey effort of 124 acoustic detection nights was achieved from 15 recorders across the three patches, with 13 of the 15 recorders logging large numbers of positive calls and confirming the presence of Howard River Toadlet at all 3 sandsheet heath patches. A total of 34 acoustic detection nights were achieved across the two reference sites, also returning positively identified calls. Results are displayed Figure 7-17.



Path: C:\Users\Erin\Documents\ArcGIS\IPackages\EZ23001 Field Survey Results ED edits July 2025_e0be4dp30\13BBF6A3-7478-4D2B-B7BD-99E74DC4FCBF.aprx | Figure 7-17. Map showing results of Howard River Toadlet surveys (eDNA and acoustic)

Figure 7-17. Map showing results of Howard River Toadlet surveys (eDNA and acoustic)

Introduced fauna

According to the NT Fauna Atlas, the introduced fauna species listed in Table 7-2 are widespread and abundant within the region, and hence likely to occur within the study area. Four introduced fauna species were detected during surveys – see Figure 7-19 for locations and Figure 7-18 for photographs.

Table 7-2. Introduced fauna species that may occur within the study area

Common name	Scientific name	Habitats	Detected during surveys?
Cattle	<i>Bos taurus</i>	Various	Yes
Water Buffalo	<i>Bubalus bubalis</i>	Riparian areas and wetlands	No
Feral Cat	<i>Felis catus</i>	Various	Yes
Feral Pig	<i>Sus scrofa</i>	Riparian areas and wetlands	Yes
House Mouse	<i>Mus domesticus</i>	Various	No
Cane Toad	<i>Rhinella marina</i>	Various	Yes
Asian House Gecko	<i>Hemidactylus frenatus</i>	Buildings and adjacent woodlands	No



Feral Cat at D2-CT.05



Cattle at D3-CT.16



Cane Toad at D3-CT.18



Feral Pig at D2-CT.08

Figure 7-18. Example photographs of pest animals detected during surveys

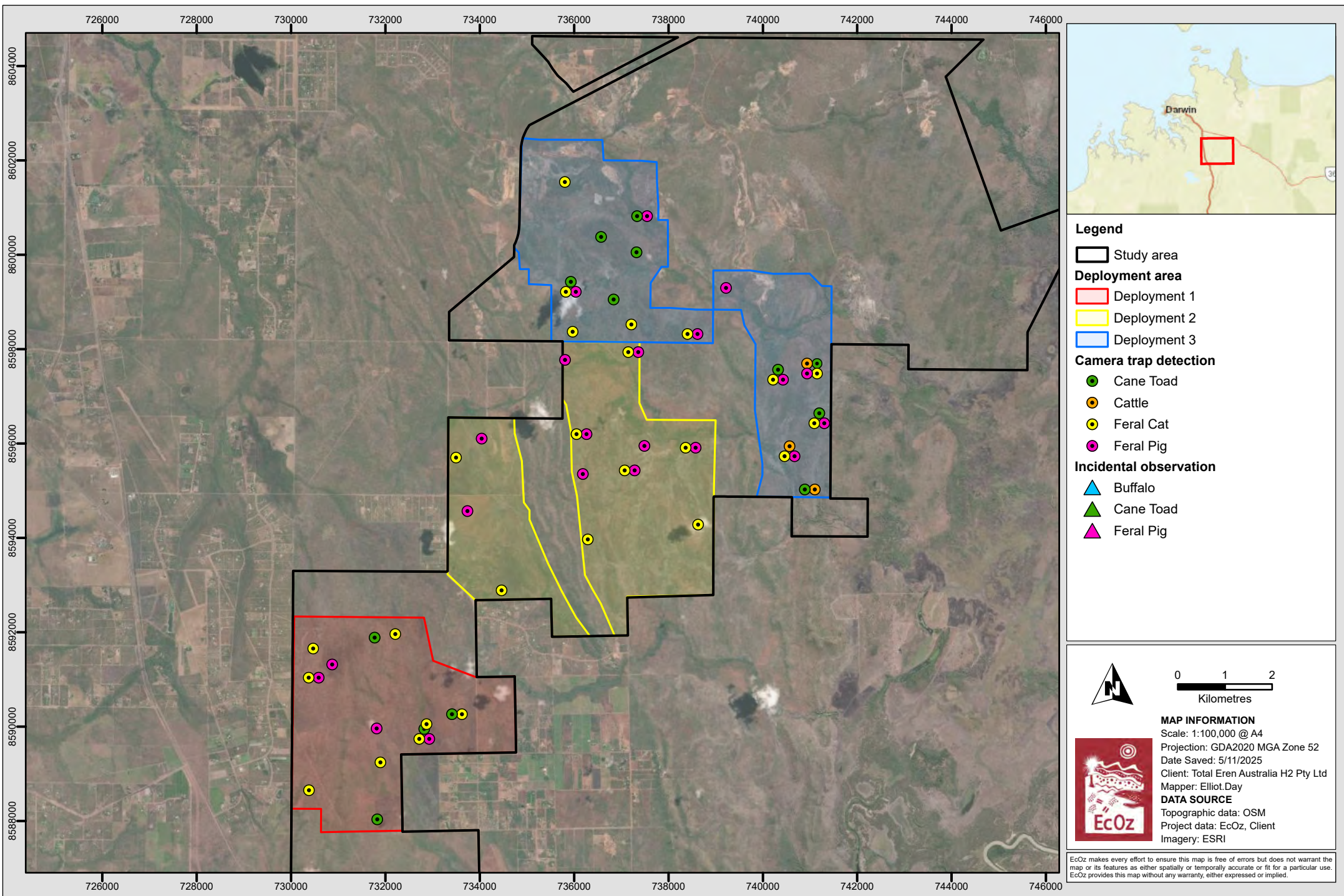


Figure 7-19. Map of pest animal records within the study area

8 MIGRATORY SPECIES

The *EPBC Act* Protected Matters Search Tool report (Appendix B) identified 34 migratory species protected under international agreements as possibly occurring within the study area. To identify which migratory species have the potential to occur in the study area, the procedure replicated that used for threatened species (see Section 2.5). The results are presented in Table 8-1.

Most of the migratory species identified have an inherently low likelihood of occurring with the study area because they occur almost exclusively in marine, coastal and estuarine environments. For many of these species – including all marine species – the study area does not contain suitable habitat, and so they are not considered further.

The remaining migratory species may occur within the terrestrial or freshwater ecosystems within the study area. However, even if individual members of some migratory species were to seasonally utilise habitat with the study area, this occurrence is expected to be of a short period and in low abundances.

Table 8-1. Migratory species 'likelihood of occurrence' assessment summary

Likelihood	Species
Migratory terrestrial species	
HIGH	Oriental Cuckoo (<i>Cuculus optatus</i>)
MEDIUM	Barn Swallow (<i>Hirundo rustica</i>)
LOW	Red-rumped Swallow (<i>Cecropis daurica</i>)
	Grey Wagtail (<i>Motacilla cinerea</i>)
	Yellow Wagtail (<i>Motacilla flava</i>)
Migratory marine or wetland species	
LOW	Oriental Reed-warbler (<i>Acrocephalus orientalis</i>)
	Common Sandpiper (<i>Actitis hypoleucos</i>)
	Pectoral Sandpiper (<i>Calidris melanotos</i>)
	Oriental Plover (<i>Charadrius veredus</i>)
	Oriental Pratincole (<i>Glareola maldivarum</i>)
	Eastern Osprey (<i>Pandion cristatus</i>)

The likelihood of occurrence assessment summarised in Table 8-1 identified two species of migratory birds that have a high or medium likelihood of being present in the study area – Oriental Cuckoo (*Cuculus optatus*) and Barn Swallow (*Hirundo rustica*).

Oriental Cuckoo

The Oriental Cuckoo is an arboreal bird which migrates from Asia to spend the non-breeding season in Australia (McCrie and Noske 2015). In Australia, the species has been sighted across coastal areas from Karratha in WA to Bega in NSW (DoE 2015).

In Darwin, the Oriental Cuckoo is known to arrive in small numbers between September and November – before departure in early April – with the species occurring in low densities (McCrie and Noske 2015). The Oriental Cuckoo has been recorded in both coastal and sub-coastal areas, where it uses a wide range of dense to open woodlands and forests – particularly the edges of riparian forests (DoE 2015, Menkhorst et al. 2017). There are records of the species outside the eastern border of the study area associated with Fogg Dam and riparian habitat along the Adelaide River.

Barn Swallow

The Barn Swallow is a rare wet season, non-breeding visitor to the Darwin region, with records from October to April (McCrie and Noske 2015). The species occurs patchily along the northern Australia coastline from the Pilbara region in Western Australia to Townsville in Queensland. In the NT, the species is known from Darwin and Croker Island (DCCEEW 2025).

The Barn Swallow almost exclusively consumes flying insects; as such, the species occurs over open vegetated country in coastal lowlands – including grasslands and open water areas, especially freshwater wetlands with high densities of flying insects (Menkhorst 2017). There are records of the species within 10 km of the north-eastern corner of the study area around Fogg Dam.

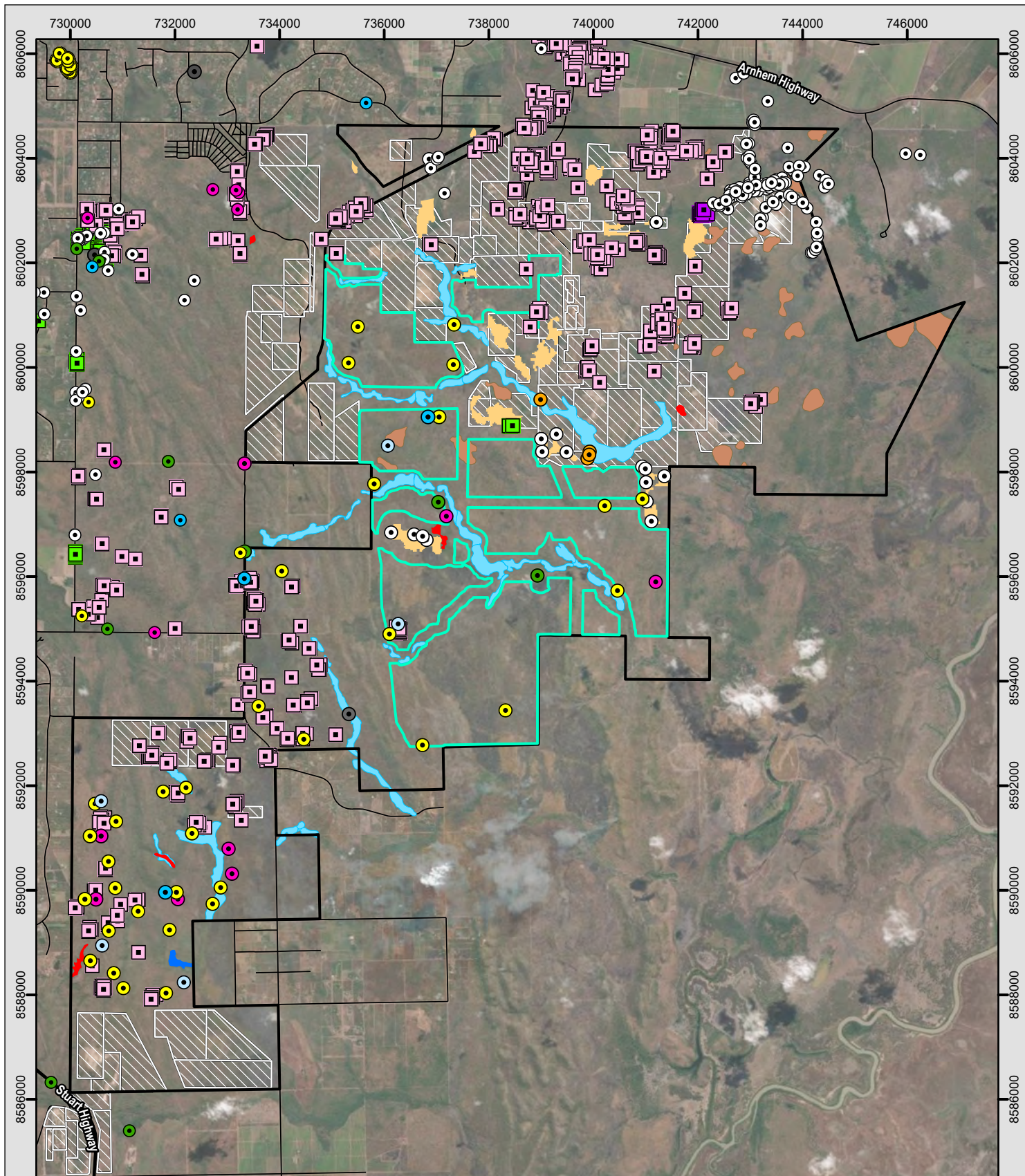
9 SUMMARY

The results of the two-year ecological survey regime undertaken across the study area are summarised in Table 9-1 and presented on a map in Figure 9-1.


Table 9-1. Summary of survey results for significant vegetation and threatened species

Value	Results	Revised likelihood of occurrence rating
Significant vegetation types		
Sandsheet heath	3 patches of very high quality (~48 ha) 3 patches of high quality (~36 ha) 7 patches of medium quality (~100 ha) 3 patches of low quality (~13 ha)	-
Rainforest	6 patches totalling 26.1 ha; all patches observed appeared to be transitional and/or very small in size	-
Riparian vegetation	41 patches totalling 357.7 ha	-
Threatened flora		
<i>Typhonium praetermissum</i>	Abundant in north-east and south-west of study area; 671 records collected across 71 quadrats	Known
<i>Stylidium ensatum</i>	Not detected; study area unlikely to support species	Low
Darwin Palm (<i>Ptychosperma macarthurii</i>)	No suitable habitat observed; study area unlikely to support species	Low
<i>Helicteres macrothrix</i>	Not detected; study area unlikely to support species	Low
<i>Cleome insolata</i>	One patch with 17 records collected.	Known
<i>Utricularia dunstaniae</i>	One patch with 67 records collected.	Known
Darwin Cycad (<i>Cycas armstrongii</i>)	Records (at varying densities) across the study area	Known
Threatened fauna		
Fawn Antechinus (<i>Antechinus bellus</i>)	Unidentifiable small rodents recorded on camera traps. None caught in follow-up Elliott trapping.	Medium
Northern Quoll (<i>Dasyurus hallucatus</i>)	No detections.	Low
Black-footed Tree-rat (<i>Mesembriomys gouldii gouldii</i>)	Two camera detections at one site.	Known
Pale Field Rat (<i>Rattus tunneyi</i>)	Unidentifiable small rodents recorded on camera traps. None caught in follow-up Elliott trapping.	Medium


Value	Results	Revised likelihood of occurrence rating
Bare-rumped Sheath-tailed Bat (<i>Saccolaimus saccolaimus nudicluniatus</i>)	Detected at four (potentially five) acoustic monitoring sites.	Known
Northern Blue-tongued Skink (<i>Tiliqua scincoides intermedia</i>)	Three camera detections and one incidental sighting.	Known
Northern Brushtail Possum (<i>Trichosurus vulpecula arnhemensis</i>)	Multiple camera detections across 29 sites, as well as two incidental sightings.	Known
Mertens' Water Monitor (<i>Varanus mertensi</i>)	Three incidental sightings.	Known
Mitchell's Water Monitor (<i>Varanus mitchelli</i>)	Four incidental sightings.	Known
Yellow-spotted Monitor (<i>Varanus panoptes</i>)	No detections.	Medium
Partridge Pigeon (<i>Geophaps smithii smithii</i>)	Four camera detections across two sites, as well as several incidental sightings.	Known
Masked Owl (<i>Tyto novaehollandiae kimberli</i>)	No detections using call playback or from analysis of acoustic recorders.	Low
Gouldian Finch (<i>Chloebia (Erythrura) gouldiae</i>)	No incidental detections (no targeted surveys).	Low
Howard River Toadlet (<i>Uperoleia daviesae</i>)	Audio detections at 13 of 15 recorders across 3 sandsheet heath patches.	Known



Legend		Threatened Flora	
Study area	Refined area of interest	Cleome insolata	Utricularia dunstaniae
Principal road	Minor road	Typhonium praetermissum	
Mineral titles - granted	Significant vegetation	Threatened Fauna	
<i>Melaleuca</i> spp. swamps (land unit 8b)	Riparian vegetation	Black-footed Tree-rat	
Intact sandsheet heath	Dry rainforest	Northern Brushtail Possum	
Spring rainforest		Bare-rumped Sheath-tail Bat	
		Northern Blue-tongued Skink	
		Mertens' Water Monitor	
		Mitchell's Water Monitor	
		Partridge Pigeon	
		Howard River Toadlet	



0 1.5 3
Kilometres



MAP INFORMATION
 Scale: 1:100,000 @ A4
 Projection: GDA2020 MGA Zone 52
 Date Saved: 9/12/2025
 Client: Total Eren Australia H2 Pty Ltd
 Mapper: Erin

DATA SOURCE
 Topographic data: OSM
 Project data: EcOz, NTG, Client
 Imagery: NTLIS

Figure 9-1. Map of threatened species and significant vegetation types recorded in surveys

10 DISCUSSION

Whether an artefact of high survey effort, or a consequence of biotic and abiotic factors, the greater Darwin region appears to be a biodiversity hotspot. The study area is very large, contains a variety of habitat types, and represents a significant proportion of the greater Darwin region that had hitherto not been surveyed. Unsurprisingly, many threatened flora and fauna species were detected within the study area.

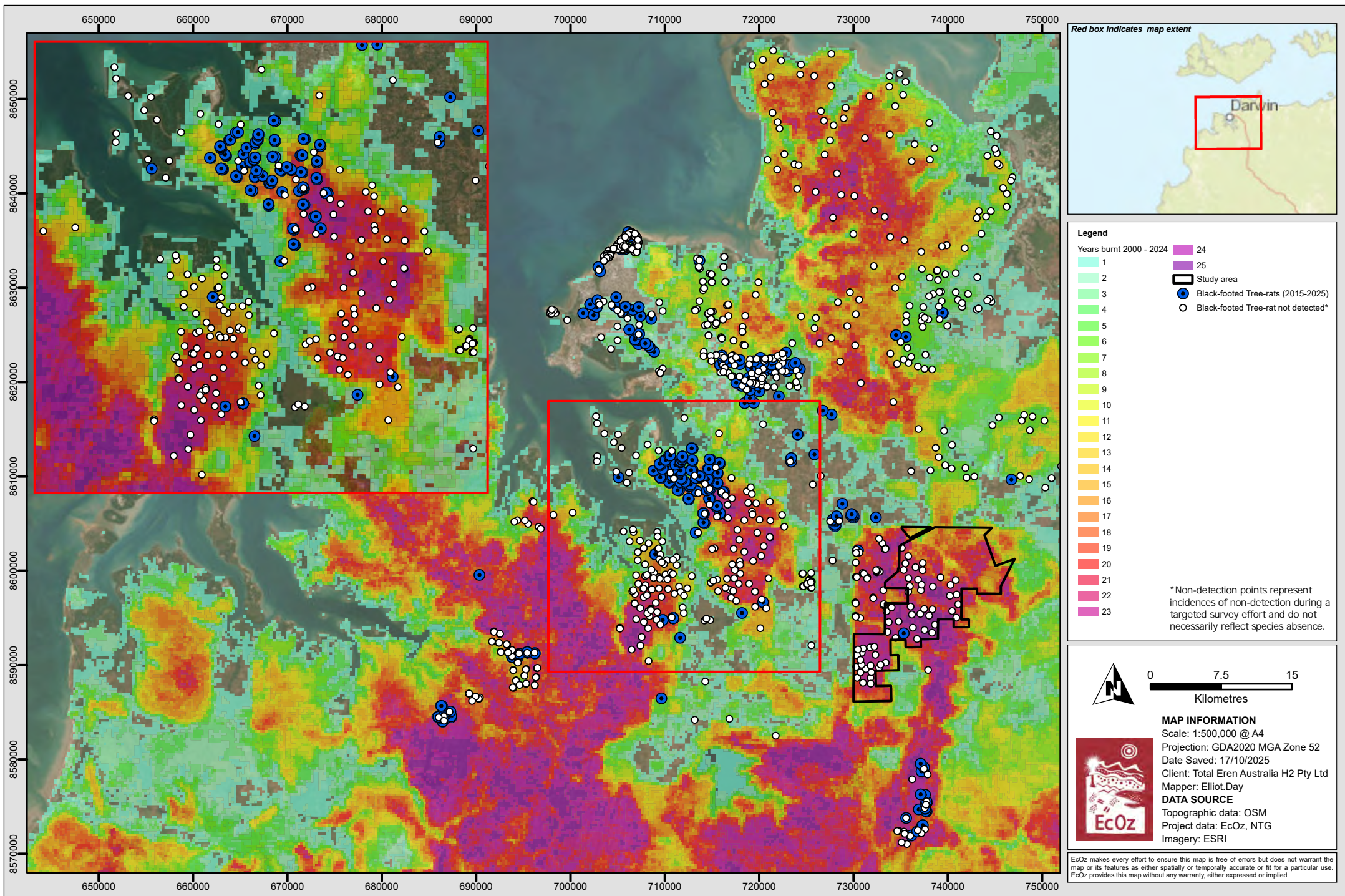
This final section of the report provides a brief qualitative assessment of the significance of threatened species identified as occurring within the study area:

- Despite comprehensive camera surveying, the **Black-footed Tree-rat** was only recorded in one location across the refined study area. There are also no other recent records in the vicinity. In contrast, the **Northern Brushtail Possum** was detected at numerous locations and appears to be widespread, but at highest density in the south-west. If present within an area, both Northern Brushtail Possum and the Black-footed Tree-rat are considered to have a high rate of being detected using the survey methods applied. Consequently, non-detection is assumed to equate to absence.

Whilst the Black-footed Tree-rat is often recorded occurring in sympatry with the Northern Brushtail Possum, the latter is more common and widespread, it is not uncommon for only Northern Brushtail Possum to be present, and therefore it is assumed to be more resilient to impacts from fire. Figure 10-1 presents fire frequency (years burnt) in the past 25 years and Black-footed Tree-rat records in the past 15 years across greater Darwin. It can be seen that Black-footed Tree-rat records are concentrated in areas that do not burn in the majority of years, or else on the periphery or in refugial areas (often riparian vegetation) of those that do. There is only one record in the middle of a frequently-burnt area (on Cox Peninsula).

- The **Bare-rumped Sheathtail Bat** was recorded in five locations across the refined survey area. Consequently, all remnant vegetation – and possibly even cleared areas – in the project area constitute foraging habitat for the Bare-rumped Sheathtail Bat. Roosting habitat is likely limited to old-growth forest with trees supporting hollows (as mapped in Figure 4-9). The species has only been ever recorded at five other locations in the greater Darwin region (all to the north), noting it is a difficult to detect species for which only recently has a definitive call signature been developed.
- There are records of **Partridge Pigeon** at eight locations in the south-west and centre of the refined study area. There are other recent records in the vicinity. The species is rarely recorded these days within the greater Darwin region – there were no records from a 2019 regional survey of Gunn Point, only one record from a 2024 regional survey of Weddell, and none thus far from ongoing surveys within greater Holtze. The records from the refined study area are therefore on the northern edge of the extent of the mainland sub-population of Partridge Pigeon.
- The detection of the **Howard River Toadlet** in the centre of the study area represents a 6 km south-eastward extension of the known distribution of the species. The westernmost Howard River Toadlet records in the study area are in a sub-catchment that has not recorded the species before.
- The **Northern Blue-tongued Skink** has drastically declined across its range because of Cane Toads. Based on the spread of recent records, the species appears to persist locally across the greater Darwin region. The detection of the Northern Blue-tongued Skink at four disparate locations across the refined study area reflects that broader regional trend.
- While **Mertens'** and **Mitchell's Water Monitor** numbers have drastically declined across their range because of Cane Toads, there does not appear to be a range contraction for these species, since there are still many recent records across its historic distribution. It is therefore not surprising for these two species to be recorded along the higher-order watercourses in the study area.

- The detection of *Cleome insolata* increases the extent of this species and increases the number of populations to eight. The population in the study area is more than 7 km to the east of the nearest known population and is in a different catchment. The number of plants detected (14) makes this one of the smallest known populations.
- The **Darwin Cycad** was recorded across the refined study area, but more often and at higher densities in the centre, and especially the south-west. The species is locally abundant in the region although, because its extent is west of Adelaide River, the easterly records in the study area are on the edge of the species' range.
- The *Typhonium praetermissum* survey for this project contributed a large number of new records for the region and extended the south-eastern range of the species slightly.
- *Utricularia dunstaniae* was previously known in the NT from only nine general locations, five of which are in the greater Darwin region. The new records of this species in the study area are more than 13 km to the south-east of the nearest known population. There are inadequate data to comment on the relative significance of the population size (63 plants).



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10-1. Map of fire frequency (since 2000) and Black-footed Tree-rat records (since 2015) in the greater Darwin region

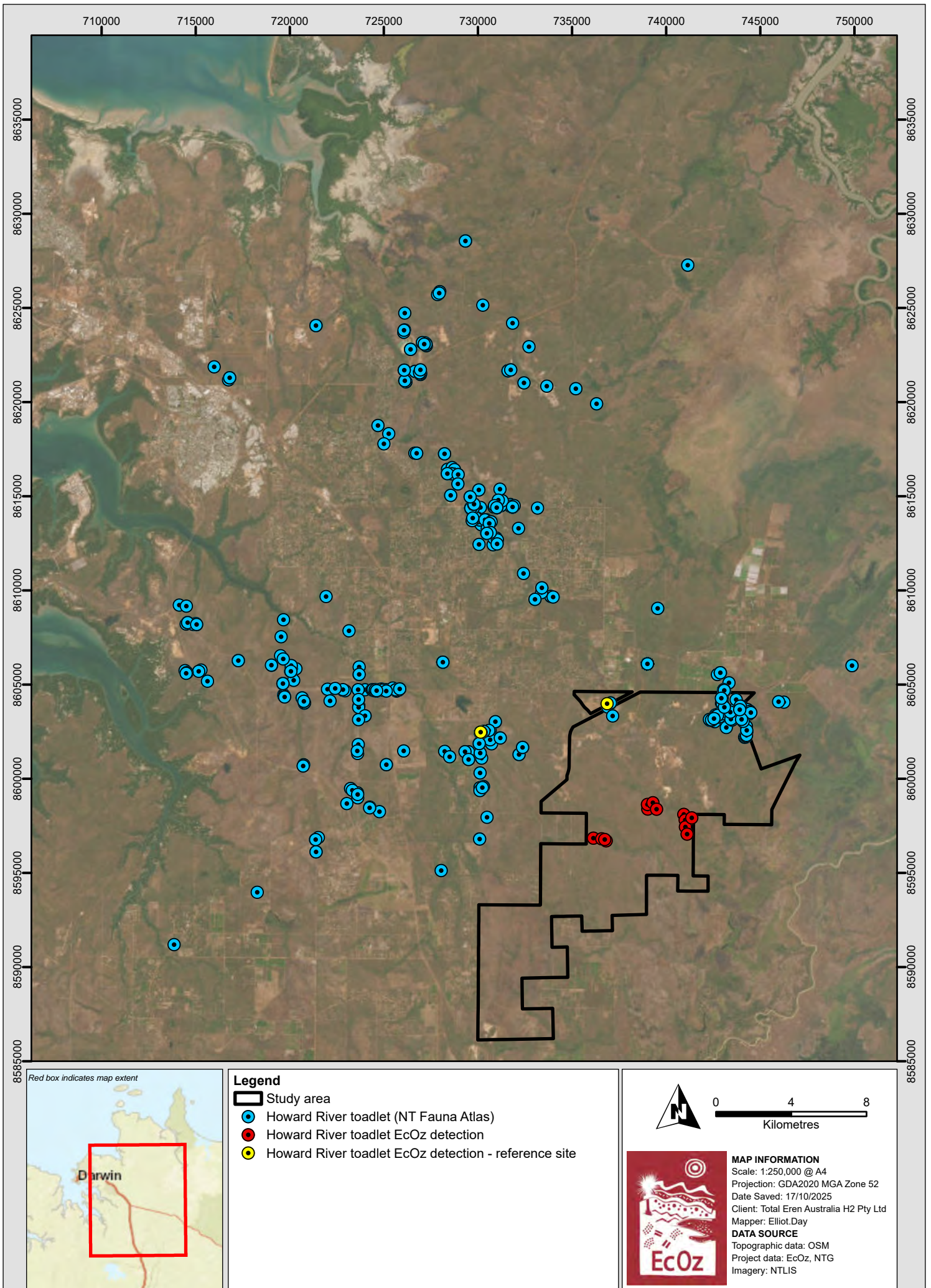
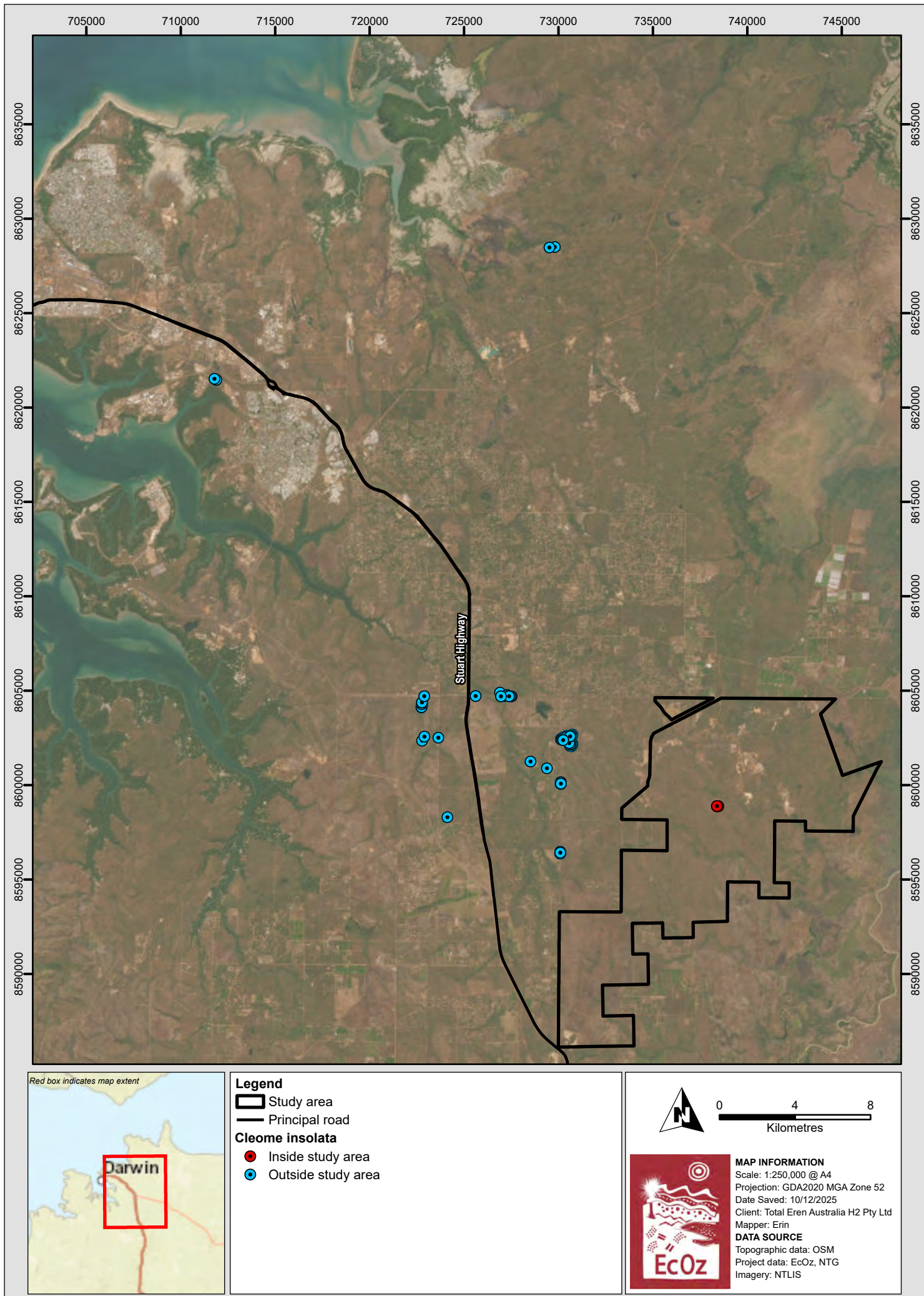
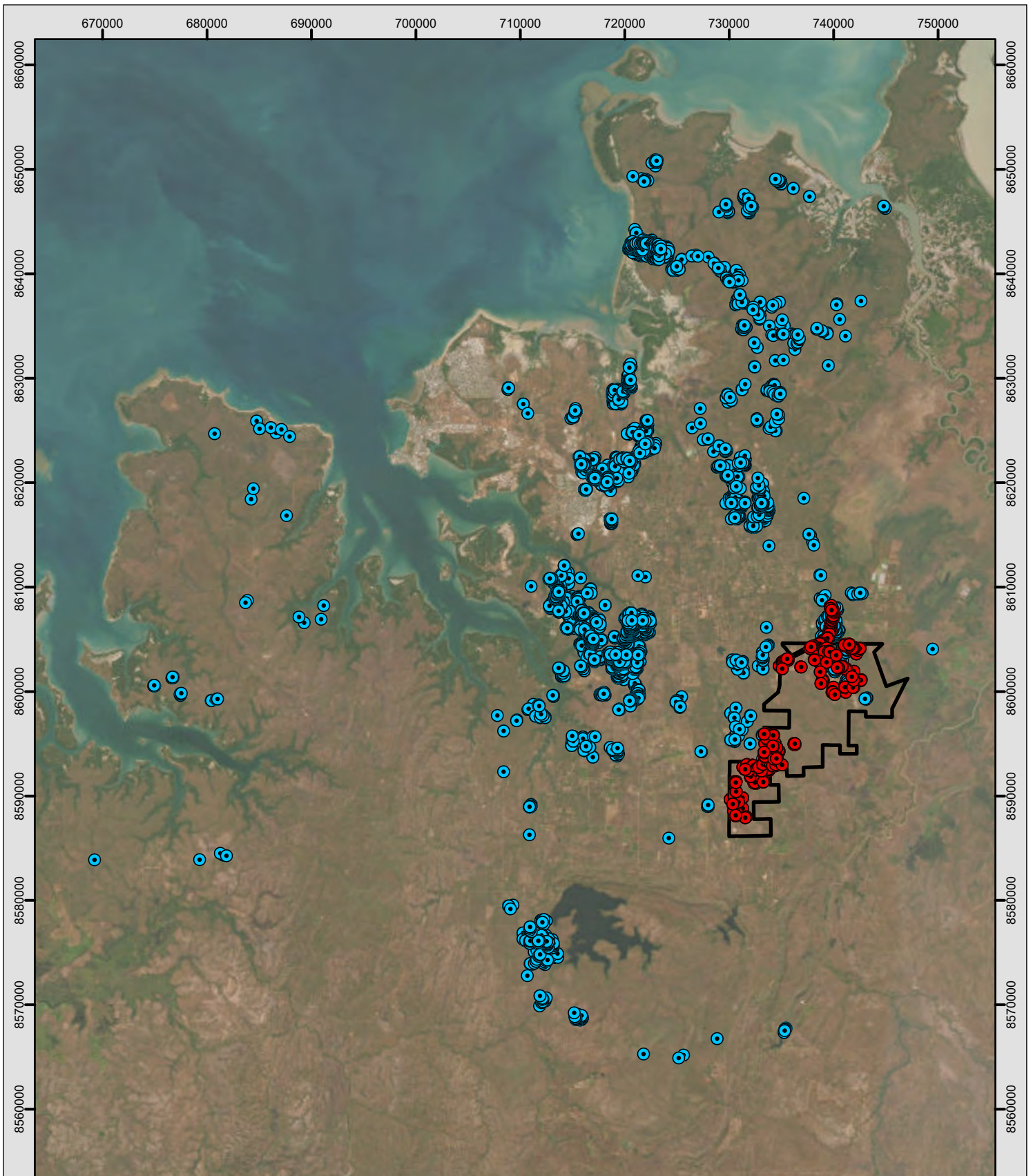


Figure 10-2. Map of extent of Howard River Toadlet



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Figure 10-3. Map of extent of *Cleome insolata*



Legend

- Study area
- Typhonium praetermissum (EcOz detection - Koolpinyah)
- Typhonium praetermissum (NT Flora Atlas)

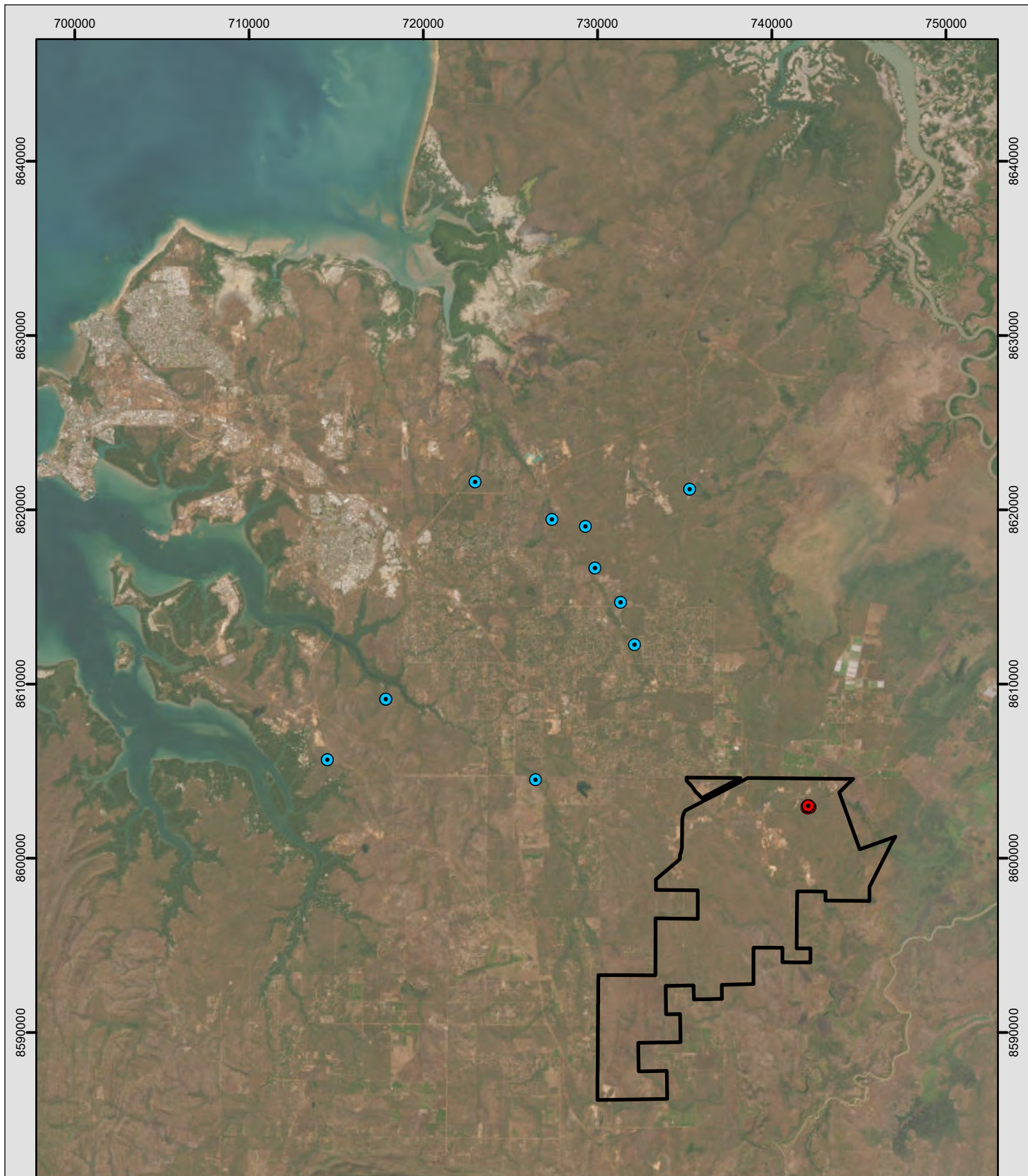
MAP INFORMATION

Scale: 1:500,000 @ A4
 Projection: GDA2020 MGA Zone 52
 Date Saved: 17/10/2025
 Client: Total Eren Australia H2 Pty Ltd
 Mapper: Elliot.Day

DATA SOURCE

Topographic data: OSM
 Project data: EcOz, NTG, TEH2
 Imagery: NTLIS

Figure 10-4. Map of extent of Typhonium praetermissum



- Legend**
- Study area
 - Utricularia dunstaniae (EcOz detection)
 - Utricularia dunstaniae (NT Flora Atlas)



MAP INFORMATION
 Scale: 1:300,000 @ A4
 Projection: GDA2020 MGA Zone 52
 Date Saved: 17/10/2025
 Client: Total Eren Australia H2 Pty Ltd
 Mapper: Elliot.Day
DATA SOURCE
 Topographic data: OSM
 Project data: EcOz, NTG
 Imagery: NTLIS

Figure 10-5. Map of extent of Utricularia dunstaniae (Greater Darwin)

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**APPENDIX A LAND UNIT GROUND-TRUTHING AND HABITAT
QUALITY ASSESSMENT REPORT**