Australia's National
Science Agency

GISERA | Gas Industry Social and Environmental Research Alliance

Note on Project Variation

The original scope of this project to identify drought refuges has been revised due to heavy rain and associated flooding taking advantage to capture information on important breeding sites of threatened or otherwise significant birds species.

The variation details and revised scope can be found by clicking here.

The original Project Order is provided in this document.

Australia's National
Science Agency

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Project Order

Short Project Title

Identifying drought refuges for terrestrial species in the Cooper Basin

Long Project Title	Finding and assessing habitat for threatened species in terrestrial environments of the Cooper Basin: the importance of drought refuges.
GISERA Project Number	B.10
Start Date	02/09/2024
End Date	30/06/2026
Project Leader	Chris Pavey

GISERA State/Territory

- [x] **Queensland**
- [ ] New South Wales
- [ ] Northern Territory
- [ ] South Australia
- [ ] Western Australia
- [ ] Victoria
- [ ] National scale project

Basin(s)

- [ ] Adavale
- [ ] Amadeus
- [ ] Beetaloo
- [ ] Canning
- [ ] Western Australia
- [ ] Carnarvon
- [ ] Clarence-Morton
- [x] **Cooper**
- [ ] Eromanga
- [ ] Galilee
- [ ] Gippsland
- [ ] Gloucester
- [ ] Gunnedah
- [ ] Maryborough
- [ ] McArthur
- [ ] North Bowen
- [ ] Otway
- [ ] Perth
- [ ] South Nicholson
- [ ] Surat
- [ ] Other (please specify)

GISERA Research Program

- [ ] Water Research
- [ ] Health Research
- [x] **Biodiversity Research**
- [ ] Social & Economic Research
- [ ] Greenhouse Gas Research
- [ ] Agriculture Research
- [ ] Land and Infrastructure Management Research
- [ ] Other (please specify)

1. Project Summary

Pastoralists, traditional owners, conservationists and the broader community all have a strong interest in ensuring the ongoing resilience of the Cooper Basin particularly its free-flowing rivers such as Cooper Creek. This concern is focused on potential impacts to the environment from onshore gas development because the Cooper is one of the most prospective sedimentary basins in Australia for development of unconventional gas resources (i.e. gas produced from shales, deep coals or tight sandstones) (Holland et al., 2020). The region, particularly its rivers and floodplains, support important environmental values including a rich biodiversity and populations of threatened species. The environment features dramatic changes in condition, described as boom-bust, that is driven by pulses in water availability and thus primary productivity. Dramatic variation in rainfall and river flows in the region produce alternating phases of boom and bust that are not predictable over time.

A key challenge in the Cooper Basin is to protect and maintain threatened species and their habitats for their continued survival and resilience through dry periods. This challenge is heightened by ongoing exploration and operation by the resource sector. Although areas of the Cooper Basin will be set aside from gas development, community concerns about protection of the natural environment remain. The dynamic nature of the Cooper Basin and its vast size means that it is essential to understand and identify what areas to protect in order to meet this challenge. Research in aquatic environments has focused on the role of waterholes as drought refuges. These are the locations within the region that provide habitat for aquatic organisms as the wider landscape dries. The protection of these sites is essential if aquatic species are to persist in the Cooper Basin.

This proposal outlines a program of research that seeks to apply the drought refuge concept to the terrestrial environments of the Cooper Basin. These are arguably the most important areas for nature conservation because without them, core species will not be able to persist i.e. they will die out during bust periods. While the location of freshwater refuges is well known and setback requirements from watercourses will protect them, this knowledge and management action does not exist for terrestrial environments. This is a shortcoming because major components of the biodiversity of the Cooper Basin occur in terrestrial environments. By identifying these important refuge areas, the project will provide invaluable information that can be used by the gas industry to avoid sites of conservation significance. Also, by developing habitat quality assessment criteria for several of these species it will facilitate site assessment by the industry. The project will combine desktop and field-based approaches to locate, assess the condition of, and manage habitat essential for ongoing persistence during the dry periods that dominate over time. The focal species will be a subset of those that are threatened or otherwise significant (endemic or near-endemic) within the Cooper Basin.

2. Project description

Introduction

The rivers and floodplains of the Cooper Basin are an iconic feature of outback Australia. Management of the region is complex; the basin is large including significant areas of Queensland and South Australia and a small section of New South Wales. The Cooper Basin as defined in the Geological and Bioregional Assessment (GBA) Program is about 130,000 km^2 in area, including 95,740 km^2 in Queensland and 34,310 km^2 in South Australia.

Oil and gas resources were first discovered in the Cooper Basin region in 1963 with over 50 years of conventional oil and gas production from the Cooper and overlying Eromanga geological basins. Exploration for and development of both conventional and unconventional gas resources in these basins continues today. Over 3,000 petroleum wells have been drilled. Recently, the Queensland government has announced moves to protect the riverine and floodplain environments of the Lake Eyre Basin, which overlaps the Cooper Basin region. Existing conventional production will be allowed to continue, but future development will be restricted with unconventional gas extraction ruled out (https://environment.des.qld.gov.au/management/policy-regulation/changes/protection-lake-eyre-basin-streams-watercourses). Existing production activities and any future developments will still have the potential for environmental impact, including in the terrestrial environments that surround the riverine and floodplain environments.

The resilience of the Cooper Basin is an important concern to a wide diversity of stakeholders in particular pastoralists, traditional owners, conservationists, and business owners that rely on nature-based tourism for their income. As an example, about 20,000 people made submissions to the most recent Lake Eyre Basin Consultation Regulatory Impact Statement (Queensland). There are diverse views regarding the future management of the Basin.

From an environmental perspective, the Cooper Basin is of national importance, and it is exceptional on a global scale. Cooper Creek has the most variable hydrological regime of any of the world's large rivers of comparable discharge (Puckridge et al. 1998). The floodplain of Cooper Creek is massive with an area of approximately 15,300 km^2 and a maximum width in excess of 60 km. The aquatic systems of the Cooper Basin are inhabited by a tremendous diversity of plants and animals and support a significant organic beef industry that depends on native pastures.

Scientific understanding of the functioning of the Cooper Basin has until now focused on the riverine and floodplain environments, particularly the aquatic systems of Cooper Creek. Rainfall in the Cooper Basin is both low (<500 mm) and amongst the most unpredictable anywhere across the globe (McMahon et al. 2008, van Etten 2009). The unpredictable rainfall combined with high rates of evaporation result in river systems experiencing extreme flow variability (Arthington and Balcombe 2012) resulting in dramatic boom-bust dynamics where floods are interspersed by long dry periods.

During bust periods, waterholes in rivers function as drought refuges for fish and other aquatic animals. The longer a drought lasts, the fewer waterholes are available in which aquatic species can persist. Of the 170 named waterholes in the channel country of Cooper Creek, 80 have been estimated to persist for 1 year without flow or rainfall and only five have been estimated to persist beyond 2 years (Bunn et al. 2006). The continued persistence of animal and plant populations in these waterholes, and thus the maintenance of at least a subset of waterholes during even the most extreme drought, is essential for aquatic species to continue to live in the Cooper Basin. Once rains come and flows return, river floods establish connectivity across the floodplain and reconnect waterholes thus redistributing aquatic species over the entire system.

This knowledge of ecological functioning of the aquatic environment has facilitated management actions where the condition of waterholes that act as drought refuges is of prime importance. In contrast, understanding of changes in the condition of land in the terrestrial environments of the Cooper Basin is poor. Likewise, the dependence of land condition on inputs from freshwater environments is not well understood. There are several prominent examples of terrestrial species that have a dependency on freshwater environments. As an example, the preferred habitat of the endangered grey grasswren, a terrestrial species, is dense areas of lignum and swamp canegrass. In turn these plants depend on periodic river flooding for persistence.

The study outlined here seeks to apply knowledge from aquatic environments to better manage terrestrial environments during natural gas exploration and development in the Cooper Basin. In particular, it seeks to transfer the concept of drought refuges from freshwater environments to the land and to develop this approach to better manage the land and its component biodiversity, particularly threatened and endemic species.

Prior Research

Boom-bust dynamics of aquatic species and the presence of drought refuges in the river channels and floodplains of Cooper Creek have been assessed in a range of previous research. The Cooperative Research Centre for Freshwater Ecology and the Australian Rivers Institute undertook a detailed examination of the location and function of aquatic refuges and of fish population dynamics in Cooper Creek (e.g. Bunn et al. 2006, Sheldon et al. 2010, Arthington and Balcombe 2012). The relationship between water flows and boom and bust dynamics of waterbirds in the Cooper Basin has been examined by Kingsford et al. (1999).

The role of waterholes as drought refuges has been studied more broadly in arid Australia within the Murray-Darling Basin. This research confirms that populations of fish and macroinvertebrates resist drought by using waterholes as drought refuges (Robson et al. 2011, Davis et al. 2013, Yu et al. 2022). Such drought refuges are rare; at a site in inland Queensland, waterholes made up only 11% of the riverine habitat (Marshall et al. 2021). The lower the number of waterholes that continue to function as drought refuges the greater the risk of regional extinctions of the species that depend on them

(Bond et al. 2015). After drought breaks with the return of flow, fish dispersal, reproduction and recruitment allow populations to recolonize denuded river reaches, making their regional populations resilient (Marshall et al. 2016, Marshall et al. 2021).

The presence of drought refuges in the terrestrial environment in arid Australia has been examined in a range of species of mammals (Pavey et al. 2014, 2017, Nano et al. 2019). The refuges are occupied throughout prolonged dry periods (that can occur for 80% or more of the time) because all ecological requirements of a species - food, shelter, mates, and predator protection – are met in the refuges. By contrast, while some or all elements may occur outside of the refuge, they are only intermittently available, for example after high rainfall or fire. The refuge areas then act as a source of animals when recolonisation occurs during and after subsequent productive periods. As animals breed and subsequently disperse from the drought populations, they occupy habitats and habitat patches outside of drought refuges and the regional population is re-established (Pavey et al. 2017).

Both the Bioregional Assessments (BA) and the Geological and Bioregional Assessments (GBA) programs have provided summaries of the natural values of the Cooper Basin including the presence of threatened species. The BA report came out in 2015 and it listed 18 taxa (species or subspecies) present within the Cooper Basin that were threatened (critically endangered, endangered or vulnerable) nationally under the *Environment Protection and Biodiversity Conservation Act (1999)*. Of these species, one was aquatic, the remainder terrestrial. The GBA listed 26 taxa as threatened nationally as of 2020 within the Cooper Basin. The list included plants, reptiles, birds and mammals. Six taxa were aquatic (birds and fish), the remainder terrestrial.

The GBA project undertook an impact and risk assessment for the Cooper Basin through a process of development of a causal network. Causal networks are graphical models that describe the cause-and-effect relationships between development activities and endpoints – the values to be protected. The GBA causal network consisted of 14 causal pathways – the logical chain of events that link unconventional gas resource development with potential impacts on water and the environment connecting hazards arising unconventional gas resource development activities with the values to be protected.

The biodiversity-rich Cooper GBA region provides potential habitat for 68 species protected under state or national legislation. The assessment prioritised 12 protected species (4 birds, 3 mammals and 5 plants) based on the importance of the Cooper GBA region to each species in order to better understand potential impacts of unconventional gas resource development on protected fauna and flora.

The causal network consisted of 22 environment-related endpoints including agricultural productivity, 4 key vegetation communities (dryland, floodplain, riparian and wetland), 9 protected areas and the 12 threatened species. Pathways of ‘potential concern’ between unconventional gas resource development activities and environment-related endpoints are primarily related to activities that

create a disturbance at the surface (transport of materials and equipment, civil construction, decommissioning and rehabilitation, and seismic acquisition). Potential impacts at the surface include contamination; reduced flooding; habitat degradation, fragmentation and loss; increased competition and predation; and mortality of native species.

Need & Scope

The community is deeply concerned about the potential impacts of unconventional gas development on the resilience of the Cooper Basin in particular its ongoing viability to support the organic beef industry, nature tourism based around free-flowing rivers such as Cooper Creek, and biodiversity conservation. This community concern has generated a range of assessments including the BA, GBA and the independent scientific report assessing development risks to free-flowing rivers in Lake Eyre Basin (Fielder et al. 2019).

While the GBA prioritized 12 species of flora and fauna that are threatened and occur in the Cooper Basin, no new information on the ecology, distribution or areas of key concern were identified in the program. Specifically, no onground work was undertaken to further knowledge. This is a significant gap for ongoing conservation of important species in the Cooper that the current project seeks to fill. In doing so it is prioritizing the habitat in dry periods to do so. This is reflected in one of the key recommendations from the independent scientific report assessing development risks to free-flowing rivers in Lake Eyre Basin (Fielder et al. 2019):

> *Protect and maintain threatened species and their habitats for their continued survival and resilience through dry periods.*

Research has shown that the habitats of species in arid landscapes during dry periods are often within drought refuges. Drought refuges need to be searched for and located before they can be protected and maintained. Within the Cooper Basin, understanding of drought refuges in freshwater environments is well established. By comparison, almost nothing is known on this subject for terrestrial species.

While the Queensland Government is restricting oil and gas resource development in the riverine and floodplain environments of the Lake Eyre Basin, resource development may continue in the terrestrial environments and potential impacts need to be managed. Identifying drought refuges will allow them to be appropriately managed and protected. Specifically, the drought refuges will be discrete sites across the landscape that once located can be communicated to the onshore gas industry to be excluded from development activities. This approach is working effectively on pastoral properties in central Australia i.e. location of threatened species refuges is communicated to property managers who avoid grazing in these locations.

Objective

The overall objective of the study is to obtain scientific understanding of the location, condition, and management of the habitat of species occupying terrestrial environments in the Cooper Basin. This information will be communicated to companies that possess the tenements where the refuges are located. The drought refuges identified in this project will be discrete sites in the landscape that are essential to conservation of species rather than desktop generated species distribution models or indexes of greenness or similar approaches. The information will be species-specific and will represent sites of importance. The study will focus on threatened and significant species, here defined as those not listed as threatened but for which the Cooper Basin is an important region (e.g. endemic or near-endemic to the Cooper Basin). The 12 priority threatened species from the GBA program will be the backbone of this list. However, it will also consider other significant species that are of importance to the community of the Cooper Basin.

The specific objectives of the study are to:

1. Use existing information to identify the potential location of drought refuges of focal threatened species.
2. Undertake field surveys at potential locations to confirm the presence of the target species.
3. Measure habitat attributes at each occupied drought refuge in order to quantify habitat condition.
4. Develop approaches for assessing habitat quality condition for each species that can be used by the gas industry when assessing potential sites and when monitoring habitat condition over time.

Methodology

The objectives of the project will be achieved by undertaking six discrete tasks each of which has a specific set of methods. The tasks and the methods are described below.

An important caveat. By definition, drought refuges only function as such during dry periods. The fieldwork described below is focussed on locating drought refuges. Because such dry periods dominate over time (80 to 90% of total time) there is a high likelihood of the fieldwork being undertaken when conditions are favourable. The length of the project should ensure that fieldwork can be undertaken when conditions are appropriate.

Task 1 will identify focal species of plants and animals within the Cooper Basin.

This task will involve the use of available reports, databases, and maps from the BA and GBA projects as well as national species databases. We will also consult with interested stakeholders within the community. The task will deliver a list of threatened and significant species in the Cooper Basin that

occupy terrestrial environments and are likely to depend on drought refuges for continued survival and resilience.

Task 2 will assemble and interrogate recent geospatial data of the focal species to identify important habitat during dry periods.

This task will focus on identifying locations that are potential drought refuges of the species assembled in task 1. It will do this through a multi-step desktop-based process. First, it will aggregate all records over the past 50 years of the focal species within the Cooper Basin into a database. Second, it will use climatological data from the BOM to identify periods of low rainfall (drought) for the Cooper Basin over the same time period. It will then focus only on the records of each of the focal species from drought periods (records from boom periods will be removed). The task will deliver information on the location of likely important habitat for the focal species during drought periods i.e. the location of potential drought refuges.

Task 3 will involve field surveys at potential drought refuges.

Fieldwork will be undertaken to locate populations of the target species in those locations identified as potential drought refuges. The field surveys will be undertaken at a time when each target species is known to be active and will use methods that are most appropriate for that species. Methods may involve the use of active searches for plants and reptiles, playback of calls for birds, and trapping and/or spotlighting for mammals. The task will deliver location data on drought refuges of each focal species.

Task 4 will measure habitat attributes of the drought refuges of each species.

A suite of habitat attributes will be measured at each drought refuge. Measurements will be taken of vegetation structure, floristics and condition, soil type and condition, and presence of threats. These measurements will be made at the sites as soon as possible after individuals of the target species have been located there. If LiDAR data are available for the sites these will be incorporated into the assessment. This task will deliver an assessment of habitat condition at each drought refuge.

Task 5 will develop a methodology for assessment of habitat quality condition for each species and for monitoring of habitat condition.

A methodology for habitat quality condition assessment will be developed for each species that aligns with the requirements of the Australian Government and with the Queensland Government's Modified Habitat Quality Assessment (MHQA) method. This methodology will be used to streamline the assessment process for future developments as needed.
In addition, a framework for ongoing monitoring of habitat condition at drought refuges will be developed. The framework will be general and will specify the key indicators that should be assessed and when.

Task 6 will see completion of reporting requirements

Preparation of a Final report for peer review via CSIRO's ePublish process and publication to the GISERA website.

Task 7 will communicate project objectives, progress and findings to stakeholders

Communication of project aims and results to broader stakeholder groups via fact sheets, newsletters and news articles, a video, scientific paper publication, and various presentations, with support from the GISERA Communication and Engagement Team.

3. Project Inputs

Resources and collaborations

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Christoph Pavey	100 days	Terrestrial ecology: threatened species, impact assessment, drought refuges, fauna survey.	30 years	CSIRO
Stewart MacDonald	85 days	Terrestrial ecology: fauna survey, habitat quality assessment, species distribution modelling.	15 years	CSIRO
Bruce Murray	35 days	Terrestrial and aquatic ecology: plant surveys, habitat quality assessment.	10 years	CSIRO
Stephanie Johnson	40 days	Geospatial analytics; field ecology.	7 years	CSIRO
Eric Vanderduys	50 days	Terrestrial ecology: fauna survey, GIS, species distribution modelling.	30 years	CSIRO

Subcontractors (clause 9.5(a)(i))	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Paul Holper	10 days	Scientific writing and editing	>20	Scientell
TBD – to develop a video or animation	3-5 days	Communication and visualization	5+ years	TBD

Technical Reference Group

The project will establish a Technical Reference Group (TRG) aimed at seeking peer-to-peer technical advice on contextual matters and to discuss research needs as well as outputs as the project progresses. The TRG will include the project leader and a group of different stakeholders as appropriate which may include:

- Traditional Owners - Mithaka Aboriginal Corporation, Wonkumarra People Native Title Claim
- Company representatives (Santos)
- Other relevant environmental groups (Desert Channels Queensland NRM, Lake Eyre Basin Scientific Advisory Panel)
- Technical expertise (from within CSIRO and the Qld Department of Environment, Science, and Innovation)
- Local government officials - Barcoo Shire Council, Quilpie Shire Council, Bulloo Shire Council

Budget Summary

Source of Cash Contributions	2023/24	2024/25	2025/26	2026/27	% of Contribution	Total
GISERA	$0	$143,653	$196,347	$0	63.21%	$340,000
- Federal Government	$0	$143,653	$196,347	$0	63.21%	$340,000
Total Cash Contributions	**$0**	**$143,653**	**$196,347**	**$0**	**63.21%**	**$340,000**

Source of In-Kind Contribution	2023/24	2024/25	2025/26	2026/27	% of Contribution	Total
CSIRO	$0	$83,594	$114,258	$0	36.79%	$197,852
Total In-Kind Contribution	**$0**	**$83,594**	**$114,258**	**$0**	**36.79%**	**$197,852**

TOTAL PROJECT BUDGET	2023/24	2024/25	2025/26	2026/27	-	TOTAL
All contributions	**$0**	**$227,247**	**$310,605**	**$0**	**-**	**$537,852**
TOTAL PROJECT BUDGET	**$0**	**$227,247**	**$310,605**	**$0**	**-**	**$537,852**

4. Communications Plan

Stakeholder	Objective	Channel (e.g. meetings/media/factsheets)	Timeframe (Before, during at completion)
Regional community stakeholders including landholders, traditional owners and wider public	To communicate project objectives, and key messages and findings from the research	A fact sheet at commencement of the project that explains in plain English the objectives of the project.	At project commencement
		Project progress reported on GISERA website to ensure transparency for all stakeholders including regional communities.	Ongoing
		Public release of final reports. Plain English fact sheet summarising the outcomes of the research.	At project completion
		Preparation of article for the GISERA newsletter and other media outlets as advised by GISERA's communication team.	At project completion
		Development of a short video on the project aims and outcomes	Following project completion
		Presentation/s about the project and on research findings where appropriate.	At completion or within 6 months of project completion.
Gas Industry & Government	To communicate the outcome of the project.	Project progress reporting (on GISERA website).	Ongoing
		Final project report and fact sheet.	At project completion
		Provision of geospatial data on the extent of drought refuges to relevant companies within gas industry (i.e., the holder of exploration license for each location).	Within 2 months of completion of task 3 (due on 28 February 2026).
		Habitat quality assessment methodologies for threatened species developed in this project provided to Australian government's Nature Positive Regulation Division within DCCEEW).	At project completion.
		Presentation of findings at joint gas industry/government Knowledge Transfer Session.	At project completion
		Dataset(s) available through CSIRO's data repository.	After completion of project
Scientific Community	Provide scientific insight into drought refuges in the Cooper Basin	Peer-reviewed scientific publication.	After completion of project
		Presentation of research results at an Australian and International Conference	After completion of project

In addition to project-specific communication activities, CSIRO's GISERA has a broader communication and engagement strategy. This strategy incorporates activities such as webinars, workshops, newsletters and development of other communication products.

5. Project Impact Pathway

Activities	Outputs	Short term Outcomes	Long term outcomes	Impact
Terrestrial biodiversity research focused on drought refuges of focal species.	• Compilation of spatial records of the focal species and alignment with boom and bust phases based on rainfall data • Databases of sites assessed and mapped • Final report. • Journal paper	• All stakeholders are informed of the location of drought refuges of the focal species. • Industry knowledge of high conservation value areas within their tenements (including geospatial data delimiting these areas). • Regulators and proponents have access to habitat quality assessment methodology for individual species.	• More efficient environmental impact assessment involving the focal species. • More efficient, less disruptive placement of gas industry infrastructure (avoiding drought refuges). • Better conservation trajectories for the focal species.	• Ongoing protection and scientific understanding of an important component of the environment of the Cooper Basin. • Contribution to Australia meeting its obligations under the Global Biodiversity Framework in relation to Goal A, target 1 (close to zero loss of areas of high biodiversity importance by 2030) and target 4 (halt human induced extinction of known threatened species).
Engagement with key stakeholders	• Factsheets and articles on GISERA website and in GISERA newsletter • Interactions with the project Technical Reference Group • Presentations to industry, government, academia and community stakeholders • Media engagement where appropriate, and video production for the GISERA website • Engagement with residents while undertaking fieldwork	• Community and other stakeholders aware of the existence and importance of drought refuges within the Cooper.		

6. Project Plan

Project Schedule

ID	Activities / Task Title (should match activities in impact pathway section)	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Identify focal plants and animals	Chris Pavey	2 September 2024	24 December 2024	Nil.
Task 2	Desktop delineation of potential refuge habitat	Stewart MacDonald & Stephanie Johnson	2 January 2025	28 March 2025	Task 1
Task 3	Field surveys of potential refuges	Chris Pavey	31 March 2025	28 February 2026	Tasks 1 and 2
Task 4	Measure refuge attributes	Chris Pavey	1 May 2025	30 April 2026	Tasks 1, 2, 3
Task 5	Habitat quality assessment methodology	Chris Pavey	1 March 2026	30 June 2026	Tasks 3 and 4
Task 6	Project reporting	Chris Pavey	2 September 2024	30 June 2026	Will vary with type of reporting
Task 7	Communicate findings to stakeholders	Chris Pavey	2 September 2024	30 June 2026	Will vary with timing of communications

Task description

Task 1: Identify focal species of plants and animals

OVERALL TIMEFRAME: 4 months (2 September 2024 - 24 December 2024)

BACKGROUND: The GBA prioritised 12 threatened species (4 birds, 3 mammals, 5 plants) as the focus of causal pathway assessment. However, other endemic or near-endemic species to the Cooper Basin may be valued by the community. Of these 2 groups of species only a subset will be chosen to focus on in this project. The species chosen will be those expected to occupy drought refuges and that will occur within areas of high prospectivity for onshore gas development.

TASK OBJECTIVES: To examine existing reports and consult with interested stakeholders to develop a list of threatened and significant species in the Cooper Basin that occupy terrestrial environments and are likely to depend on drought refuges for continued survival and resilience.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A list of target focal species that will be the basis of the remaining tasks for the project.

There are no other specific deliverables for this task; however, the methods and outcomes will be discussed in the final report for the project.

Task 2: Assess geospatial data on the focal species to identify important habitat during dry periods

OVERALL TIMEFRAME: 3 months (2 January 2025 - 28 March 2025)

BACKGROUND: A range of databases hold location records of the focal species that will be determined in task 1. Most of these data have not been systematically collected and none have been interrogated with the aim of obtaining the location of drought refuges. Most species in the study area occur widely during wet (boom) periods when primary productivity is high. In contrast, records during the long intervening dry periods are rarer. Database searches will be carried out to identify those sites that are only occupied during dry periods. This will be done by accessing historical rainfall data and determining the occurrence of dry periods. Records during wet periods will be filtered out of the search for each species. This will produce information of potential drought refuges of each of the focal species.

TASK OBJECTIVES: To obtain information on the geospatial locations that are potentially drought refuges of each of the target species.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A database that for each of the focal species has the locations of potential drought refuges within the study area. The results will be discussed in the final report for the project.

There are no specific deliverables for this task; however, mapping outputs will be used in subsequent tasks.

Task 3: Undertake field surveys of potential drought refuges of focal species.

OVERALL TIMEFRAME: 11 months (31 March 2025 - 28 February 2026)

BACKGROUND: The desktop assessment in task 2 will identify the geospatial location of a number of potential drought refuges for each species. Field surveys in each location are needed to determine whether the species is present. These need to be undertaken during periods of low primary productivity (dry periods), hence the long duration of this task. The study design will include multiple visits to each location. Surveys will be undertaken using methods that are appropriate for the target species at each location. These methods will vary and depend on the composition of the final list of focal species but are likely to include active searches, call playback, trapping and spotlighting.

TASK OBJECTIVES: To undertake field surveys to determine whether the target species is currently occupying each of the potential drought refuges.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Knowledge of the location of drought refuges of focal species within the study area in the Cooper Basin.

A specific deliverable will be geospatial data on the spatial extent of each drought refuge identified during this task. These data will be supplied to the company that is the holder of the exploration licence for each location.

Task 4: Measure habitat attributes and assess habitat condition of drought refuges.

OVERALL TIMEFRAME: 12 months (1 May 2025 - 30 April 2026)

BACKGROUND: To facilitate future efforts to find the focal species, especially during environmental assessments for onshore gas development, it is important to characterise the key components of the drought refuges for each species that are identified in task 3. At each drought refuge a range of environmental variables will be measured including:

- structural and floristic components of the vegetation;
- soil type and condition;
- fire history; and
- disturbance regime including presence of potential threats.

This will enable common features of drought refuges to be recognised and will assist in future survey work. These measurements should be taken as soon as possible after the target species is located at a site.

TASK OBJECTIVES: There are two objectives as follows:

- To determine common features of the drought refuges of each focal species and, thus, to build a model of how to identify drought refuges of that species; and
- To assess habitat condition at each individual drought refuge.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: The main output from this task will be a detailed description of the characteristics of the drought refuges of each focal species.

Task 5: Develop a methodology for assessment of habitat quality condition at drought refuges for each focal species.

OVERALL TIMEFRAME: 4 months (1 March 2026 - 30 June 2026)

BACKGROUND: Habitat quality assessment is integral to assessing both environmental impacts from a proposed development and the suitability of offset proposals. While existing, established methodologies exist for some species, the majority of threatened species prioritised in the GBA Cooper assessment are not adequately accounted for by existing habitat assessment methods. The Environment Assessment branch of the Australian Government's Department of Climate Change, Energy, the Environment and Water (DCCEEW) acknowledges that this results in protracted negotiations with proponents and suboptimal environmental outcomes.

Given that the majority (probably all) of the focal species to be selected in task 1 of this project will not be accounted for by existing habitat assessments and the need for this information for both proponents and regulators of the onshore gas industry, this task has been added to here.

TASK OBJECTIVES: To produce a habitat quality assessment methodology, focussed on dry period habitat, for each focal species covered in this project that is also listed nationally as threatened. In other words, the methodology will be written for each species that could trigger a referral under the *Environment Protection and Biodiversity Conservation Act* (EPBCA).

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A series of habitat quality assessment methodologies prepared at a sufficient level of detail to be submitted for potential use to the Australian Government (Environment Assessment Queensland branch, Nature Positive Regulation Division, DCCEEW).

Task 6: Project Reporting

OVERALL TIMEFRAME: Full duration of the project (2 September 2024 – 30 June 2026)

BACKGROUND: All aspects of reporting are covered in this task.

TASK OBJECTIVES: To provide the necessary reporting as required.

TASK OUTPUTS AND SPECIFIC DELIVERABLES:

1) Preparation of a final report outlining the scope, methodology, scenarios, assumptions, findings and any suggestions/options for future research;

2) Following CSIRO ePublish review, the report will be submitted to the GISERA Director for final approval; and

3) Provide 6 monthly progress updates to GISERA office.

Task 7: Communicate project objectives, progress and findings to stakeholders.

OVERALL TIMEFRAME: Full duration of project (2 September 2024 – 30 June 2026)

BACKGROUND: Communication of GISERA's research is an important component of all research projects. The dissemination of project objectives, key findings and deliverables to relevant and diverse audiences allows discourse and decision making within and across multiple stakeholder groups.

TASK OBJECTIVES: Communicate project objectives, progress and findings to stakeholders through meetings, Knowledge Transfer Session, fact sheets, project reports and journal article/s, in collaboration with GISERA Communication Team.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Communicate project objectives, progress and results to GISERA stakeholders according to standard GISERA project procedures, which may include, but are not limited to:

1) Engagement with an established Technical Advisory Group.
2) Two project factsheets: A fact sheet will be developed at commencement of a project, and another that will include peer-reviewed results and implications will be developed at completion of project. Both to be published to the GISERA website.
3) Preparation of an article for GISERA newsletter and other media outlets as advised by GISERA's communications team.
4) Project reporting.
5) Knowledge Transfer session with Government/Gas Industry.
6) Peer reviewed scientific manuscript ready for submission to relevant journal.
7) Presentation of research results at an Australian and International Conference.
8) Development of project-specific communication tool, where appropriate.

Project Gantt Chart

Task	Task description	2024-25										2025-26											
		Sep 24	Oct 24	Nov 24	Dec 24	Jan 25	Feb 25	Mar 25	Apr 25	May 25	Jun 25	Jul 25	Aug 25	Sep 25	Oct 25	Nov 25	Dec 25	Jan 26	Feb 26	Mar 26	Apr 26	May 26	Jun 26
1.	Identify focal plants and animals																						
2.	Desktop delineation of potential refuge habitat																						
3.	Field surveys of potential refuges																						
4.	Measure refuge attributes																						
5.	Habitat quality assessment methodology																						
6.	Project reporting																						
7.	Communicate findings to stakeholders																						

7. Budget Summary

Expenditure	2023/24	2024/25	2025/26	2026/27	Total
Labour	$0	$212,747	$252,605	$0	$465,352
Operating	$0	$14,500	$48,000	$0	$62,500
Subcontractors	$0	$0	$10,000	$0	$10,000
Total Expenditure	**$0**	**$227,247**	**$310,605**	**$0**	**$537,852**

Expenditure per task	2023/24	2024/25	2025/26	2026/27	Total
Task 1	$0	$15,728	$0	$0	$15,728
Task 2	$0	$40,836	$0	$0	$40,836
Task 3	$0	$142,750	$191,993	$0	$334,743
Task 4	$0	$18,228	$50,093	$0	$68,321
Task 5	$0	$0	$33,483	$0	$33,483
Task 6	$0	$3,882	$9,014	$0	$12,896
Task 7	$0	$5,823	$26,022	$0	$31,845
Total Expenditure	**$0**	**$227,247**	**$310,605**	**$0**	**$537,852**

Source of Cash Contributions	2023/24	2024/25	2025/26	2026/27	Total
Federal Govt (63.21%)	$0	$143,653	$196,347	$0	$340,000
Total Cash Contributions	**$0**	**$143,653**	**$196,347**	**$0**	**$340,000**

In-Kind Contributions	2023/24	2024/25	2025/26	2026/27	Total
CSIRO (36.79%)	$0	$83,594	$114,258	$0	$197,852
Total In-Kind Contributions	**$0**	**$83,594**	**$114,258**	**$0**	**$197,852**

	Total funding over all years	Percentage of Total Budget
Federal Government investment	$340,000	63.21%
CSIRO investment	$197,852	36.79%
Total Expenditure	**$537,852**	**100%**

Task	Milestone Number	Milestone Description	Funded by	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year Completed	Payment $ (excluding CSIRO contribution)
Task 1	1.1	Identify focal plants and animals	GISERA	Sept-24	Dec-24	2024/25	$9,942
Task 2	2.1	Desktop delineation of potential refuge habitat	GISERA	Jan-25	Mar-25	2024/25	$25,814
Task 3	3.1	Field surveys of potential refuges	GISERA	Mar-25	Feb-26	2025/26	$211,606
Task 4	4.1	Measure refuge attributes	GISERA	May-25	Apr-26	2025/26	$43,189
Task 5	5.1	Habitat quality assessment methodology	GISERA	Mar-26	Jun-26	2025/26	$21,166
Task 6	6.1	Project reporting	GISERA	Sept-24	Jun-26	2025/26	$8,152
Task 7	7.1	Communicate findings to stakeholders	GISERA	Sept-24	Jun-26	2025/26	$20,131

8. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
				$
				$
Ownership of Non-Derivative IP (clause 12.3)	CSIRO			
Confidentiality of Project Results (clause 15.6)	Project Results are not confidential.			
Additional Commercialisation requirements (clause 13.1)	Not Applicable			
Distribution of Commercialisation Income (clause 13.4)	Not applicable			
Commercialisation Interest (clause 13.1)	**Party**		**Commercialisation Interest**	
	CSIRO		N/A	

9. References

Arthington, A. H., and Balcombe, S. R. 2011. Extreme flow variability and the 'boom and bust' ecology of fish in arid-zone floodplain rivers: a case history with implications for environmental flows, conservation and management. Ecohydrology 4: 708–720.

Bond, N. R., Balcombe, S. R., Crook, D. A., Marshall, J. C., Menke, N. and Lobegeiger, J. S. 2015. Fish population persistence in hydrologically variable landscapes. Ecological Applications 25: 901–913.

Bunn, S. E., Thoms, M. C., Hamilton, S. K. and Capon, S. J. 2006. Flow variability in dryland rivers: boom, bust and the bits in between. River Research and Applications, 22: 179–186.

Davis, J., Pavlova, A., Thompson, R. and Sunnucks, P. 2013. Evolutionary refugia and ecological refuges: key concepts for conserving Australian arid zone freshwater biodiversity under climate change. Global Change Biology 19: 1970–1984.

Fielder, D. P., Grady, S. G. and Broadbent, L. M. 2019. Assessing development risks to the ecological values of the free flowing rivers of Kati Thanda-Lake Eyre Basin (Qld). An Independent Scientific Expert Panel Report prepared for the Department of Environment and Science, Queensland Government, Brisbane.

Holland, K. L., Brandon, C., Crosbie, R. S. et al. 2021. Impact assessment for the Cooper GBA region. Geological and Bioregional Assessment Program: Stage 3 synthesis. Department of Agriculture, Water and the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

Marshall, J. C., Menke, N., Crook, D. A., Lobegeiger, J. S., Balcombe, S. R., Huey, J. A., et al. 2016. Go with the flow: the movement behaviour of fish from isolated waterhole refugia during connecting flow events in an intermittent dryland river. Freshwater Biology 61: 1242–1258.

Marshall, J. C., Lobegeiger, J. S. and Starkey, A. 2021. Risks to fish populations in dryland rivers from the combined threats of drought and instream barriers. Frontiers in Environmental Science 9: 671556.

McMahon, T. A., Murphy, R. E., Peel, M. C., Costelloe, J. F. and Chiew, F. H. S. 2008. Understanding the surface hydrology of Lake Eyre Basin: Part 1—Rainfall. Journal of Arid Environments 72: 1853-1868.

Nano, C. E. M., Randall, D. J., Stewart, A. J., Pavey, C. R. and McDonald, P. J. 2019. Bottom-up drivers of central rock-rat (*Zyzomys pedunculatus*) site occupancy: floristic gradients and 'boom-bust' ecosystem stochasticity help explain the short-term colonization dynamics of an endangered desert rodent. Austral Ecology 44: 838-849.

Pavey, C. R., Addison, J., Brandle, R., Dickman, C. R., McDonald, P. J., Moseby, K. and Young, L. I. 2017. The role of refuges in the persistence of Australian dryland mammals. Biological Reviews 92: 647-668.

Pavey, C. R., Cole, J. R., McDonald, P. J. and Nano, C. E. M. 2014. Population dynamics and spatial ecology of a declining desert rodent *Pseudomys australis*: the importance of refuges for persistence. Journal of Mammalogy 95: 615-625.

Puckridge J.T., Sheldon F., Walker K.F. & Boulton A.J. 1998. Flow variability and the ecology of large rivers. Marine and Freshwater Research 49: 55–72.

Robson, B. J., Chester, E. T. and Austin, C. M. 2011. Why life history information matters: drought refuges and macroinvertebrate persistence in non-perennial streams subject to a drier climate. Marine and Freshwater Research 62: 801.

Sheldon F., Bunn S.E., Hughes J.M., Arthington A.H., Balcombe S.R. & Fellows C.S. 2010. Ecological roles and threats to aquatic refugia in arid landscapes: dryland river waterholes. Marine and Freshwater Research, 61, 885–895.

Van Etten, E. J. B. 2009. Inter-annual rainfall variability of arid Australia: greater than elsewhere? Australian Geographer 40:109–120.

Yu, S., Rose, P.M., Bond, N.R., Bunn,S.E. and Kennard, M.J. 2022. Identifying priority aquatic refuges to sustain freshwater biodiversity in intermittent streams in eastern Australia. Aquatic Conservation: Marine and Freshwater Ecosystems 32: 1584–1595.