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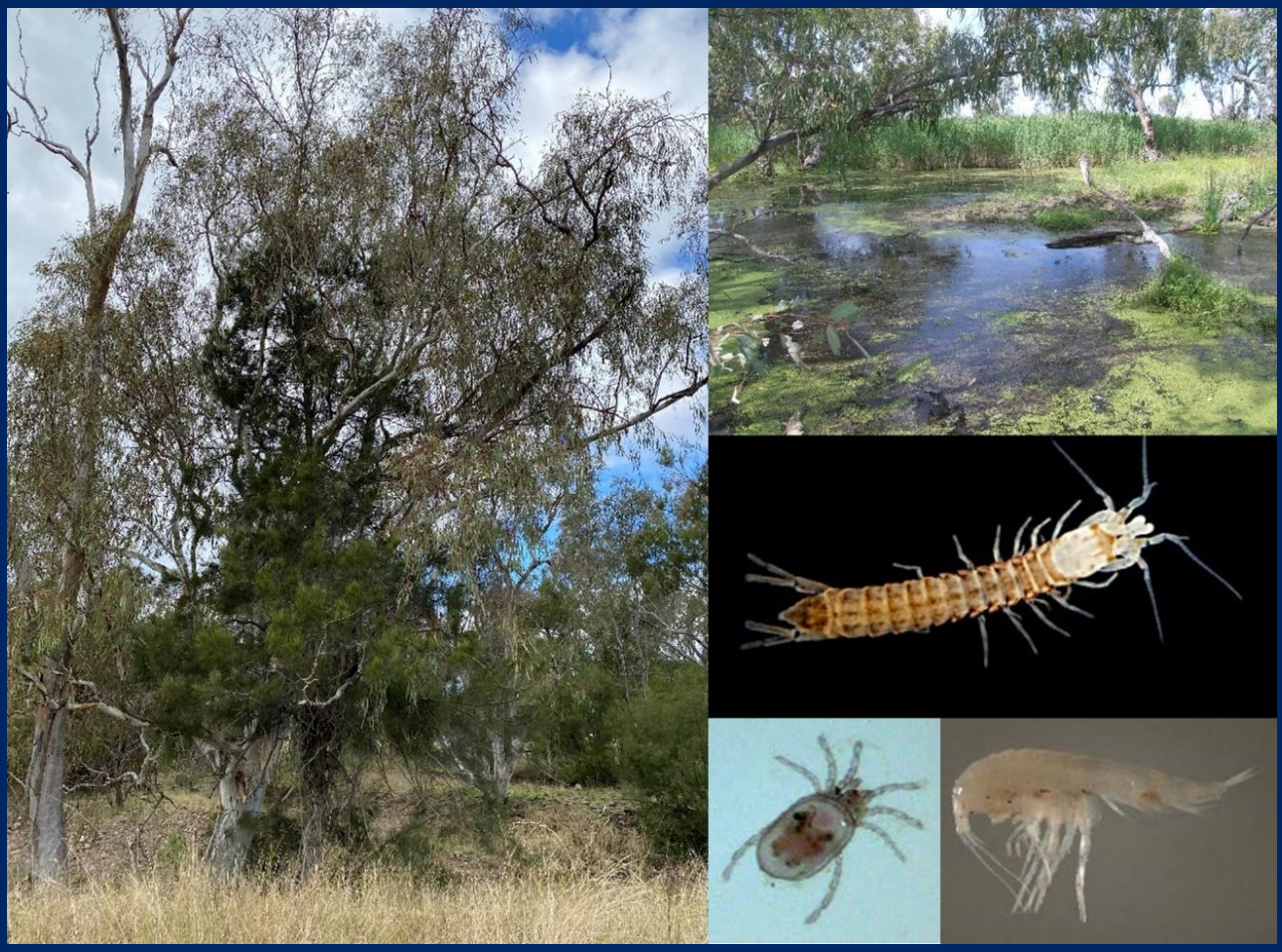
NSW GOVERNMENT

Groundwater dependent ecosystems

Environmental Outcomes Monitoring and Research Program Annual Report 2021-2022



Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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More information

This work was completed by the Surface Water Science unit of NSW Department of Planning and Environment. Please visit our website for more information.

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Contents

Abbreviations and Acronyms

	Description
Basin Plan	Murray-Darling Basin Plan 2012
BWS	Basin-wide Environmental Watering Strategy
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
DPE- EHG	New South Wales Department of Planning and Environment – Environment and Heritage Group
DPE-Water	New South Wales Department of Planning and Environment – Water Group
DPI Fisheries	NSW Department of Primary Industries Fisheries
EOMRP	Environmental Outcomes Monitoring and Research Program
EWRs	Environmental Watering Requirements
Flow MER	CEWO Environmental Water MER program
FMP	Floodplain Management Plan
FPH	Floodplain harvesting
GDE	Groundwater Dependent Ecosystems
HEVAE	High Ecological Value Aquatic Ecosystems
LTWPs	Long Term Water Plans
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MER	Monitoring, evaluation and reporting
NMDB	Northern Murray-Darling Basin
NRAR	Natural Resources Access Regulator
NRC	Natural Resources Commission
NSW	New South Wales
TEC	Threatened Ecological Community under the *NSW Biodiversity Conservation Act 2016*
SDL	Sustainable Diversion Limit
WMA	Water Management Act 2000 (NSW)
WRP	Water resource plan
WSP	Water sharing plan

Monitoring groundwater dependent ecosystems

River red gum forest in the Macquarie Marshes. Photo credit: Sharon Bowen

What are groundwater dependent ecosystems?

Groundwater dependent ecosystems (GDEs) are 'ecosystems that need access to groundwater to meet all or some of their water requirements to maintain their communities of plants and animals, their ecological processes and ecosystem services' (NSW DPE 2023). The dependence of GDEs on groundwater varies from seasonal or episodic, to continual (Howe et al. 2007). GDEs can range in size from a few metres to many square kilometres.

GDEs can be grouped into three broad types (Eamus et al. 2006; Richardson et al. 2011):

1. Groundwater dependent vegetation (also referred to as terrestrial GDEs), are ecosystems that depend on the sub-surface presence of groundwater, often accessed via the capillary fringe or vadose zone (that is, the subsurface water just above the water table that is not completely saturated) (Naumburg et al. 2005; Eamus et al. 2006a). Plant species within a community may exhibit differing degrees of groundwater dependency (Hatton and Evans 1998) and can range from being entirely dependent on the groundwater to partial or infrequent dependency (Zencich et al. 2002; Eamus et al. 2006; Froend and Drake 2006).

2. Aquatic GDEs, are environments where the groundwater meets the surface such as rivers, wetlands and springs. These GDEs are considered dependent on groundwater if the presence of groundwater is essential to the biota and ecological processes of that wetland at some stage of their life span (Howe et al. 2007).
3. Subterranean GDEs are those that occur in saturated zones of an aquifer. These include water-filled voids in a variety of geological matrices such as karst (caves), fractured rock and alluvial ecosystems. They also include 'hyporheic' ecosystems that occur in the sediments of surface waters and form an ecotone between surface and groundwater ecosystems (Hose et al. 2022).

Why are we monitoring groundwater dependent ecosystems?

The condition of GDEs are dependent upon access to groundwater. That access can be influenced by water management decisions such as changed surface water flow regimes, groundwater recharge, groundwater drawdown, and groundwater quality. Hence, understanding the location, extent and condition of GDEs is essential for surface and groundwater water planning and management. This information allows the Department of Planning and Environment - Water (the department) to consider and protect the needs of ecosystems dependent on groundwater when making resource management decisions and developing plans to share water between people and the environment.

Report purpose

The 2021-22 Annual Report for the groundwater dependent ecosystem theme (this document) outlines completed activities and their findings under the Environmental Outcomes Monitoring and Research Program (EOMRP) between July 2021 and June 2022.

This annual report is one of a set of 5 different themes for the EOMRP. The themes are:

1. Floodplain connectivity and inundation
2. Ecological processes
3. Water dependent native vegetation
4. Water dependent fauna
5. Groundwater dependent ecosystems (this report).

The EOMRP delivers information annually to meet several requirements. These include NSW reporting obligations under the Basin Plan Schedule 12, performance indicator research, data collection and analysis to inform and evaluate water sharing plans and floodplain management plans, to contribute to the NSW River Condition Index (RCI) tool, the High Ecological Value Aquatic Ecosystems (HEVAE) spatial layer, and the NSW State of the Environment Reports.

The EOMRP projects are staged over several years, building knowledge about water dependent ecosystems and their responses to water management plans, actions and decisions. For further

information about the EOMRP see the EOMRP website. Technical reports for each research project will be published separately and made available on the department's website.

The EOMRP was designed to implement the NSW Water Management Monitoring, Evaluation and Reporting (MER) framework (DPIE Water 2020) which addressed Basin Plan requirements. The EOMRP was extended in 2022 to cover coastal and non-Basin areas. A new framework designed specifically for the evaluation of all NSW water sharing plans is in development. The department is undertaking this work in response to the Natural Resources Commission (NRC) findings and recommendations about the way we monitor, evaluate, and report information about water sharing plan outcomes.

Report structure

The GDE theme incorporates monitoring of groundwater dependent vegetation and groundwater ecosystem health which link to the Basin Plan's basin-wide environmental watering strategy (MDBA 2019) and NSW water sharing plan objectives. This report presents information from a project under the groundwater dependent ecosystems theme in the NSW groundwater sources (Figure 1).

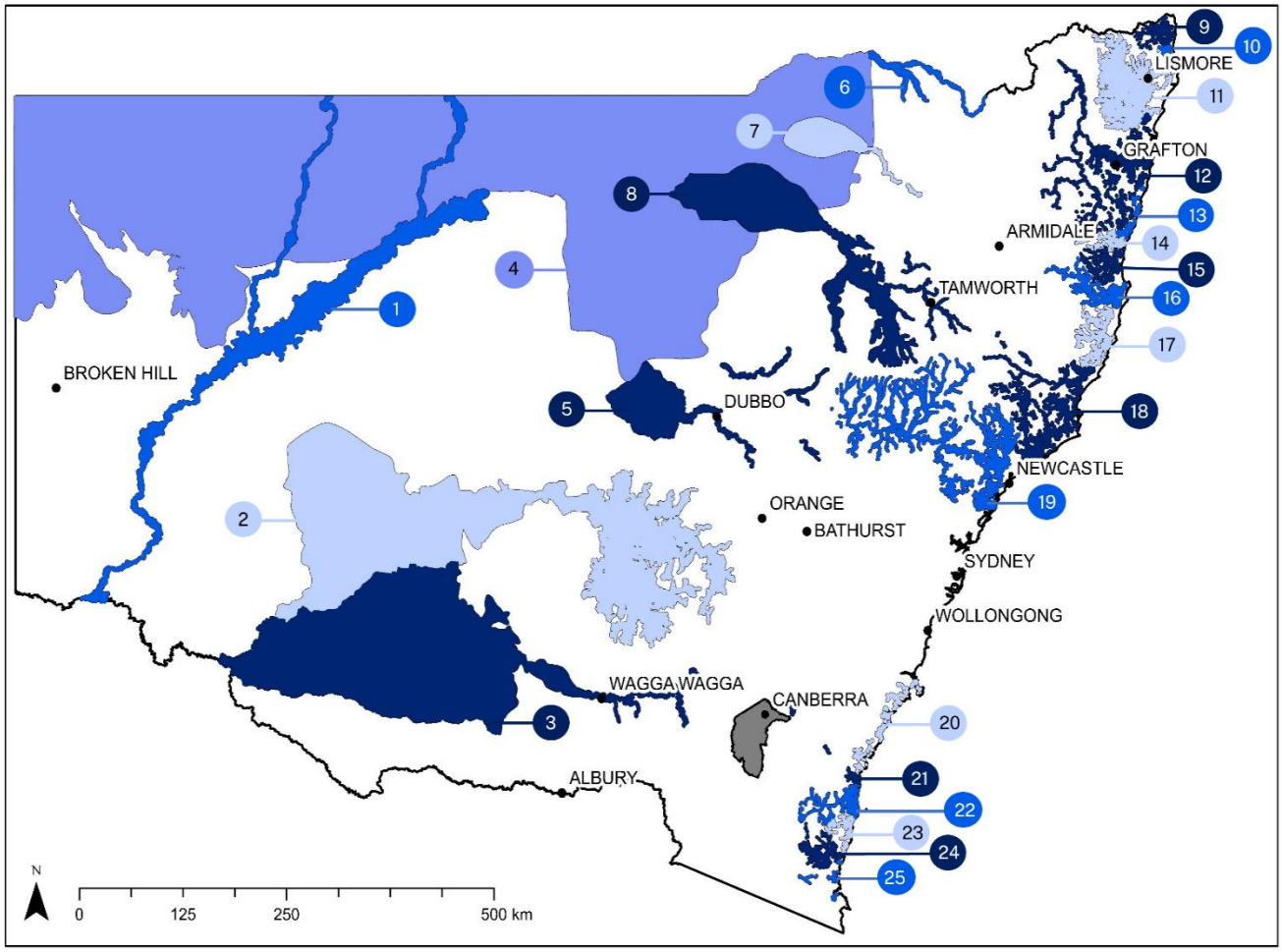

Figure 1. Map of NSW showing NSW Groundwater Water Sharing Plan areas.

Note: Fractured and porous rock, and buried water sources not shown.

Groundwater Water Sharing Plan Legend:

1. Darling Alluvial Groundwater Sources
2. Lachlan Alluvial Groundwater Sources
3. Murrumbidgee Alluvial Groundwater Sources
4. NSW Great Artesian Basin Shallow Groundwater Sources
5. Macquarie-Castlereagh Groundwater Sources
6. NSW Border Rivers Alluvial Groundwater Sources
7. Gwydir Alluvial Groundwater Sources
8. Namoi Alluvial Groundwater Sources
9. Tweed River Area Unregulated and Alluvial Water Sources
10. Brunswick Unregulated and Alluvial Water Sources
11. Richmond River Area Unregulated ad Alluvial Water Sources
12. Clarence River Unregulated and Alluvial Water Sources
13. Coffs Harbour Area Unregulated and Alluvial Water Sources
14. Bellinger River Area Unregulated ad Alluvial Water Sources
15. Nambucca Unregulated and Alluvial Water Sources
16. Macleay Unregulated and Alluvial Water Sources
17. Hastings Unregulated and Alluvial Water Sources
18. Lower North Coast Unregulated and Alluvial Water Sources
19. Hunter Unregulated and Alluvial Water Sources
20. Clyde River Unregulated and Alluvial Water Sources
21. Deua River Unregulated and Alluvial Water Sources
22. Tuross River Unregulated and Alluvial Water Sources
23. Murrah-Wallaga Area Unregulated and Alluvial Water Sources
24. Bega and Brogo Rivers Area Regulated, Unregulated and Alluvial Water Sources
25. Towamba River Unregulated and Alluvial Water Sources

Drivers of environmental outcomes

Groundwater is a valuable resource that supports a range of plants and animals in a diversity of different environments (for example, above ground vegetation communities and underground specialised animals and microbial communities). It is also a source of water that can be extracted for use in agriculture, industry and households.

Many factors impact the quality of groundwater and the plants and animals that depend on groundwater systems, many of which are beyond the control of water resource managers. The extraction of groundwater in NSW is regulated by the Water Management Act (2000). This Act and the Basin Plan (2012) set rules and limits around how much groundwater can be sustainably taken without adversely impacting the plants and animals that rely on groundwater.

Water management also includes consideration of connectivity between rivers and aquifers which is critical for local groundwater recharge. This is critical for allowing groundwater to refill to levels sufficient to be sustained during dry conditions. High rainfall events contribute to the overall regional groundwater recharge; however, these events are generally sporadic in nature.

This report focuses on providing baseline data on the extent of groundwater dependent vegetation in NSW.

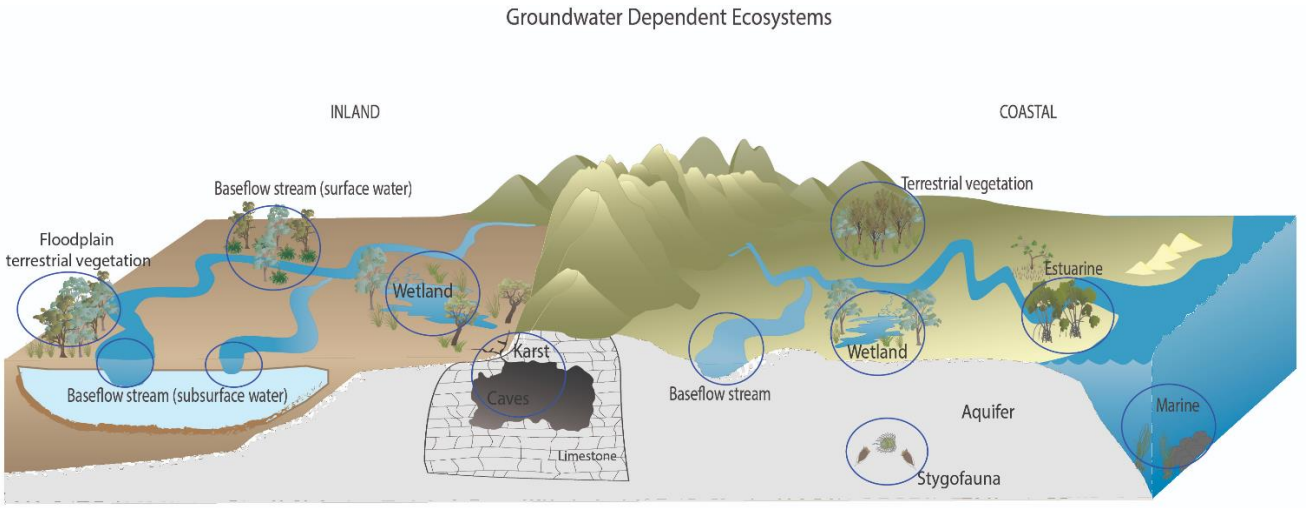

Figure 2 Landscape position of groundwater dependent ecosystems. Source https://water.dpie.nsw.gov.au/science-data-and-modelling/surface-water/environmental-outcomes-monitoring-and-research-program/groundwater-dependent-ecosystems

Determining the extent of high priority groundwater dependent vegetation in NSW

Project Team

Jodie Dabovic and Lucy Dobbs.

Project collaborators

This project is led by the department.

Project aims

The department has been undertaking a project to define the extent of high priority groundwater dependent vegetation communities to produce High Priority Groundwater Dependent Ecosystem maps for use in NSW groundwater sharing plans.

The aim of the 2021-2022 project was to complete the mapping in coastal areas for use in coastal NSW groundwater sharing plans. These maps assist in providing a baseline for the extent of vegetation based high priority groundwater dependent ecosystems at the time of commencement of the current groundwater water sharing plans.

Key project questions

- What is the extent of vegetation based, high priority groundwater dependent ecosystems in coastal NSW water sharing plan areas?

Link to water management activities

- Do current groundwater access rules in coastal NSW water sharing plans adequately protect the vegetation based high priority groundwater dependent vegetation ecosystems?

Methods

A 2-step modelling process was used to identify the location of high priority groundwater dependent vegetation and wetlands in NSW (Dabovic et al. 2019). The eastern portion of the base

layer map, the *NSW State Vegetation Type map* (NSW DPE 2023a, Roff et al. 2022), was updated and completed by the Environment and Heritage Group of the department in 2022. The modelling process was run for map areas that covered the Hawkesbury-Nepean, Hunter-Central Rivers, Northern Rivers, Southern Rivers and Sydney Metro catchment management areas of the High Priority Groundwater maps following the below steps.

Step 1

The first modelling process selected the map units (polygons) of the *NSW State Vegetation Type Map* and assigned a probability of groundwater dependence of the vegetation communities based on species composition and their known use of groundwater. In addition, satellite analysis of the greenness of vegetation during drought conditions and the depth to the groundwater table were used as criteria (Kuginis et al. 2016). This resulted in a map of the vegetation communities that were probably using groundwater.

The identification of groundwater dependent vegetation and wetlands can be accessed from the *Sharing and Enabling Environmental Data* (SEED) website: Spatial Layer of Probable Vegetation Groundwater Dependent Ecosystems in NSW

Step 2

The second modelling process used the *Probable Vegetation Groundwater Dependent Ecosystems in NSW map* (step 1*)* as the base layer. The vegetation mapping units (polygons) that were high probability were run through a second modelling process (Dabovic et al. 2019), which applied the *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE) framework* (Aquatic Ecosystems Task Group 2012). This process selected a subset of the polygons of the map that met the criteria of being of high or very high value under this HEVAE framework to produce a second map. For more information on the HEVAE framework visit our website HEVAE

The ecological value dataset is also available on the SEED website: Spatial Layer of HEVAE Vegetation Groundwater Dependent Ecosystems Value in NSW.

These *HEVAE Vegetation Groundwater Dependent Ecosystems Value in NSW* maps have been used to produce the *High Priority Groundwater Dependent Ecosystem* maps that are used in Groundwater water sharing plans in NSW.

Results

In 2021-22 the *HEVAE Vegetation Groundwater Dependent Ecosystems Value in NSW* map areas that covered the Hawkesbury-Nepean, Hunter-Central Rivers, Northern Rivers, Southern Rivers and Sydney Metro catchment management areas were completed to provide maps for water sharing plan use.

Next steps

Monitoring the extent of high priority vegetation based GDEs in NSW

The next step is to develop methods to monitor change in the spatial extent of high priority GDEs over time using satellite and aerial imagery. This will include the landuse and landcover programs managed by the Department of Planning and Environment, Environment and Heritage Group, such as the *Statewide Landcover and Tree Study Program* (NSW DPE 2023b) and the *NSW Landuse Program* (NSW DPE 2023c). These products will be investigated to determine if they can be used to track the change in extent of woody and non woody groundwater dependent vegetation over time.

Health of subterranean groundwater ecosystems

In 2020 the department collected a baseline data set on the health of subterranean groundwater ecosystems across the NSW Murray-Darling Basin using the Groundwater health index (Korbel and Hose 2011, 2017).

In 2023-2024 fieldwork will be undertaken in the Gwydir, Namoi, Macquarie, Murray, Murrumbidgee and Lachlan River catchments which span a range of climatic and geological conditions across the Basin. This work will enable reporting on the health of subterranean GDEs in the next Murray Darling Basin Plan Matter report in 2024.

The project aims will:

1. collect a comparative data set to allow comparison with 2020 baseline data to report on subterranean groundwater ecosystem health over time for future evaluations such as water sharing plan evaluation and Basin Plan requirements
2. use the groundwater health index (Korbel and Hose 2011, 2017) to identify the specific impacts of changes in groundwater level and quality within groundwater resource plan areas of the Murray Darling Basin between 2020 and 2023
3. collect a baseline data set on the health of subterranean groundwater ecosystems in coastal NSW water sharing plan areas, to enable health to be tracked over time for future water sharing plan environmental evaluations.

Proposed Research

In addition, research activities with Macquarie University on GDE ecosystems is continuing under the following projects and these results will inform future monitoring activities:

- Establishing the links between groundwater ecosystem health, groundwater dependent vegetation and wetland health in the Murray Darling Basin.
- Using eDNA in groundwater to detect tree groundwater use.
- Predicting the impacts of groundwater drawdown on groundwater ecosystems (ARC Linkage LP190100927, collaboration with Macquarie University and University of New South Wales).

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