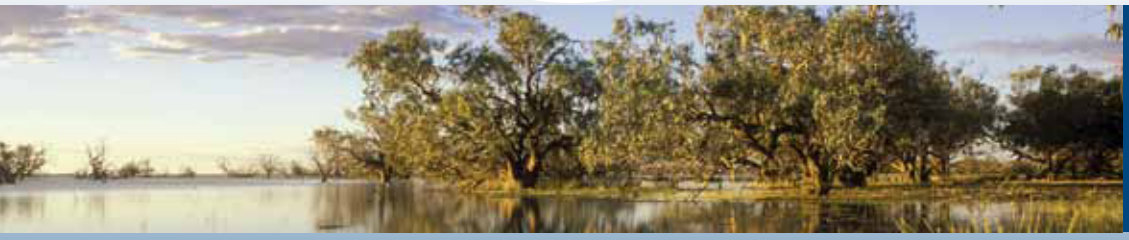
Aquatic ecosystems toolkit



CASE STUDY 1: Lake Eyre Basin

Based on work undertaken by Ms Jennifer Hale and Dr Shane Brooks
for the Aquatic Ecosystems Task Group

2012

Part 1 Identifying High Ecological Value Aquatic Ecosystems (HEVAE)
1.1 Groundwork before identifying HEVAE

Other sections of this document are available from
<www.environment.gov.au/water/publications/environmental/ecosystems/ae-toolkit-cs-1.html>

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This case study is based on trials of the draft Guidelines for Identifying High Ecological Value Aquatic Ecosystems, and the draft Aquatic Ecosystem Delineation and Description Guidelines. The final reports from these trials are as follows:

Hale, J. (ed.) (2010). Lake Eyre Basin High Conservation Aquatic Ecosystem Pilot Project. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Jennifer Hale, Kinglake.

Hale, J., and Brooks, S. (2011). *Trialling the guidelines for the delineation of High Ecological Value Aquatic Ecosystems (HEVAE) in the Lake Eyre Basin (LEB)*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Jennifer Hale, Kinglake.

These reports are available on request from the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

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These trials were undertaken during the time when guidance on the identification, delineation and description of aquatic ecosystems was an area of active policy development. The work informing the contents of this publication was carried out under budgetary and time restraints, resulting in limited ability to incorporate all available datasets and information into the process.

Citation

Aquatic Ecosystems Task Group (2012). Aquatic Ecosystems Toolkit. *Case Study 1: Lake Eyre Basin*. Department of Sustainability, Environment, Water Population and Communities, Canberra.

The publication can be accessed at <http://www.environment.gov.au/water>

Front page: Lake Goyder, part of a network of lakes and swamps that fill from Cooper Creek in north-east South Australia (Peter Canty)

Kaporilya Springs, Northern Territory (Diane Conrick)

Part 1: Identifying High Ecological Value Aquatic Ecosystems (HEVAE)

1.1 Groundwork before identifying HEVAE

Whilst the Lake Eyre Basin (LEB) covers 15 percent of Australia, it is remote and poorly studied compared with similarly sized drainage divisions. The LEB spans four state/territory boundaries (Figure 1), and information collected prior to this project was not consistent or comprehensive across the whole basin. Before applying Module 3 *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)*, preliminary work was required to integrate existing data sets, to provide a basin-wide information base.

Step 1 Identify purpose

The purpose of the assessment was to test the draft HEVAE Framework, and draft delineation guidelines, (which have now been developed into Module 3: *Guidelines for Identifying HEVAE*, and Module 4: *Aquatic Ecosystem Delineation and Description Guidelines*, respectively) in the Lake Eyre Basin.

Step 2 Map and classify aquatic ecosystems

A consistent and comparable classification of aquatic ecosystems was required to apply a number of the HEVAE criteria (particularly 'diversity' and 'representativeness'). Two typologies were developed, one for riverine and one for non-riverine aquatic ecosystems. This trial pre-dated the Australian National Aquatic Ecosystem (ANAE) Classification Scheme, however the principles of the ANAE Classification Scheme were used to identify aquatic ecosystem types.

Non-riverine (lacustrine/palustrine) aquatic ecosystems were defined as those that are not connected to a mapped drainage channel, or are substantially wider than the channel (e.g. a lake fed by a river). Riverine ecosystems were defined as all aquatic ecosystems and deepwater habitats within a channel that are naturally or artificially created, periodically/continuously contain moving water, or form a connecting link between two bodies of standing water.

A set of key classification attributes that each jurisdiction could apply were identified for both non-riverine and riverine systems (Table 1).

The application of the classification system was based predominantly on existing data sources. However, in order to minimise the number of systems that were classified as 'unknown' due to a lack of information on one or more attribute, defaults based on stated assumptions were used. Defaults were, in the absence of evidence or knowledge to the contrary:

- fresh
- non-permanent
- riverine systems were considered channels
- groundwater source was considered unconfined.

The final output was mapping of non-riverine aquatic ecosystems into 27 possible categories, and riverine ecosystems into 32 categories, based on combinations of attributes (e.g. lowland/floodplain/surface water/non-permanent/fresh).

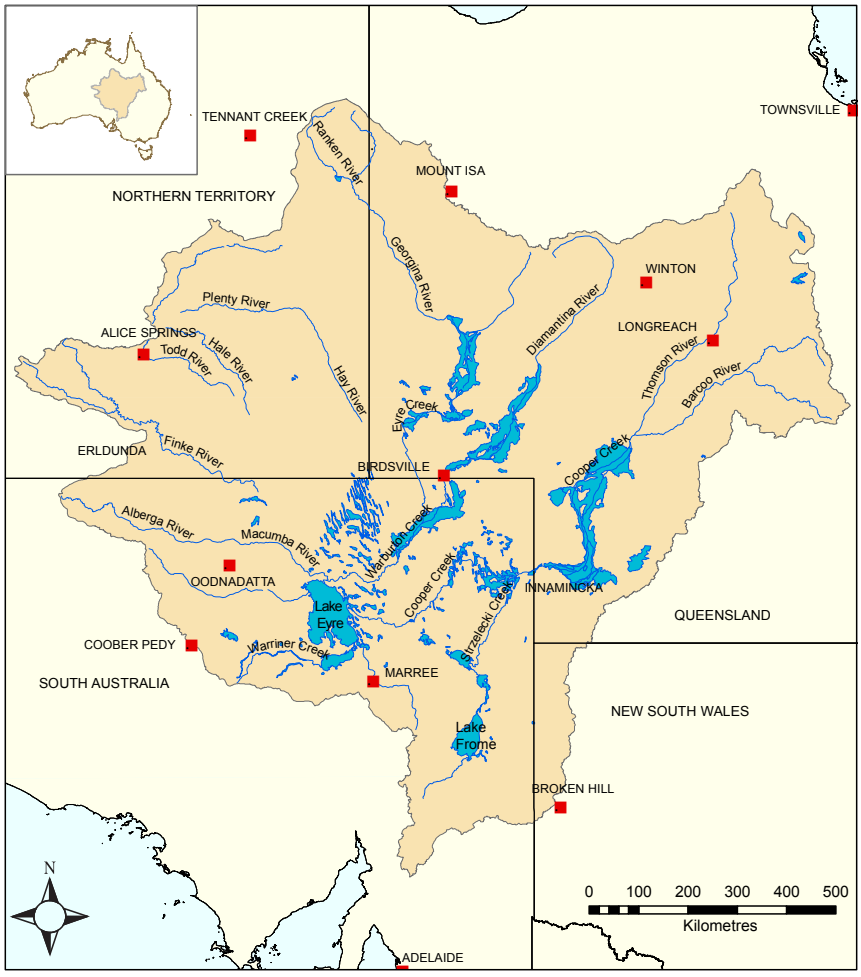

Figure 1 **Map of the Lake Eyre Basin drainage division showing major river systems and jurisdictional boundaries**

Table 1 **Key attributes used to classify non-riverine and riverine aquatic ecosystems across the Lake Eyre Basin**

ATTRIBUTE	DESCRIPTION	NON-RIVERINE/ RIVERINE
Landform: Upland Lowland	Based on a measure of roughness applied across the basin using the 9 second Digital Elevation Model.	Non-riverine & riverine
Dominant water source: Groundwater Surface water	The 'groundwater' attribute is applied to those aquatic ecosystems that have been identified in mapping or expert panel review as being fed predominately by groundwater (e.g. springs). The 'surface water' attribute covers all wetland systems that have not been identified as having characteristics that would indicate they are predominately groundwater fed. A sub-category of artesian versus unconfined aquifer sources was applied to separate deep-water aquifer-fed systems from surficial groundwater systems.	Non-riverine & riverine
Connectivity: Floodplain Non-floodplain	Floodplains are defined in this trial* as (The National Committee on Soil and Terrain, 2009[1]): 'alluvial plains characterised by frequently active erosion and aggradation by channelled or overbank stream flow. Unless otherwise specified "frequently active" is to mean that flow has an Average Recurrence Interval of 50 years or less.' The non-floodplain category covers the remaining systems that may receive some flow from local watershed creeks but are only very rarely or very minimally influenced by true river systems. The 'non-floodplain' (spring) category includes all mapped springs.	Non-riverine
Connectivity: Channel Waterhole Spring	Channel—water mostly flowing if present but may persist for a few days as shallow water after flow stops. Waterhole—water remains after flow stops for periods of weeks through to permanent. Spring—aquifer discharge feature on bank or bed of watercourse or very close on adjacent cliff; discharge may be intermittent and may rarely produce surface flows (i.e. a seepage spring).	Riverine
Water regime: Near-permanent Non-permanent	Near-permanent—defined as those waterbodies that hold water for >70% of the time. Non-permanent—defined as those waterbodies that hold water for <70% of the time.	Non-riverine & riverine
Water type: Fresh Saline	Adoption of the Queensland wetland mapping definition where fresh is <3 ppt and saline >3 ppt. In the context of the LEB, the attribute is applied based on the average conditions within the wetland (i.e. the wetland may become more saline as it dries, but is considered fresh if for the majority of the time it holds water, salinity is <3 ppt). However, few aquatic ecosystems contained salinity data. In these cases salinity was identified through expert opinion or defaulted to fresh.	Non-riverine & riverine

* Note this definition differs somewhat from the one used in the ANAE Classification Scheme (Module 2), which defines floodplains as 'areas that are intermittently inundated by the lateral overflow of riverine, lacustrine or palustrine systems, by direct precipitation, or by groundwater'.

1 The National Committee on Soil and Terrain (2009). Australian Soil and Land Survey Field Handbook, Third Edition, CSIRO Land and Water, Canberra.

Step 3 Determine scale, r egionalisation, and spatial units

The scale, regionalisation and spatial units relevant to the LEB HEVAE trial are illustrated in Figure 2.

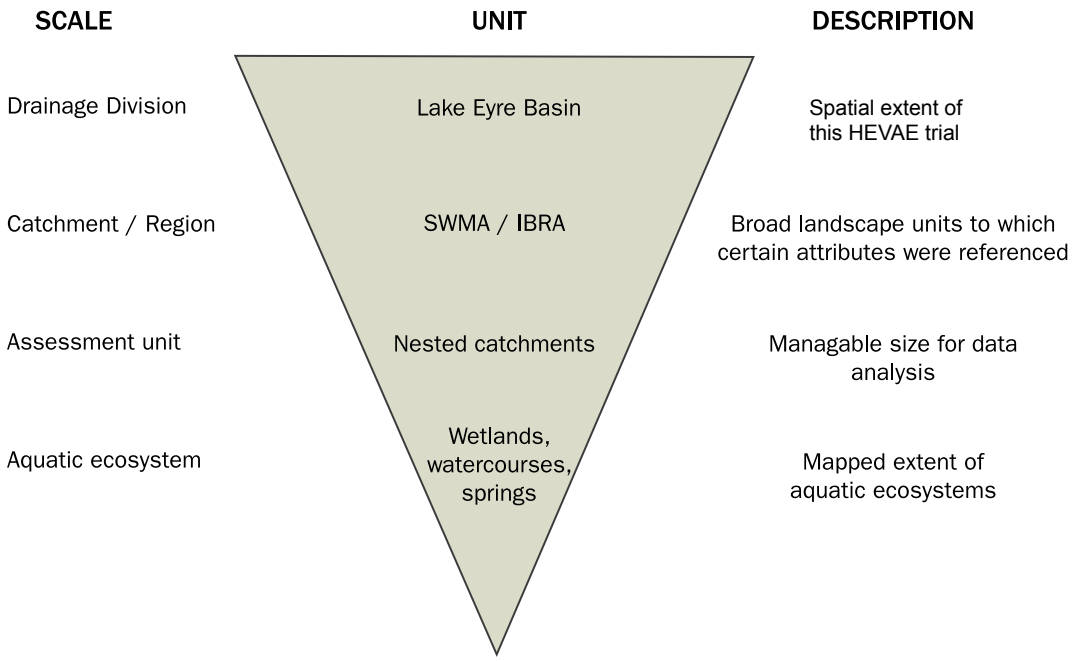

Figure 2 Spatial scales used in the LEB HEVAE trial

a. Determine scale and regionalisation

The LEB drainage division boundary was defined by the Australian Water Resources Council (AWRC) in the 1960s, and this boundary has been formally recognised in the LEB Agreement process. However, in 2005, Duguid et al. documented the need for a major boundary change associated with the catchment of the Karinga Creek and flow along the creek into the Finke River. Subsequently, Geoscience Australia has re-mapped major river basin and drainage division boundaries across Australia using a digital terrain model. This is part of a new Australian Hydrological Geospatial Fabric (Geofabric). A near-final draft of the revised drainage division boundaries was obtained for use in the LEB HEVAE trial. Queensland, South Australia and NSW chose to use the old boundary because of its official status under the LEB Agreement, and because they had data already organised according to that boundary, while the Northern Territory chose to use the new boundary.

Selection of an appropriate regionalisation for use at broader scales proved problematic, and three options were considered: river catchments, Interim Bioregionalisation of Australia (IBRA), and a regionalisation based on landscape form and function (a modified form of IBRA that accounted for the major hydro-geomorphic types and landscape processes occurring in the LEB).

The project's Technical Working Group (TWG) and Expert Reference Panel (ERP) (see Expert knowledge input (below) decided that more than one regionalisation scheme could be selected for application to different aspects

of the HEVAE criteria. Two existing regionalisations (Figures 3a and b) were selected that had broad applicability to aquatic ecosystem attributes:

- Aquatic based regionalisation—Australian Surface Water Management Areas (SWMA) (with a further split in South Australia to Lake Frome and Western Rivers). SWMA provide a broad stratification on aquatic ecosystem characteristics and account for both longitudinal and lateral connectivity. They were used specifically for identification of endemic species at the sub-basin scale as well as for referencing diversity of aquatic ecosystems and species richness of fish.
- Geomorphic and climate-based regionalisation—Interim Bioregionalisation of Australia (IBRA) was selected for referencing attributes that are known to vary with climate and geomorphology across the basin (e.g. plant and amphibian species richness).

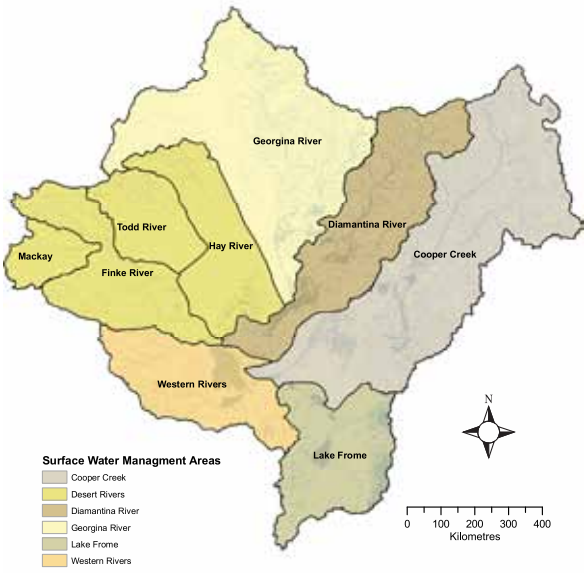

Figure 3a **Surface Water Management Areas (SWMA) in the Lake Eyre Basin**

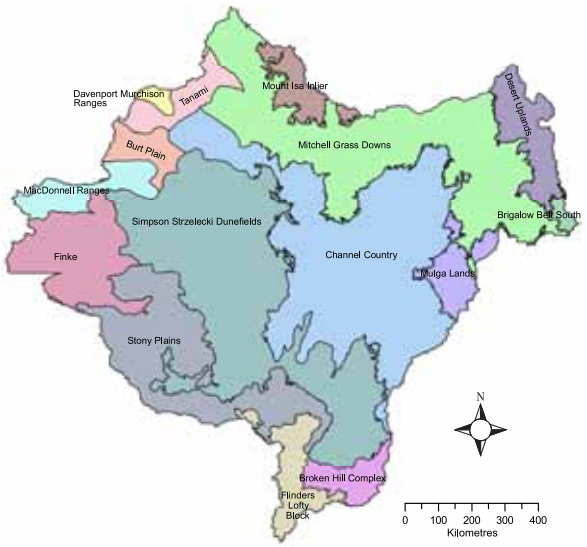

Figure 3b **Interim Bioregionalisation of Australia (IBRA) regions within the Lake Eyre Basin**

b. Select spatial units

A top-down catchment-based approach was used to identify HEVAE, by assigning data to assessment units rather than individual wetlands, waterholes or river reaches. This approach partially overcame the problem of sample bias and uneven distribution of data between aquatic ecosystems in the LEB. While the systematic description or delineation of important aquatic ecosystems within the assessment units was not possible, assessment units that had a high probability of containing one or more HEVAE could be identified. In some instances an assessment unit could also meet the HEVAE criteria because of the presence of more than one disconnected aquatic ecosystem.

Two available datasets with delineations of catchments were investigated both based on digital elevation models (DEM):

- the recently developed National Catchment Boundaries (NCB) nested catchments that are being beta tested by the Bureau of Meteorology for the Geofabric (based on the Pfafstetter technique)

- the 500-square-kilometre nested catchments data set provided by the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).

The NCB nested catchments were rejected as the variability in area of 'catchments' within any given level was considered too great for the LEB HEVAE trial, and there were instances where boundaries did not align with on-ground knowledge of the TWG members. As a consequence, the 500-square-kilometre nested catchments data set provided by DSEWPaC was selected as an appropriate scale for the assessment units. This resulted in approximately 1100 units across the LEB.

Each jurisdiction further customised these catchments as necessary to balance objective boundaries derived from a DEM and ecologically meaningful units of an appropriate size. The process resulted in 1035 assessment units across the LEB ranging in size from 82 to 29 000 square kilometres, with a median size of approximately 1000 square kilometres (Figure 4).

To apply the attributes for criteria (see Step 4b), each assessment unit needed to be ascribed to a SWMA and IBRA region. Overlaying of the boundaries of assessment units with each of the regionalisations indicated that a large number of assessment units spanned a regional boundary. To address this, a '50 percent' rule was applied whereby the assessment units were ascribed to the region in which more than 50 percent of its area lay.

The intersection of the drainage division with the IBRA regions resulted in an imperfect fit, and a number of IBRA regions were dissected by the drainage division boundary. There were several small areas of IBRA regions that lay predominantly outside the LEB, which contained too few assessment units (less than three) for meaningful, referential evaluations to be made. As a consequence, assessment units in these small, partial IBRA regions were subsumed into adjoining IBRA regions for the purpose of referential evaluations.

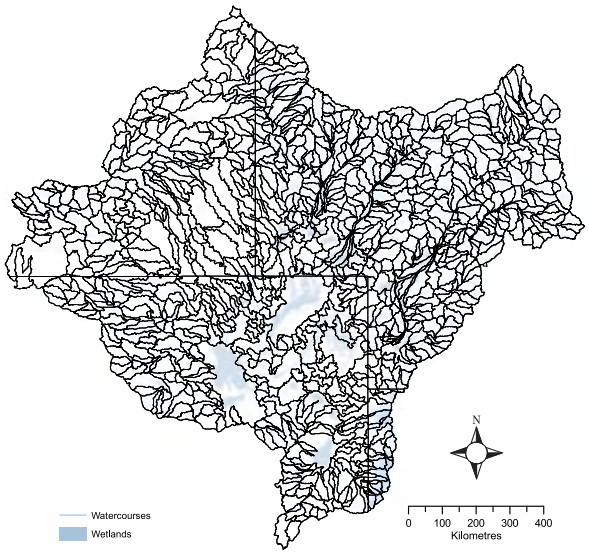

Figure 4 **Assessment units in the LEB using the 500-square-kilometre nested catchments data set**

Expert knowledge input

The Technical Working Group (TWG) comprising representatives from the NSW, Northern Territory, South Australia, Queensland and Australian governments was established to conduct the HEVAE trials. The TWG worked in collaboration with scientific experts from government and research organisations (the Expert Reference Panel).

The Expert Reference Panel (ERP) was assembled for both the HEVAE identification and delineation trials. The ERP comprised of scientists with expertise in a range of relevant fields (including hydrology, geomorphology, fish, waterbirds, vegetation, macroinvertebrates) and local knowledge and experience in the LEB. The ERP met with the TWG twice during the HEVAE identification trial and once during the delineation trial, and also contributed expert knowledge out of session.

The ERP's role in the identification of potential HEVAE was to:

- provide advice on decisions made regarding the method
- augment the application of attributes and criteria for the identification of HEVAE, and provide advice on the data and knowledge to delineate HEVAE by the input of expert opinion.

1.2 Identifying HEVAE

Step 4 Assign attributes to chosen spatial unit

a. Selection of criteria

At the time the trial was undertaken, there were six HEVAE criteria: diversity, distinctiveness, vital habitat, evolutionary history, naturalness and representativeness. These were the criteria that were applied in this trial.

b. Selection of attributes

Information on aquatic ecosystems and species is unevenly distributed (both spatially and temporally) across the LEB drainage division. Information available for this trial of the HEVAE process was limited further by resource and time constraints, such that only data that was readily available in a spatial format could be utilised. In an attempt to supplement this limited data, attributes were developed that allowed for expert opinion and/or local knowledge to act as an input to the process.

Consideration was given to finding scientifically defendable attributes, and care was taken to avoid 'double-dipping' i.e. including similar measures across several criteria. Additional attributes for macroinvertebrates, fossils, aquatic ecosystem extent, priority species and vital habitat were suggested, however these were not able to be implemented for this trial because of data or resource constraints. The selected attributes are listed in Table 2.

Aquatic ecosystem-dependent species

A list of native species in the LEB considered to be dependent on aquatic ecosystems was developed for use in applying attributes. The concept of 'aquatic ecosystem-dependent species' was strictly applied to fauna species and applied only to those that were fully aquatic (e.g. fish) or those that were considered dependent on aquatic ecosystems for a significant part of their lifecycles (e.g. waterbirds). A broader definition of aquatic ecosystem dependence was applied to flora species and included all species that were reliant on inundation.

There were some limitations on the application of this list. No invertebrate species were included in the systematic analysis, only vertebrates. The preparation of a list of vascular plants was hampered in some states by lack of access to appropriate experts, the difficulty of the task itself, and a lack of knowledge about inundation dependence. Defining 'dependence' was also a limiting factor.

c. Development of metrics

The rationale and data requirements for the selected metrics are detailed in Table 2.

d. Compile and assign data

A geo-database template containing fields for each attribute was populated with an application of the attributes, not the raw data/species records, which remained with jurisdictions. In the majority of cases, the process was limited to readily available, spatially stored information held in jurisdictional databases. The exceptions to this were attributes derived from national datasets (e.g. River Disturbance Index) and attributes populated by expert opinion and local knowledge (e.g. waterbird breeding). The completed database from each jurisdiction was integrated into a single geo-database that contained the outputs of attribute application as well as scoring and weighting.