



Australia's National
Science Agency



Parabathynellidae; a type of crustacean
found during the current research.

GROUND AND SURFACE WATERS

GISERA | Gas Industry Social and Environmental Research Alliance

Examination of stygofauna ecosystems of the Beetaloo Sub-basin

CSIRO scientists have completed a project investigating the distribution and ecology of stygofauna in the groundwater aquifers of the Beetaloo Sub-basin.

Key points

- This project has significantly improved knowledge of stygofauna diversity and species composition within the Beetaloo Sub-basin.
- This improved understanding provides a scientific basis for assessing potential impacts associated with above-ground development.
- Any activities that change the physical or chemical condition of aquifers in the Beetaloo Sub-basin may threaten persistence and distribution of stygofauna species.
- This work builds knowledge of effective sampling techniques for surveying stygofauna and highlights strengths and weaknesses of different sampling approaches.
- Detection success of stygofauna varies by method; video and net sampling have limitations, while eDNA offers promising insights but requires further refinement to improve reliability. No method alone ensured 100% detection accuracy.
- Video evidence confirmed that stygofauna, particularly shrimp, are primarily associated with cavities and screened bore sections with suitable openings for movement.

This project, conducted through CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA), improves our understanding of stygofauna communities across the Beetaloo Sub-basin.

Stygofauna are tiny animals that live in groundwater systems or aquifers. They are important as a biodiversity resource, an indicator of groundwater ecosystem health, and potential providers of ecosystem services such as nutrient cycling.

Studying these communities is essential for advancing our understanding of groundwater ecology, the health of aquatic ecosystems, and the impacts of human activities on water resources in unique environments like the Beetaloo Sub-basin.

For this project, groundwater bores within the Beetaloo Sub-basin were sampled across three surveys:

- October 2022 (pre-wet season)
- July–September 2023 (dry season)
- April–May 2024 (post-wet season)

Sampling targeted 45 bores across the Tindall Limestone of the Daly Basin, the Anthony Lagoon Formation, and the Gum Ridge Formation of the Georgina Basin, with a mix of cased and non-cased bores.

Of the 45 targeted bores, 33 were successfully surveyed for water quality, nutrients, microbial community structure, and stygofauna diversity.

Results of these studies are important for informing appropriate policy and management responses to onshore gas and other development proposals.



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The Beetaloo Sub-basin

The Beetaloo Sub-basin lies southeast of Katherine in the Northern Territory and spans approximately 30,000 square kilometres. The estimated gas resources for the Beetaloo sub-basin are of similar size to other major gas producing basins in Australia, such as the Surat Basin in Queensland and the Bonaparte/Browse basins in Western Australia.

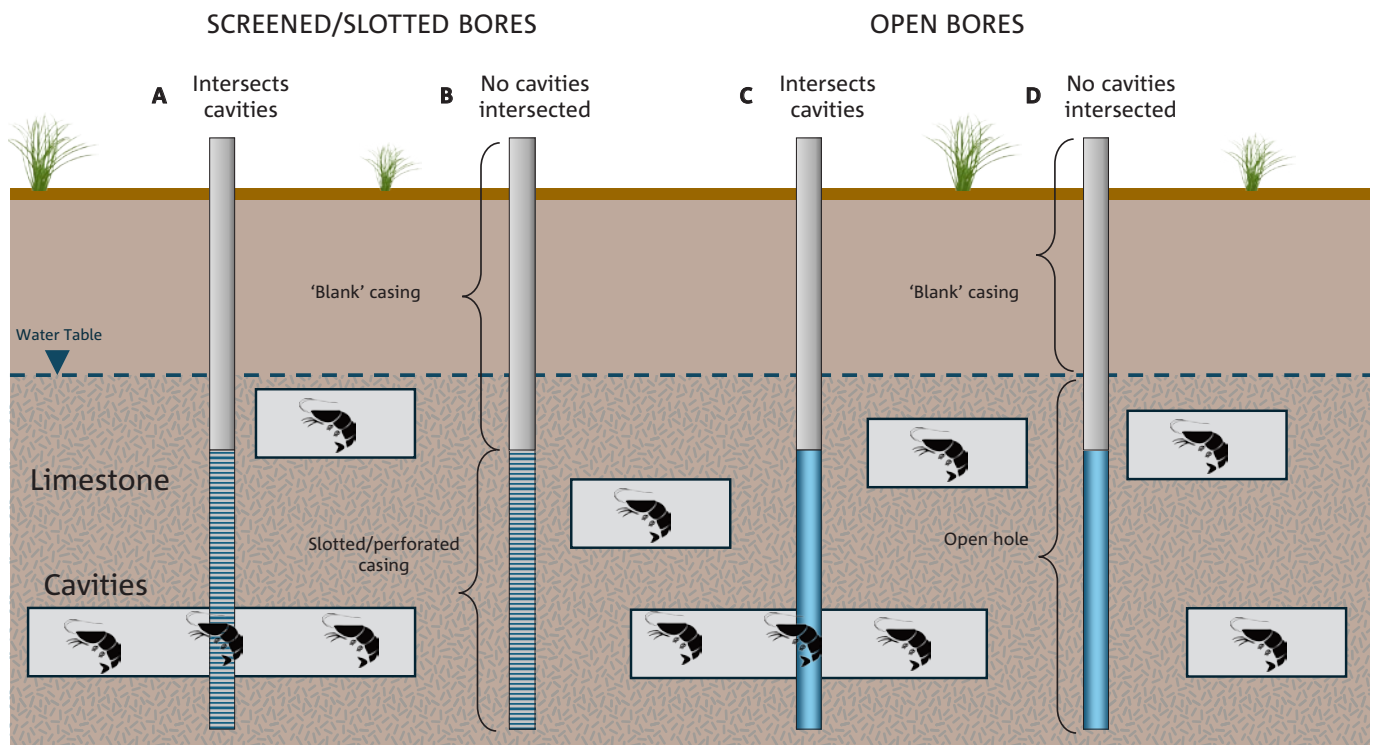
The Cambrian Limestone Aquifer (CLA) system is the major aquifer in the Beetaloo Sub-basin with important cultural, environmental and economic values.

Assessing potential risks to stygofauna from gas development activities in the Northern Territory requires detailed knowledge of the stygofauna present and their distribution within the aquifers.

The Beetaloo Sub-basin's unique geological formations and climatic conditions have shaped the evolution and adaptation of stygofauna. Studying these organisms is essential for biodiversity conservation and water resource management.



Use of fine mesh nets in some wells were successful in capturing stygofauna, which were transferred to holding jars.



Video evidence confirmed that stygofauna, particularly shrimp, are primarily associated with cavities and screened bore sections with suitable openings for movement.

Addressing key knowledge gaps

The development of onshore gas activities in the Northern Territory has highlighted significant gaps in our knowledge and understanding of groundwater ecosystems in regions impacted by these activities.

CSIRO began to address these gaps in 2019, when researchers conducted a pilot-scale study of stygofauna communities in the aquifers of the Beetaloo Sub-basin. This revealed that aquifers in the Beetaloo Sub-basin support a diverse range of stygobitic species – those species that exclusively inhabit groundwater and are believed to be relics of surface biota.

The pilot study was followed by a more extensive baseline study, conducted as part of the Strategic Regional Environmental and Baseline Assessment (SREBA) in 2022.

This latest research builds on both previous studies, using a complementary approach and data to:

- define the environmental conditions that drive the extent and distribution of stygofauna assemblages across the Beetaloo Sub-basin
- develop an understanding of the ecology of the environment that supports stygofauna in subterranean groundwater
- understand how stygofauna may be impacted by onshore petroleum activities and implications for management and monitoring.

Extent and distribution

Key insights into the environmental conditions influencing the extent and distribution of stygofauna assemblages include:

- The occurrence of stygofauna within bores appears to be driven by geology and the intersection of bores with cavities.
- The presence of cavities was the strongest indicator of the likely occurrence of stygofauna in a given bore.
- Water chemistry as a means of predicting the presence of stygofauna was limited due to the overall similarity of water chemistry across the region's bores.



The shrimp *Parisia unguis* is an apex predator within Beetaloo stygofauna communities. At 10mm to 20mm it truly is the monster in the dark. Results reveal genetically distinct populations across the Beetaloo Sub-basin.



The CSIRO stygofauna research team in the field (l to r) Daryl Nielsen, Gavin Rees and project lead Paul McInerney.

Ecology of stygofauna-supporting environments

This project reinforced the findings of previous studies, confirming that stygobitic communities in the Beetaloo Sub-basin are dominated by crustaceans.

Additional findings included:

- Bore characteristics, year of collection and geography significantly influence microbial community structure. However, geographical distance did not necessarily predict different communities, suggesting local influences.
- Video analysis revealed that larger stygofauna such as shrimp were only observed near or within cavities.
- Net, video and eDNA-based sampling each have unique strengths and limitations for detecting stygofauna. eDNA methods are an area of active research, and are expected to improve with further application.
- For the shrimp *Parisia unguis* results reveal genetically distinct populations within the Beetaloo Sub-basin, with minimal overlap occurring between two of the sampled populations. This suggests that although some populations are genetically distinct, some gene flow is still evident among populations. Further sampling is required to better understand gene flow between *Parisia unguis* populations.

Further study and monitoring

While some knowledge gaps remain – particularly regarding stygofauna food webs and energy pathways – the study has improved understanding of the environmental conditions that sustain these communities.

Activities that alter the physical or chemical conditions of aquifers in the Beetaloo Sub-basin may pose risks to stygofauna species. These findings highlight the importance of ongoing monitoring to safeguard groundwater ecosystems.

More information

Read more [about this project](#)

[Watch the CSIRO stygofauna explainer video](#)

Learn about [other GISERA research in the Northern Territory](#)



Beetaloo stygofauna include tiny crustaceans – this *Parabathynellidae* species is around 1.5mm.

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GISERA is a collaboration between CSIRO, Commonwealth and state governments and industry established to undertake publicly-reported independent research. The purpose of GISERA is to provide quality assured scientific research and information to communities living in gas development regions focusing on social and environmental topics including: groundwater and surface water, greenhouse gas emissions, biodiversity, land management, the marine environment, and socio-economic impacts. The governance structure for GISERA is designed to provide for and protect research independence and transparency of research.