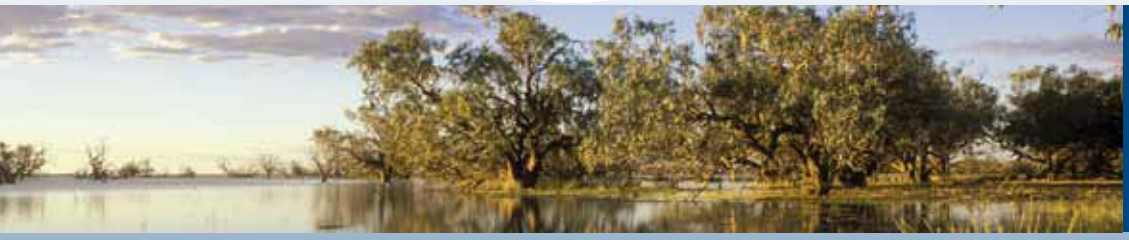
Aquatic ecosystems toolkit



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 2: Aquatic ecosystem delineation and description

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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Authors/endorsement

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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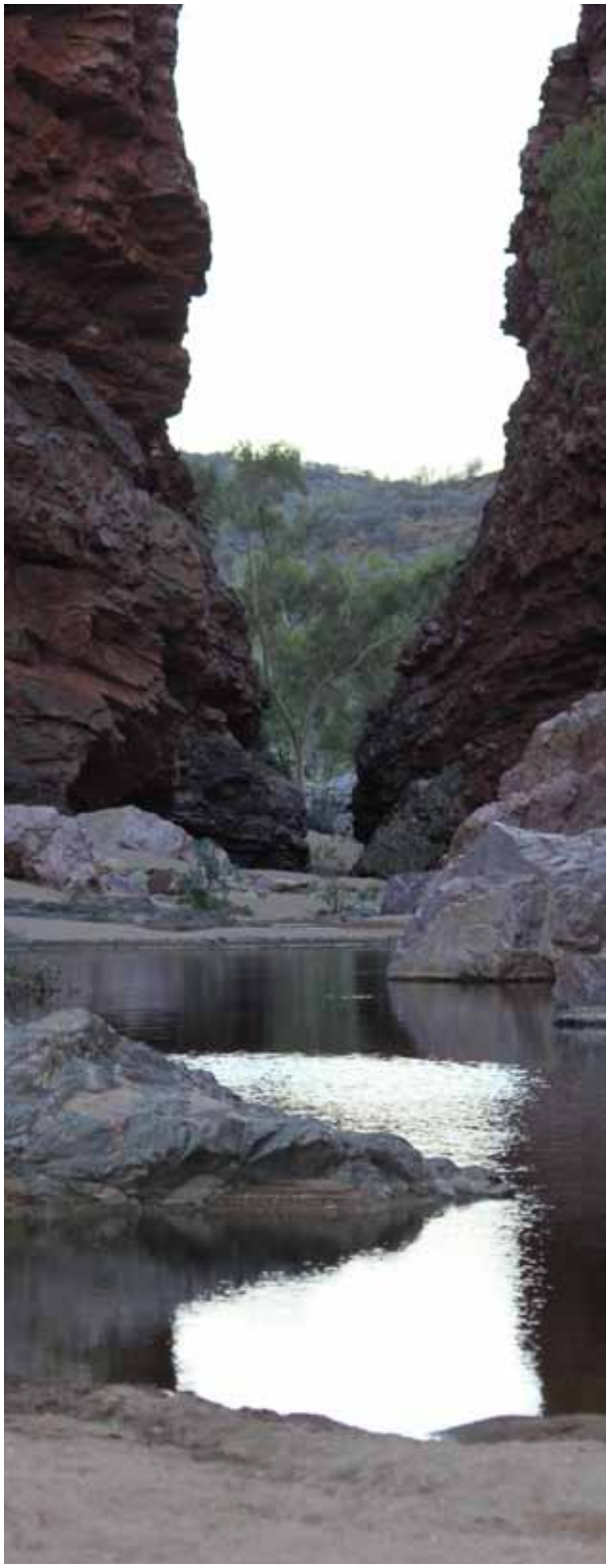
Citation

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)



Simpsons Gap, Northern Territory (Diane Conrick)

Part 2: Aquatic ecosystem delineation and description

Draft guidelines for delineating aquatic ecosystems were trialled in the Lake Eyre Basin, on four sites identified through the trial of the HEVAE identification guidelines:

- Test Site 1: Assessment unit 6455 (contains Dalhousie Springs)
- Test Site 2: Assessment units 4264, 4293, 4438 (contains Lake Galilee)
- Test Site 3: Assessment units 1000, 1001, 1002 (contains Coongie Lakes)
- Test Site 4: Assessment units 4779, 5088, 5093, 5094 (contains Chewings Range spring-fed pools).

These four sites were selected (by negotiation with jurisdiction representatives) to cover a broad range of variables such as:

- aquatic ecosystems (i.e. springs, rivers, floodplains and lakes)
- jurisdictions (NSW, NT, QLD and SA)
- values (e.g. diversity of aquatic ecosystems, threatened species, endemic species, vital habitat)
- available data (i.e. both data poor and data-rich areas).

It should be noted that the selection of known and named aquatic ecosystems, rather than simply high-ranking assessment units, to some extent affected the outcomes of the delineation trial. The draft delineation guidelines specified that the identification and delineation of aquatic ecosystems should follow an objective approach from assessment unit to core element and Ecological Focal Zone (EFZ). The selection process for this trial decided *a priori* which aquatic ecosystems within the

high-ranking units would be selected for delineation. While this did not affect the outcome for three of the trial sites, it made a significant impact for one (Test Site 2–Lake Galilee).

2.1 Assessment Unit 6455—Dalhousie Springs

Step 1 Identify/review values, aquatic ecosystem classification, and components and processes for the high ecological value aquatic ecosystems or assessment units

Assessment unit 6455 scored very highly for criteria 1 (Diversity), 2 (Distinctiveness) and 4 (Evolutionary History) (Table 8). In particular the assessment unit scored highly for:

- fish species (diversity and endemic)
- high diversity of plants and aquatic ecosystems
- endangered ecological community (the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin)
- refuge (permanent water).

Table 8 Outputs of LEB HEVAE trial for assessment unit 6455

CRITERIA	RANK	ATTRIBUTES	RANK
1. Diversity	Very High	Diversity of aquatic ecosystem type	Very High
		Diversity of native aquatic ecosystem-dependent spp. fish	Very High
		Waterbirds	Medium
		Reptiles	High
		Frogs	High
		Mammals	Null
		Woody plants	Very High
		Non-woody plants	Very High
		Diversity of aquatic ecosystem vegetation types (QLD only)	N/A
2. Distinctiveness	Very High	Threatened species	Moderate
		Priority species	Null
		Migratory bird species (East Asian–Australasian Flyway)	Low
		Threatened aquatic ecological community	Very High
		Conservation status of aquatic regional ecosystems (QLD only)	N/A
3. Vital habitat	Medium	Waterbird abundance	Null
		Significance of site for waterbird breeding (large colonial breeding events)	Null
		Refugia (permanent water)	Very High
4. Evolutionary History	Very High	Endemic species	Very High

Step 2 Identify the core elements

There were eight types of aquatic ecosystems within the assessment units; the values were associated with the permanent freshwater springs and associated wetlands in the Dalhousie Springs complex (T Gotch 2010, pers. comm., 14 December). The springs are populated by endemic fish species contributing to the very high scores for refugia, endemic species and diversity of fish species. They are groundwater fed and scored very high for the threatened aquatic ecological community of the Great Artesian Basin. The 'core elements' of this HEVAE were therefore defined as the springs in the Dalhousie Springs complex (Figure 17).

Step 3 Identify and summarise the critical components and processes

An ecological description was not undertaken as part of this trial, thus critical components and processes were not identified.

Step 4 Identify the ecological focal zones (EFZ) and delineate the overall EFZ

Available data layers that were assessed for the purpose of objectively delineating the ecological focal zone (EFZ) with comments on their applicability are provided in Figures 18 to 23.

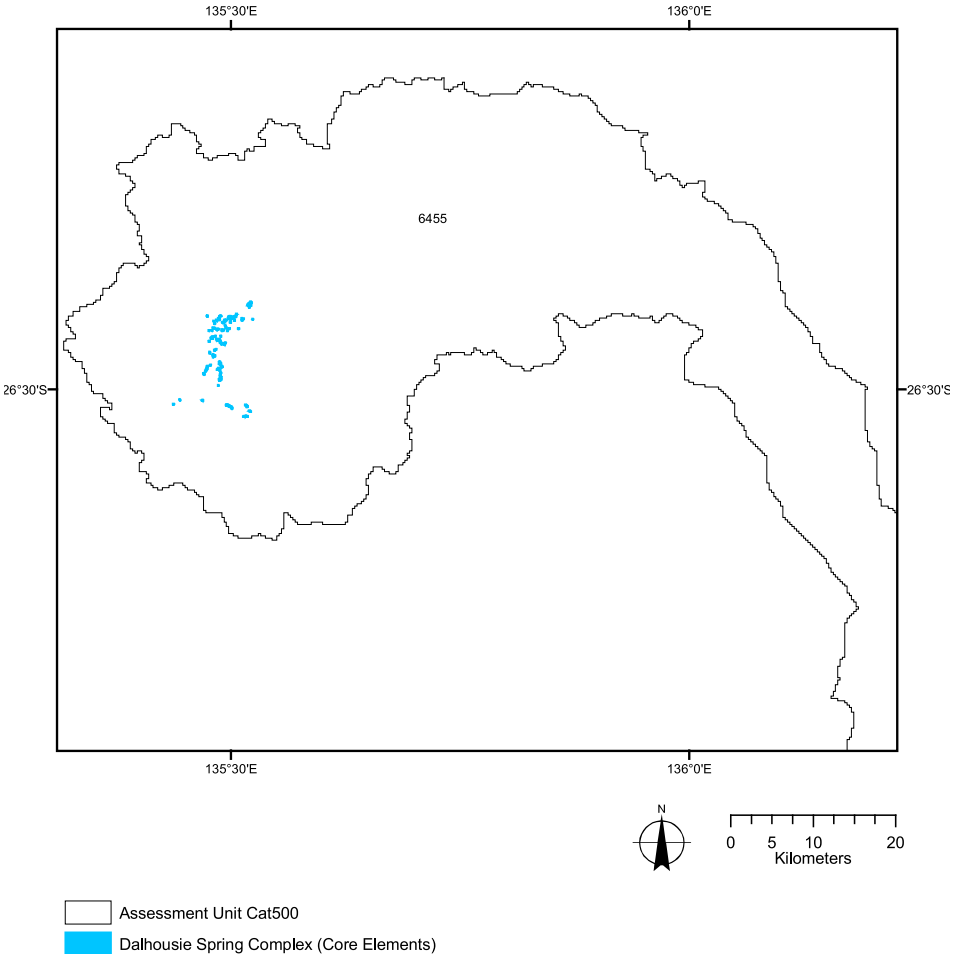


Figure 17 **Aquatic ecosystems that contribute significantly to the values of assessment unit 6455. These are the core elements to be used for delineating the ecological focal zone.**

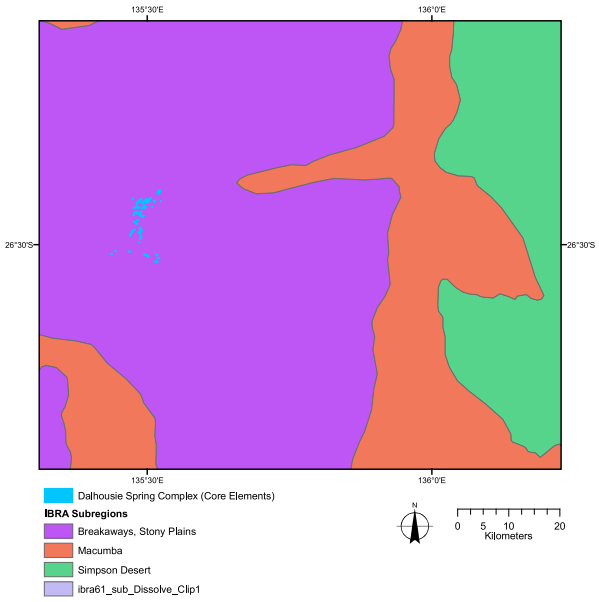


Figure 18 **IBRA subregions surrounding the core elements identified within assessment unit 6455**

Do not appear to align with any identifiable landscape features, geomorphic or ecological processes related to the core elements and were not considered useful to inform the process of defining the EFZ.

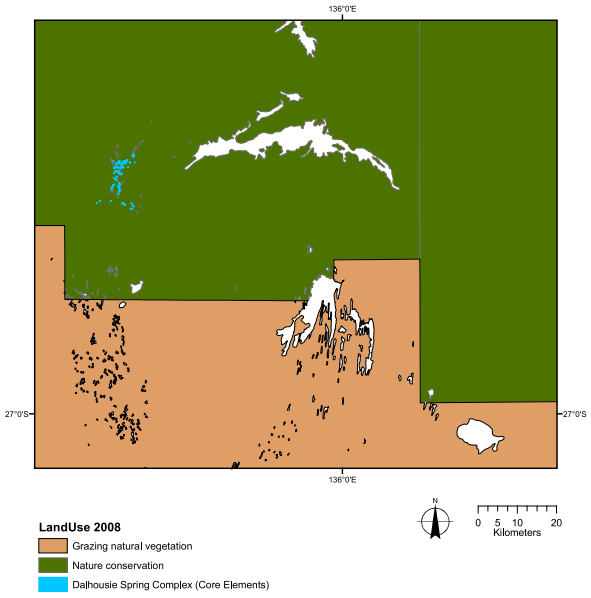


Figure 19 **Land use surrounding the core elements identified within assessment unit 6455 (2008 Land Use)**

Only distinguished two land uses operating at broad scales and neither are relevant to any ecologically meaningful boundaries that may inform the EFZ.

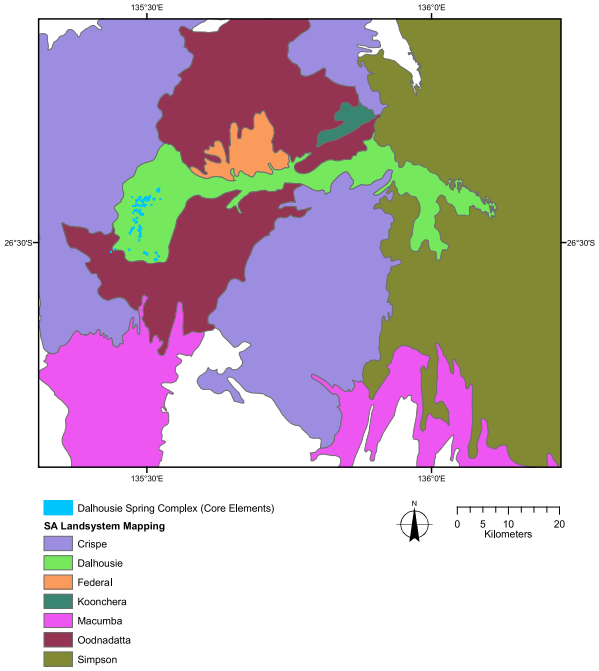


Figure 20 **Land systems mapping of the area surrounding the core elements identified within assessment unit 6455 (South Australian Land System mapping)**

The Dalhousie Land System contains the core elements and downstream drainage area. These downstream areas are predominantly dry salt and clay pans that do not contribute to the ecological values of the HEVAE and the Expert Reference Panel felt should be excluded from the EFZ.

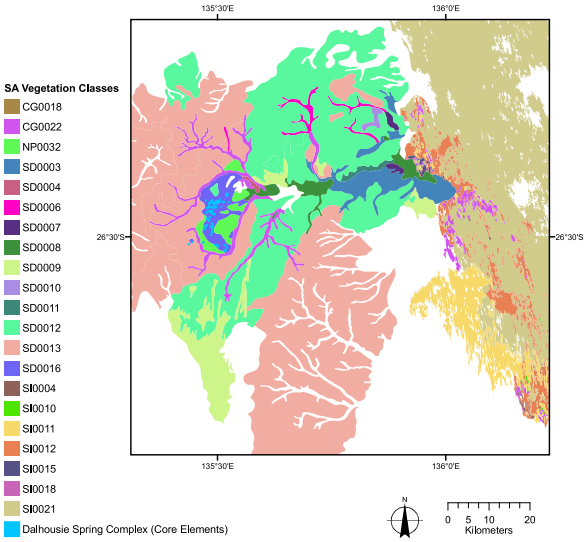


Figure 21 **Dominant vegetation classes in the area surrounding the core elements identified within assessment unit 6455 (South Australian vegetation ID mapping).**

The vegetation class SD0016 is the wetland vegetation that is fed directly from the springs and this may provide a suitable boundary for the EFZ given the values of the assessment unit are very tightly associated with the spring itself and the diversity of woody and non-woody plants in the adjacent vegetation.

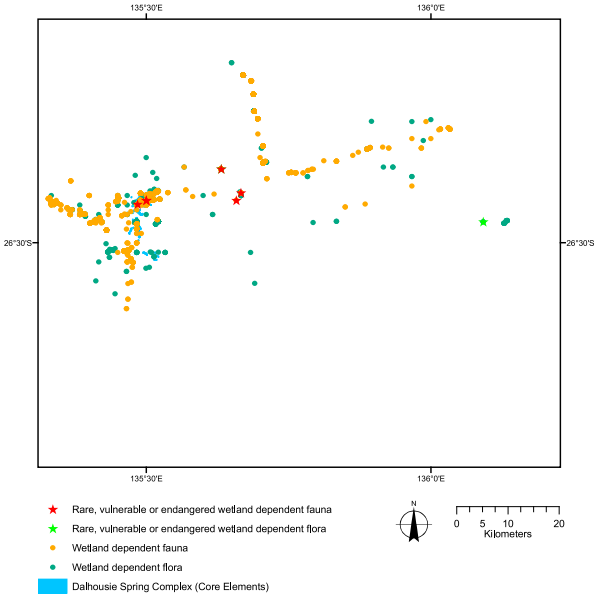


Figure 22 **Location of species records for wetland-dependent flora and fauna in assessment unit 6455.**
Stars indicate locations with species listed as rare, vulnerable or endangered in South Australia.
(Note: does not include fish, for which data was not available).

The locality of records for wetland-dependent species appear more strongly associated with the road network than with aquatic habitats reflecting strong sampler bias. Only six records for threatened wetland-dependent fauna were found, all being migratory bird species (SA could not supply location data for fish for this project). Only two records for threatened wetland-dependent plants were found and these were not associated with the core elements.

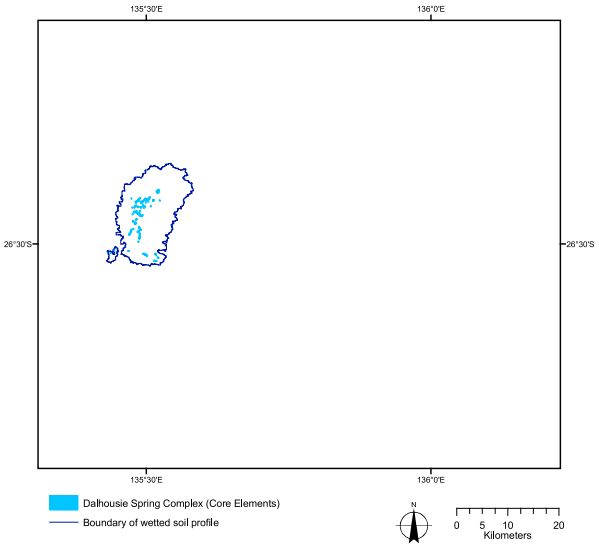


Figure 23 **Boundary of wetted soil profile surrounding the core elements identified within assessment unit 6455 as determined by 3 m airborne imagery 2010.**

Soil moisture provided by the springs underpins the distribution of the associated wetland habitats (expert opinion of Travis Gotch, SA Arid Lands NRM). The boundary of surrounding the springs was mapped in 2010 by Dr D. C. White at the University of Adelaide, as part of the 'Allocating water and maintaining |springs in the Great Artesian Basin' program (NWI 2008–2012).

As the values of this site were predominantly related to fish and permanent wetland features, it was determined that hydrology was the most important feature for identifying the EFZ. The delineation of the EFZ was informed by the expert opinion of Travis Gotch and is based on hydrology (i.e. equivalent to the wetted area around the springs). The ERP agreed that the boundary of the wetted soil profile provided an ecologically meaningful and objective method for determining the boundary of the EFZ for the core elements of the Dalhousie Springs complex (Figure 24).

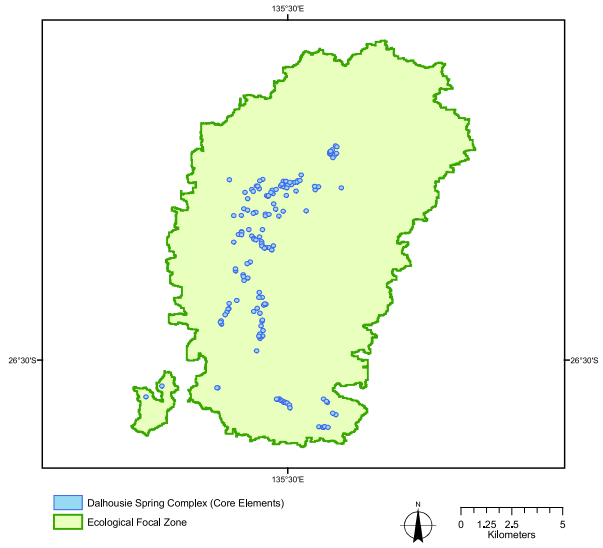


Figure 24 **Delineated HEVAE ecological focal zone containing the Dalhousie Springs complex**

Step 5 Identify/develop conceptual models

An ecological description was not undertaken as part of this trial, thus conceptual models were not identified or developed.

Step 6 Identify threats

An ecological description was not undertaken as part of this trial, thus threats were not identified.

Ormiston Gorge, Northern Territory (Diane Conrick)

Output—Aquatic Ecosystem Delineation Record Sheet

AQUATIC ECOSYSTEM DELINEATION RECORD SHEET	
Name of aquatic ecosystem	Dalhousie Springs
Date of delineation	January 2011
Purpose for delineation (e.g. water planning)	Case study
Ecosystem description	A supergroup of approximately 80 active Great Artesian Basin springs located in the Witjira National Park.
Ecosystem types	Lowland, non-floodplain, groundwater, permanent, fresh
Land use	Conservation (National Park)
Land tenure	National Park
Scale	HEVAE criteria were applied at the 500 km^2 nested catchment scale, site was delineated at the spring super group scale.
Experts involved	Travis Gotch (South Australia Arid Lands NRM)
Datasets used	Lake Eyre Basin Aquatic Ecosystem Mapping (2010) developed for the Lake Eyre Basin HEVAE Trial; held by SEWPaC (ERIN). Dalhousie Springs wetted soil profile (Dr D. C. White, University of Adelaide)
Gaps/limitations	Fish survey data was not made available to inform the process; species records showed a strong sampler bias and correlated with the road network; vegetation mapping was not available at a suitable resolution to inform the process.
HEVAE criteria met	☑ Criteria 1 ☑ Criteria 2 ☐ Criteria 3 ☑ Criteria 4 ☐ Criteria 5 ☐ Criteria 6
Summary of Values	Criteria related: • fish species (diversity and endemic); • high diversity of plants; • high diversity of aquatic ecosystems; • endangered ecological community (the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin); and • refuge (permanent water). Identified by experts: • as above, plus endemic macroinvertebrates.
Description/ justification	As the values of this site were predominantly related to fish and permanent wetland features, it was determined that hydrology was the most important feature for identifying the EFZ. The delineation of the EFZ was informed by the expert opinion of Travis Gotch and is based on hydrology (i.e. equivalent to the wetted area around the springs).
Presence in other listing	☐ Ramsar ☐ World Heritage Areas ☐ Flyways ☐ EPBC threatened species.

2.2 Assessment Units 4264, 4293, 4438—Lake Galilee

Step 1 Identify/review values, aquatic ecosystem classification, and components and processes for the high ecological value aquatic ecosystems or assessment units

Lake Galilee spans three assessment units (4264, 4293 and 4438) which scored 'very highly' for criterion 2 (Distinctiveness), and waterbird abundance (attribute for criterion 3), amongst others (Table 9). A rare wetland type was identified within assessment unit 4438 (Riverine type 25—upland, waterhole, groundwater, permanent, saline). The high scores for 'distinctiveness' were driven by the threatened ecological community of the Great Artesian Basin springs. The springs are located in the periphery of the assessment units and not associated with Lake Galilee. Additionally, the rare wetland type (Riverine type 25) identified through the LEB HEVAE trial is most likely the product of mapping errors and those that knew the site well expressed doubt that it occurred in the site.

Members of the ERP indicated that Lake Galilee had a number of values that were not identified through the LEB HEVAE trial because of data deficiencies. In particular, they considered the site to have values associated with:

- waterbird feeding and breeding
- macroinvertebrates (rare species)
- rare and threatened vegetation types (regional ecosystems)
- geomorphic features (beaches on the north-western shoreline).

Table 9 Outputs of LEB HEVAE trial for assessment units 4264, 4293, 4438 (highest rank shown)

CRITERIA	RANK	ATTRIBUTES	RANK
1. Diversity	Medium	Diversity of aquatic ecosystem type	Low
		Diversity of native aquatic ecosystem-dependent spp. fish	Null
		Waterbirds	High
		Reptiles	Low
		Frogs	Medium
		Mammals	Null
		Woody plants	Low
		Non-woody plants	Low
		Diversity of aquatic ecosystem vegetation types (QLD only)	Very High
2. Distinctiveness	Very High	Threatened species	Low
		Priority species	Medium
		Migratory bird species (East Asian–Australasian Flyway)	Medium
		Threatened aquatic ecological community	Very High
		Conservation status of aquatic regional ecosystems (QLD only)	Very High
3. Vital habitat	Medium	Waterbird abundance	Very High
		Significance of site for waterbird breeding (large colonial breeding events)	Null
		Refugia (permanent water)	Very High
4. Evolutionary History	Very High	Endemic species	Low

Spatially displaying the expert-identified values for this site was not possible with the available data. No location data was provided for waterbird breeding, feeding and abundance nor are exact areas important to macroinvertebrate communities known. The important geomorphic features were visible on satellite imagery, but not at the resolution of the imagery available for publication.

Step 2 Identify the core elements

The delineation of core elements was based on existing wetland mapping and was informed by expert opinion. Core elements were considered to be the wetland polygons associated with the main body of the lake, but excluding inflowing channels (Figure 25). The focus on Lake Galilee reflects the expert derived values adopted by the ERP.

Step 3 Identify and summarise the critical components and processes

An ecological description was not undertaken as part of this trial, thus critical components and processes were not identified.

Step 4 Identify the ecological focal zones (EFZ) and delineate the overall EFZ

Available data layers that were assessed for the purpose of objectively delineating the ecological focal zone (EFZ) with comments on their applicability are provided in Figures 26 to 28.

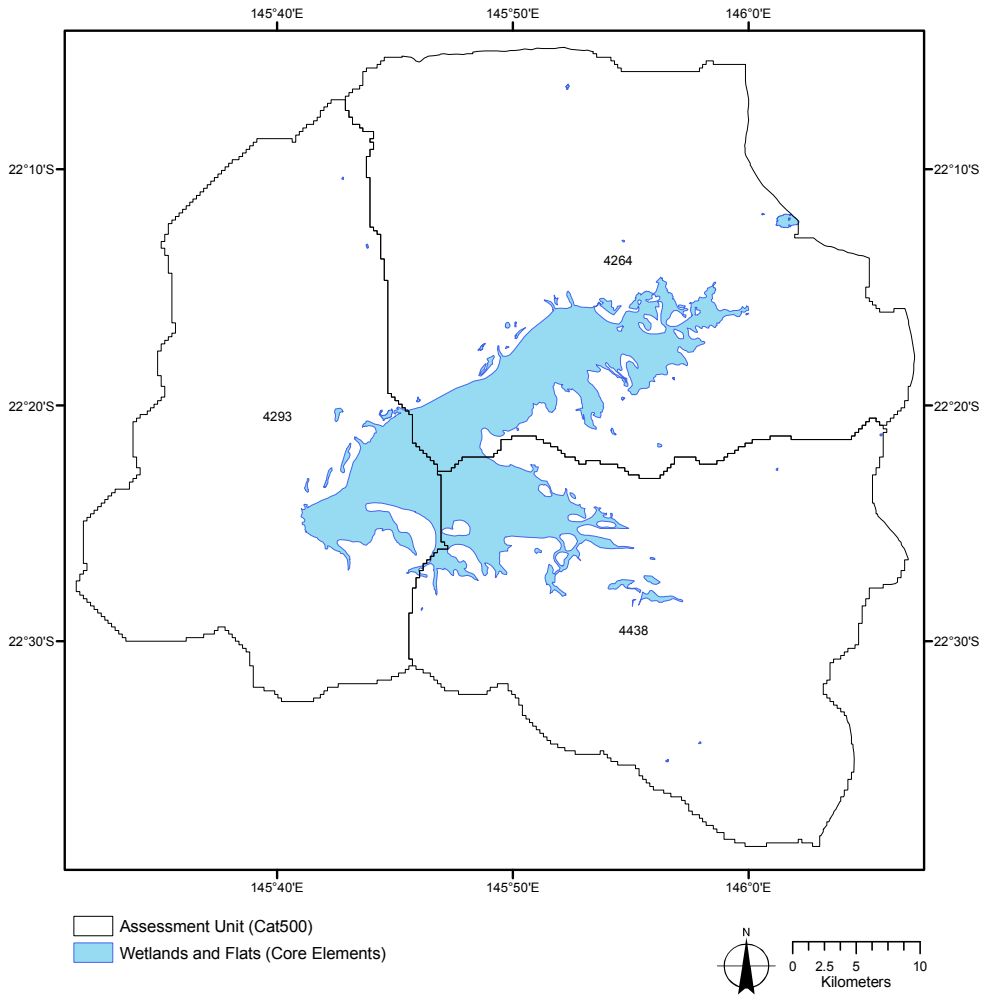


Figure 25 **Aquatic ecosystems that contribute significantly to the values of assessment units 4264, 4293, and 4438.**
These are the core elements to be used for delineating the ecological focal zone.

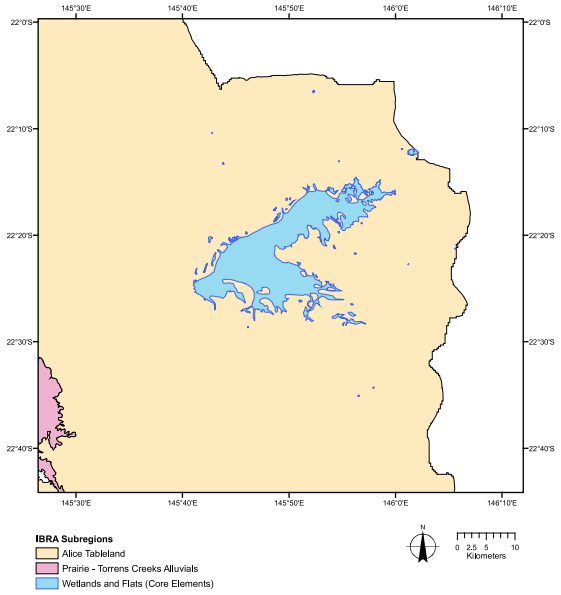


Figure 26 IBRA subregions surrounding the core elements identified within assessment units 4264, 4293, and 4438

Do not appear to align with any identifiable landscape features, geomorphic or ecological processes related to the core elements and were not considered useful to inform the process of defining the EFZ.

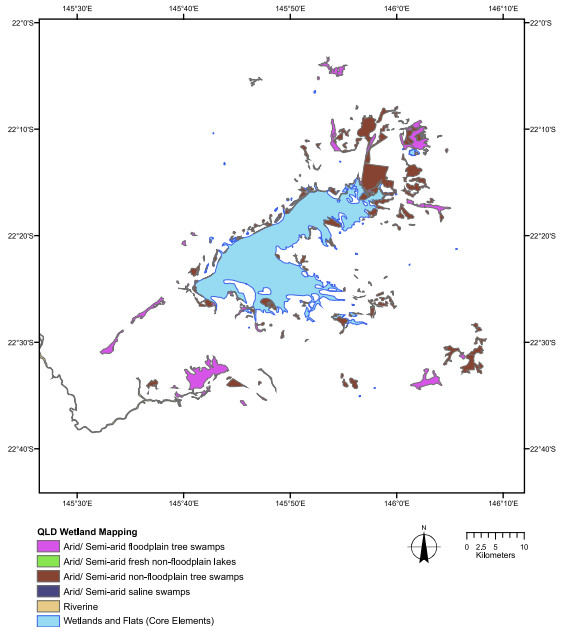


Figure 27 QLD Regional Ecosystem mapping surrounding the core elements identified within assessment units 4264, 4293, and 4438 (Wetland mapping and classification for Queensland 2009)

Only partial coverage associated with specific wetland types but does highlight the presence of tea-tree swamps in various locations around the fringes of Lake Galilee.

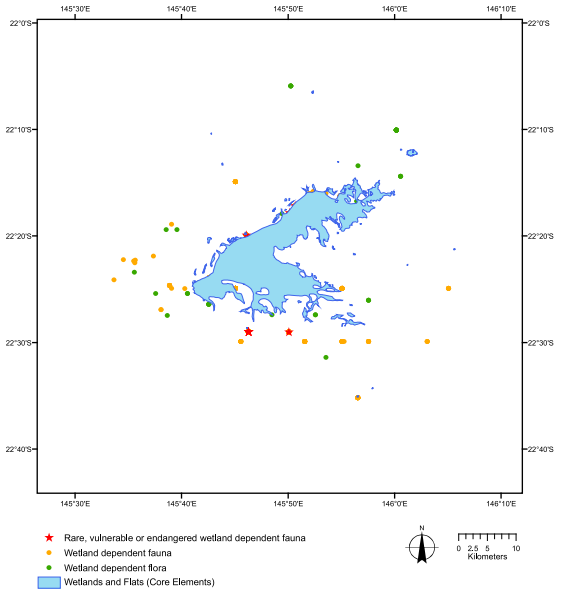


Figure 28 Location of species records for wetland-dependent flora and fauna in assessment units 4264, 4293, and 4438. Stars indicate locations with species listed as rare, vulnerable or endangered in Queensland

The locality of records for wetland-dependent species were for the most part not associated with Lake Galilee, nor other wetlands in the vicinity. All of the faunal records were migratory waterbirds and the recorded data may represent sites of access along the road network rather than associations with aquatic ecosystems. Only three sites had threatened wetland-dependent birds and no threatened wetland-dependent plants were recorded. These data were considered by the ERP to be too sparse and not closely related to the core element (Lake Galilee) and therefore not useful in delineating the lake's EFZ.

Because of the paucity of available data the EFZ was defined by expert opinion using wetland and vegetation mapping to delineate the wetland areas on the lake fringe and including a buffer to capture discernable alluvial features (Figure 29):

1. Small zone—[Core Elements]

This is the lake bed plus fringing palustrine wetlands plus bordering dunes. It equates to what might be considered wetland plus 'riparian' zone. However, in substantial areas this option does not extent beyond the wetland core area.

2. Core elements plus a buffer—[Option 1 EFZ]

A buffer has been added to include additional areas adjacent to the wetland proper where there was no buffer around the core area in the above option. The additional area is based on discernable alluvial/wetland-type features but where these features kept going, an arbitrary cutoff was utilised. The buffer can be several kilometres wide but as these lakes are themselves 20 to 35 kilometres wide/long it doesn't look out of scale.

3. Whole catchment—[Option 2 EFZ]

At the workshop there was discussion on including other alluvial or lake-related geomorphological features in the EFZ. In some cases these features have clear boundaries e.g. the fans clearly visible on the imagery to north-west of Lake Galilee and Buchanan, or the clay plains of the old lake bed (with partially cleared gidgee) clearly discernable to the north of Galilee, but in others they either didn't have clear boundaries or started to include most of the catchment. Therefore, the third option is the whole catchment. Obviously the whole catchment would not normally equate to the EFZ but is justified in this case as:

- the catchments are not large relative to the wetlands, and all drainage lines in the catchment feed directly into the lakes and thus would comply with the EFZ definition i.e. the area that supports the values of the core elements in terms of function and connectivity
- the catchments include mainly areas that would have been part of the old lake beds—there are a few areas of residuals in the catchments that would not have been the original lake beds but it wasn't sensible to exclude them.

Ecological focal zones were identified for each of the identified values. The EFZ for geomorphic features includes the beaches on the north-western shoreline (Figure 29). The EFZ for waterbirds and macroinvertebrate values could also be defined by surrounding terrestrial regional ecosystems (Figure 29). The EFZ for waterbirds includes Lake Buchanan and Cauckingburra Swamp (hereafter referred to as the Lake Buchanan complex) and includes the beaches and relevant regional ecosystems surrounding these wetlands (Figure 29). This EFZ was justified based on expert knowledge that birds that breed within the lake may use the Lake Buchanan complex as core feeding grounds and as such both feeding and breeding habitats were important for maintaining waterbird values (J Reid 2010, pers. comm., 14 December). Direct evidence of waterbird feeding at the Lake Buchanan complex is lacking, however, for the purposes of this trial the working group agreed to base the EFZ on the presumption of this being the case because:

- It generated the scenario where the potential EFZ for different values were at different spatial scales (i.e. the discrete nature of the geomorphic features versus the larger area required for waterbirds).
- It supported the concept of a disjunct EFZ.

The EFZ for Lake Galilee includes the regional ecosystems surrounding the lake, and a separate polygon at the Lake Buchanan complex including the regional ecosystems surrounding these features. The ERP recommended that the EFZs for each attribute be retained for informing future management of the site.

The delineation of this site could be improved by further interpretation and mapping. The use of finer scale vegetation mapping and/or satellite imagery may have been useful in providing a more objective delineation of the EFZ for this site.

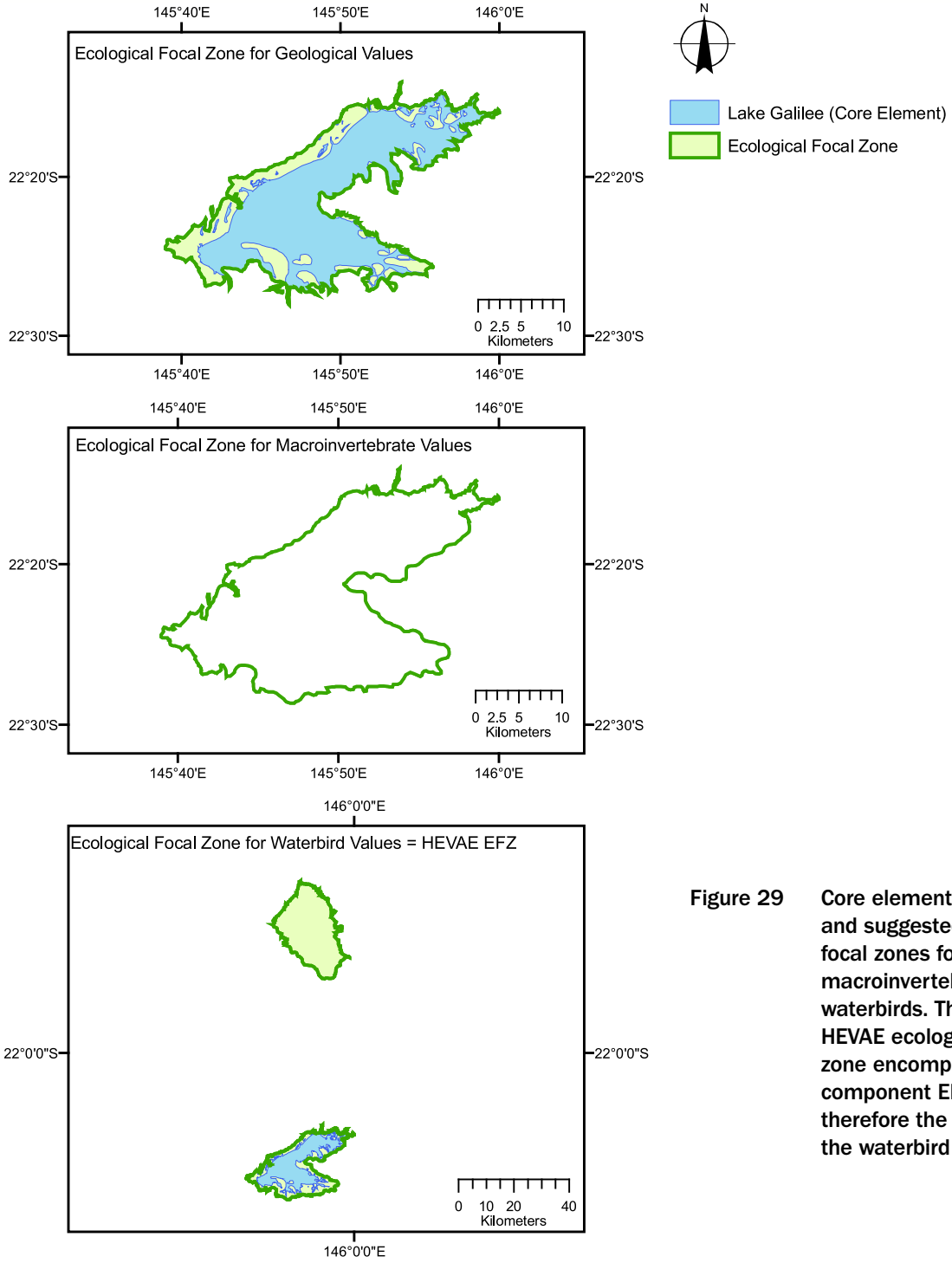


Figure 29 **Core element (Lake Galilee) and suggested ecological focal zones for geology, macroinvertebrates and waterbirds. The delineated HEVAE ecological focal zone encompasses all component EFZ and is therefore the same as the waterbird EFZ**

Step 5 Identify/develop conceptual models

An ecological description was not undertaken as part of this trial, thus conceptual models were not identified or developed.

Step 6 Identify threats

An ecological description was not undertaken as part of this trial, thus threats were not identified.

Output—Aquatic Ecosystem Delineation Record Sheet

AQUATIC ECOSYSTEM DELINEATION RECORD SHEET	
Name of aquatic ecosystem	Lake Galilee
Date of delineation	January 2011
Purpose for delineation (e.g. water planning)	Case study
Ecosystem description	Lake Galilee is a saline playa tectonic terminal lake in central Queensland. It is located in a shallow closed basin bordered by the Great Dividing Range to the west and north. Its catchment is internally draining, fed by some 20 seasonal streams.
Ecosystem types	Upland, non-floodplain, surface water, permanent, fresh Upland, non-floodplain, surface water, permanent, saline
Land use	Conservation (lake bed); agriculture (surrounding area)
Land tenure	Unallocated state land
Scale	HEVAE criteria were applied at the 500 km^2 nested catchment scale, site was delineated at the aquatic ecosystem scale (i.e. the lake and associated EFZ).
Experts involved	Julian Reid, (Australian National University)—waterbirds Brian Timms (University of New South Wales)—macroinvertebrates and geomorphology Bruce Wilson (QLD Department of Environment and Resource Management)—vegetation
Datasets used	Lake Eyre Basin Aquatic Ecosystem Mapping (2010) developed for the Lake Eyre Basin HEVAE Trial, held by SEWPaC (ERIN) QLD Regional Ecosystem Mapping (QLD DERM)
Gaps/limitations	The delineation of the HEVAE Lake Galilee was problematic for a number of reasons. Firstly, it was not identified through a strict application of the process as a potential HEVAE and so values associated with the site were informed predominantly by expert opinion (although the data for some attributes from the LEB HEVAE Trial supported the expert opinion). Secondly, none of the available data layers provided a clear delineation of the EFZ. Instead the delineation was informed almost exclusively by expert opinion and as such transparency was lost in the process. The delineation of this site could be improved by further interpretation and mapping. The use of finer scale vegetation mapping and/or satellite imagery may have been useful in providing a more objective delineation of the EFZ for this site.

HEVAE criteria met	☐ Criteria 1 ☐ Criteria 2 ☑ Criteria 3 (waterbird abundance) ☐ Criteria 4 ☐ Criteria 5 ☐ Criteria 6
Summary of values	Criteria related: • waterbird abundance. Identified by experts: • waterbird feeding and breeding • macroinvertebrates (rare species) • rare and threatened vegetation types (regional ecosystems) • geomorphic features (beaches on the north-western shoreline).
Description/ justification	Because of the paucity of available data the EFZ was defined by expert opinion using wetland and vegetation mapping to delineate the wetland areas on the lake fringe and including a buffer to capture discernable alluvial features. Ecological focal zones were identified for each of the identified values. The EFZ for geomorphic features includes the beaches on the north-western shoreline (as informed by Brian Timms). The EFZ for waterbirds and macroinvertebrate values could also be defined by surrounding terrestrial regional ecosystems (as informed by Bruce Wilson). The EFZ for waterbirds includes Lake Buchanan and Cauckingburra Swamp and includes the beaches and relevant regional ecosystems surrounding these wetlands (as informed by Julian Reid). This EFZ was justified based on expert knowledge that birds that breed within the lake may use Lake Buchanan and Cauckingburra Swamp as core feeding grounds and as such both feeding and breeding habitats were important for maintaining waterbird values (J Reid 2010, pers. comm., 14 December).
Presence in other listing	☐ Ramsar ☐ World Heritage Areas ☐ Flyways ☐ EPBC threatened species.

2.3 Assessment Units 1000, 1001, 1002—Coongie Lakes

Step 1 Identify/review values, aquatic ecosystem classification, and components and processes for the high ecological value aquatic ecosystems or assessment units

Coongie Lakes spans three assessment units (1000, 1001 and 1002) which scored very highly for criteria 1 (Diversity) and 3 (Vital Habitat) (Table 10). In particular the assessment unit scored highly for:

- aquatic ecosystem types (diversity, permanent water)
- fish (species richness, endemic species)
- waterbirds (species richness, abundance, breeding, threatened species)
- plant species richness.

Table 10 Outputs of LEB HEVAE trial for assessment units 1000, 1001, 1002 (highest rank shown)

CRITERIA	RANK	ATTRIBUTES	RANK
1. Diversity	Very High	Diversity of aquatic ecosystem type	Very High
		Diversity of native aquatic ecosystem-dependent spp. fish	Very High
		Waterbirds	Very High
		Reptiles	Medium
		Frogs	High
		Mammals	Very High
		Woody plants	Very High
		Non-woody plants	Very High
		Diversity of aquatic ecosystem vegetation types (QLD only)	Very High
2. Distinctiveness	Medium	Threatened species	High
		Priority species	Null
		Migratory bird species (East Asian–Australasian Flyway)	Medium
		Threatened aquatic ecological community	Null
		Conservation status of aquatic regional ecosystems (QLD only)	Not applicable
3. Vital habitat	Very High	Waterbird abundance	Very High
		Significance of site for waterbird breeding (large colonial breeding events)	Very High
		Refugia (permanent water)	Very High
4. Evolutionary History	High	Endemic species.	High

Step 2 Identify the core elements

The delineation of core elements was based on existing wetland mapping and was informed by expert opinion. Ephemeral floodplain wetlands dominate the landscape of assessment units 1000, 1001 and 1002, however, some values are linked directly to other ecosystem types (e.g. permanent waterholes with endemic fish populations give high values for refugia and endemic fish) and so all aquatic ecosystem types were considered to contribute to the values of the units. Based on expert opinion, the core elements were restricted to the main Cooper Creek drainage. Wetlands in the southern half of assessment unit 1001 associated with Strzelecki Creek flood infrequently and were less likely to be contributing to the values of this unit than wetlands of the Cooper Creek. The eastward boundary was drawn to exclude the stony rises which were considered to be part of a separate system. The core elements were therefore initially defined as all aquatic ecosystem types fed from Cooper Creek within the assessment units 1000, 1001 and 1002 (Figure 30).

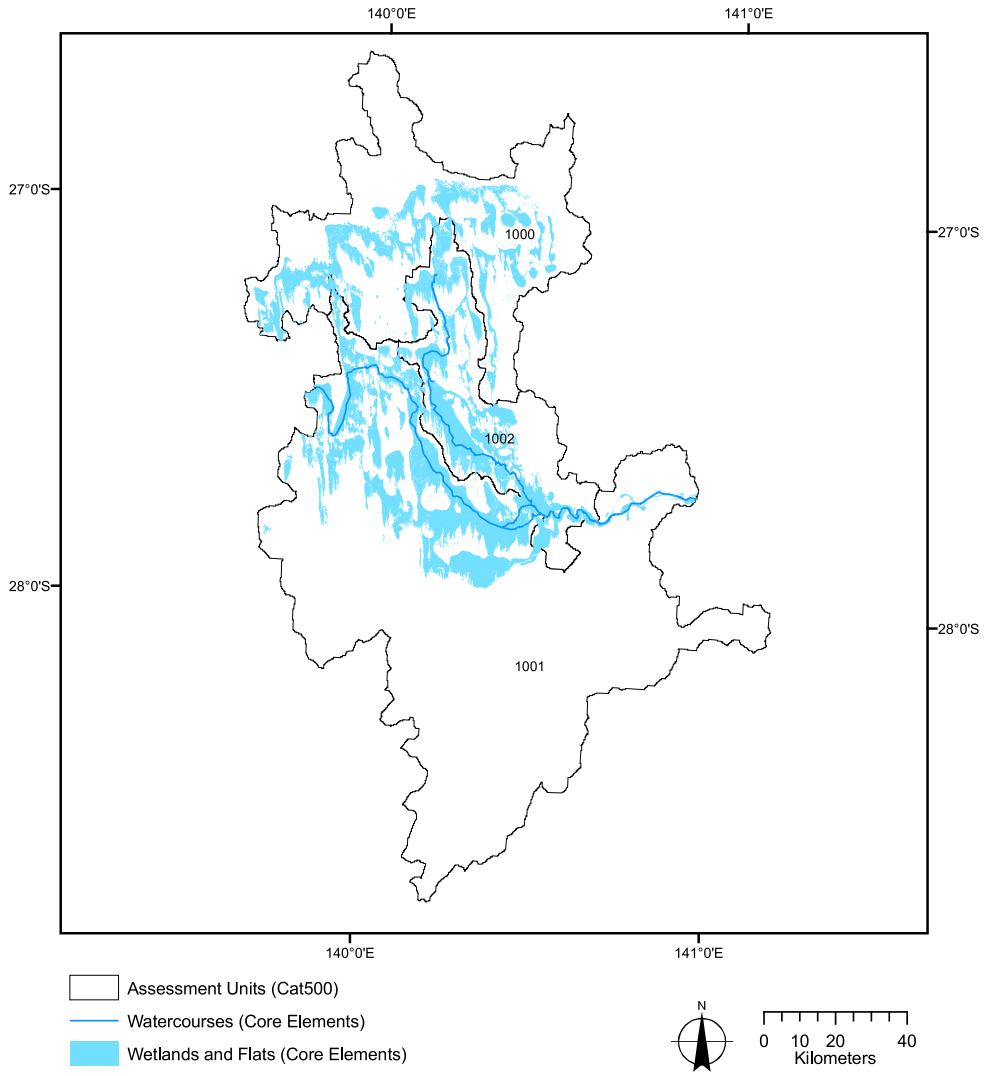


Figure 30 **Aquatic ecosystems that contribute significantly to the values of assessment units 1000, 1001 and 1002.**
These wetlands of the Cooper Creek drainage are the core elements to be used for delineating the ecological focal zone.

After delineation of the EFZ core elements were reassessed as all mapped aquatic ecosystems within the EFZ. Core elements for different values were proposed by the ERP as follows:

- core elements for fish equate to the area between Cullyamurra Waterhole and Coongie Lake
- core elements for aquatic ecosystem diversity include all aquatic ecosystems in the EFZ
- core elements for waterbirds include major waterholes and floodplains within the system.

However, despite the suggestion of different core elements for different values, it was not possible to delineate this with the available data. Firstly, data provided did not include the names for watercourses and wetlands and so the isolation of the core element for fish was problematic. In addition, the core elements for waterbirds were not described by the experts in sufficient detail for individual aquatic ecosystems to be identified.

Step 3 Identify and summarise the critical components and processes

An ecological description was not undertaken as part of this trial, thus critical components and processes were not identified.

Step 4 Identify the ecological focal zones (EFZ) and delineate the overall EFZ

Available data layers that were assessed for the purpose of objectively delineating the EFZ with comments on their applicability are provided in Figures 31 to 36.

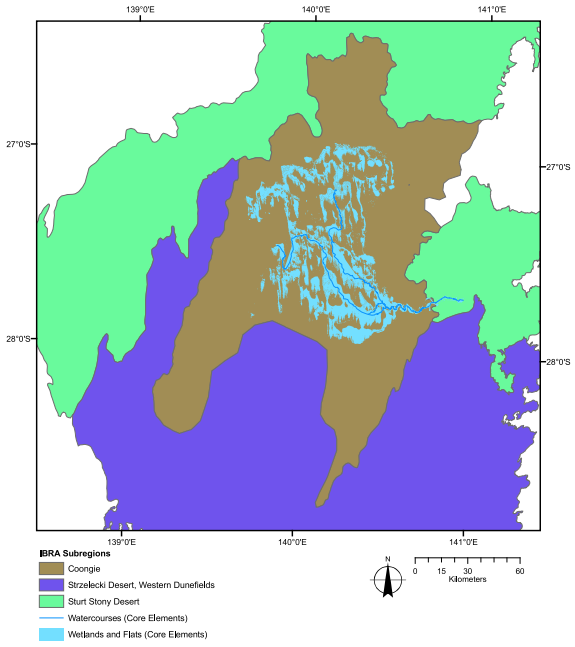


Figure 31 IBRA subregions surrounding the core elements identified within assessment units 1000, 1001 and 1002

The Coongie IBRA subregion encompasses all of the core elements. It also includes areas to the north and east of the Cooper Creek drainage, as well as the Strzelecki Creek system to the south that in the expert opinion of Julian Reid (2010, pers. comm., 14 December) are quite different (and more ephemeral) than the core elements in the Cooper Drainage. The western projection of the Coongie IBRA subregion contains the continuation of Cooper Creek and a similar landscape to the core elements of assessment units 1000, 1001 and 1002.

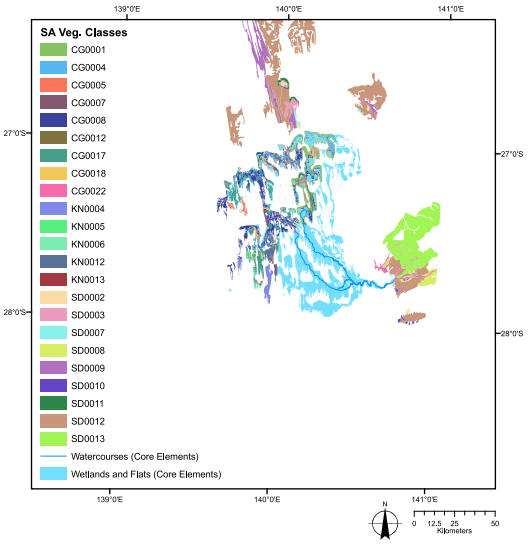


Figure 32 Dominant vegetation classes in the area surrounding the core elements identified within assessment units 1000, 1001 and 1002 (South Australian vegetation ID mapping)

Dominant vegetation type mapping is patchy, does not appear to relate to the core elements, and is not considered further in the determination of the EFZ.

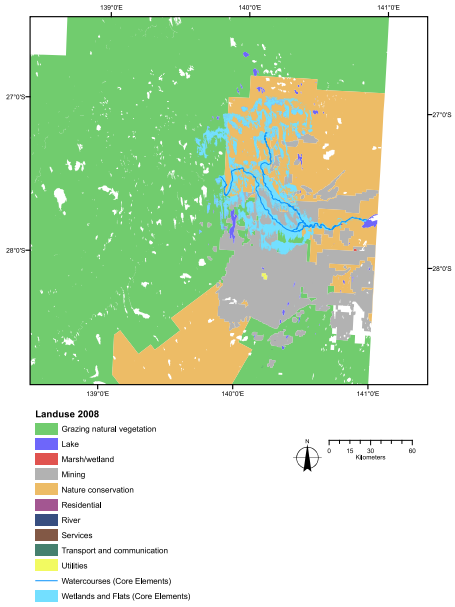


Figure 33 2008 land use surrounding the core elements identified within assessment units 1000, 1001 and 1002

The area of the core elements does not appear relevant to any ecologically meaningful boundaries that may inform the EFZ. Much of the area falls under large-scale mining and/or grazing leases, the boundaries of which do not relate to aquatic ecosystems. The 2008 Land Use layer includes some wetlands, but these are a small subset of wetland features found in other data layers.

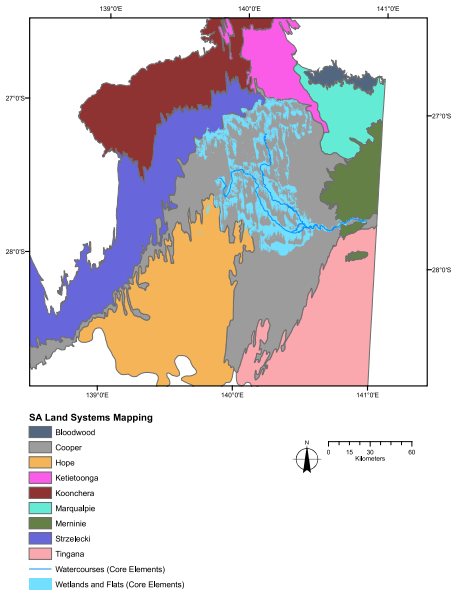


Figure 34 Land systems mapping of the area surrounding the core elements identified within assessment units 1000, 1001 and 1002

The Cooper Land System contains the core elements and downstream drainage area and may provide a good approximation of the EFZ for this HEVAE. The Strzelecki Creek system which was excluded by the Expert Reference Panel for being too ephemeral is also included, however digital elevation modelling (DEM) could be used to remove the Strzelecki Creek system from the Cooper Land System to give the EFZ. Given the apparent dominance of the drainage boundaries on the land system determination in this case it may be more sensible to just use DEM to define the EFZ.

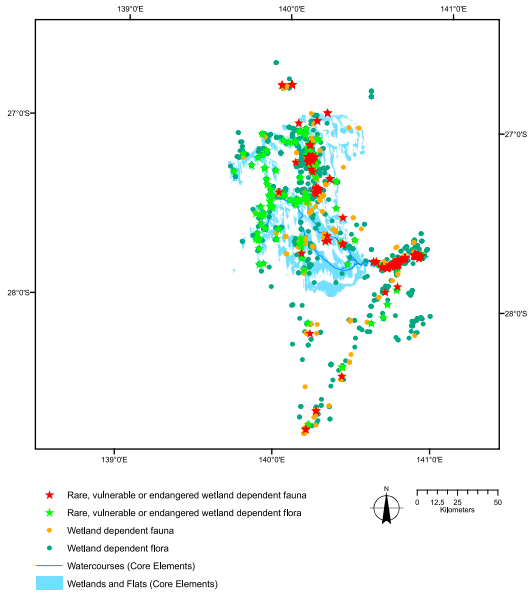


Figure 35 **Location of species records for wetland-dependent flora and fauna in assessment units 1000, 1001 and 1002. Stars indicate locations with species listed as rare, vulnerable or endangered in South Australia**

The locality of records for wetland-dependent species appear more strongly associated with the road network than with aquatic habitats, reflecting strong sampler bias. Only six records for threatened wetland-dependent fauna were found, all being migratory bird species (South Australia could not supply location data for fish for this project). Only two records for threatened wetland-dependent plants were found and these were not associated with the core elements.

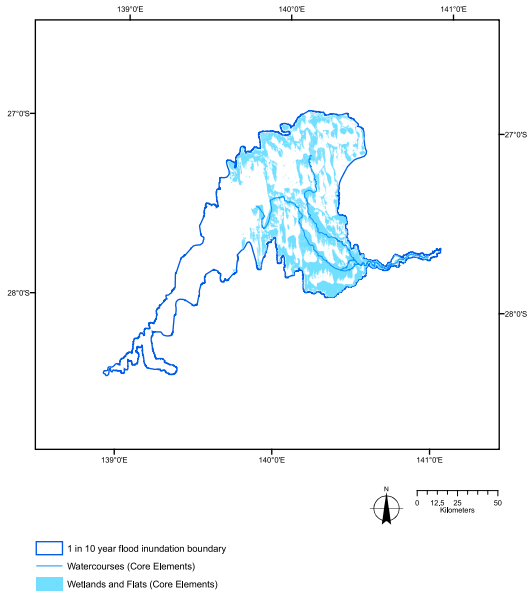


Figure 36 **One in 10 year flood inundation limit for the lower Cooper Creek containing the core elements identified within assessment units 1000, 1001 and 1002**

Widespread flooding of Cooper Creek is known to be a major driver of the ecological values exhibited by the core elements in this landscape. The Expert Reference Panel supported using the 1 in 10 year flood inundation extent as a potential EFZ. More infrequent flood frequencies (larger floods) could be used to define a larger EFZ though very infrequent flooding may be too stochastic to drive the values expressed by the core elements. The 1 in 10 flood frequency is probably an upper limit for supporting waterbird breeding and vegetation communities and therefore may represent a reasonable approximation to the EFZ.

The EFZ for this system (Figure 37) is based on hydrological connectivity and geomorphology. The EFZ boundary corresponds to the one in 10 year inundation extent of the Coongie Lake complex and extends from Cullyamurra Waterhole, following the Cooper flood out and lakes down to just below Lake Hope.

As the EFZ boundary extends beyond the original assessment units identified through the LEB HEVAE Trial the core elements were reassessed to include all aquatic ecosystems within the EFZ that contribute to the values of the HEVAE (as informed by expert opinion) (Figure 37).

The justification for the choice of one in 10 year inundation extent, as opposed to a one in 20 ARI or one in 100 ARI was not explicitly provided. It was the consensus of the Expert Reference Panel that one in 10 years seemed to be appropriate with respect to arid zone ecology, but more detail was not provided.

The use of flora and fauna records is of limited use in this case as it is strongly influenced by sampling bias. Improvements to the delineation of the Coongie Lakes HEVAE could be made if there was more comprehensive mapping of habitats from across the site. A combined vegetation and aquatic ecosystem map across the assessment units may have been useful in defining key habitat areas for waterbird feeding and breeding. However, as current vegetation mapping is at a relatively coarse resolution and does not extend across the entire site this was not feasible. Additionally, there are comprehensive waterbird data available for this site, although they are not currently in a spatial form that might provide indicators of diversity such as number of different feeding/breeding guilds and abundance (based on mean or maximum counts) for individual waterbodies within the Coongie Lakes. Whether this would be valuable in terms of delineating the HEVAE, however, is not known.

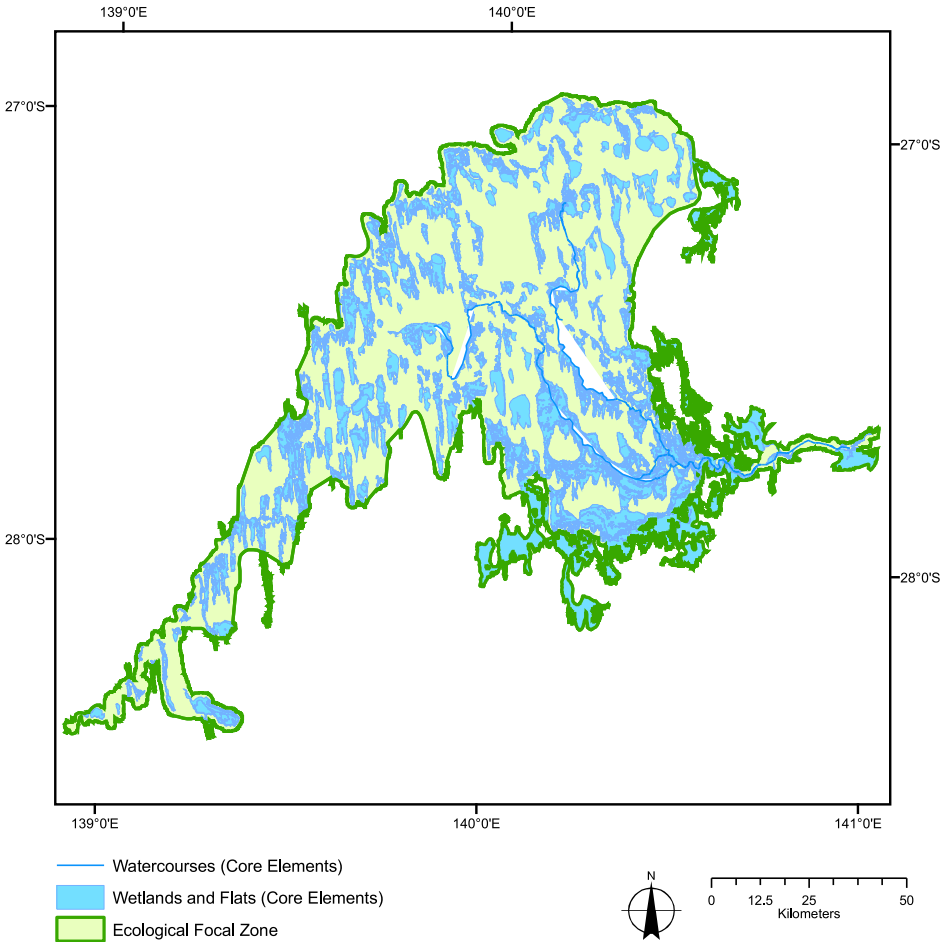


Figure 37 **Delineated HEVAE ecological focal zone containing Coongie Lakes and wetlands of the lower Cooper Creek**

Step 5 Identify/develop conceptual models

An ecological description was not undertaken as part of this trial, thus conceptual models were not identified or developed.

Step 6 Identify threats

An ecological description was not undertaken as part of this trial, thus threats were not identified.

Output—Aquatic Ecosystem Delineation Record Sheet

AQUATIC ECOSYSTEM DELINEATION RECORD SHEET	
Name of aquatic ecosystem	Coongie Lakes
Date of delineation	January 2011
Purpose for delineation	Case study
Ecosystem description	Coongie Lakes is a system of lakes, streams and floodplain of the Cooper Creek system from the South Australian–Queensland border downstream to Lake Hope (Lake Pando). It includes the north-west branch of Cooper Creek, the northern overflow and their many waterholes and terminal lakes covering an area of approximately 1.9 million hectares.
Ecosystem types (dominant types)	Non-riverine: • lowland, floodplain, surface water, non-permanent, fresh • lowland, non-floodplain, surface water, non-permanent, saline. Riverine: • lowland, channel, surface water, non-permanent, fresh • lowland, waterhole, surface water, permanent, fresh.
Land use	Conservation
Land tenure	National Park
Scale	HEVAE criteria were applied at the 500 km^2 nested catchment scale, site was delineated at the aquatic ecosystem scale (i.e. the floodplain and associated EFZ).
Experts involved	Julian Reid (Australian National University)—waterbirds.
Datasets used	Lake Eyre Basin Aquatic Ecosystem Mapping (2010) developed for the Lake Eyre Basin HEVAE Trial; held by SEWPaC (ERIN). Coongie Lakes 1 in 10 year flood inundation mapping (provided by SA Department of Environment and Natural Resources).
Gaps/limitations	Expert opinion and local knowledge provided by Julian Reid (independent waterbird expert) informed the choice of a suitable data layer for the delineation of the EFZ and identification of core elements within. The EFZ corresponded to the 1 in 10 year inundation flood extant, with upstream and downstream extent determined by geomorphology. However, the justification for the choice of 1 in 10 year inundation extent, as opposed to a 1 in 20 ARI or 1 in 100 ARI was not explicitly provided. It was the consensus of the Expert Reference Panel that 1 in 10 years seemed to be appropriate with respect to arid zone ecology, but more detail was not provided.

AQUATIC ECOSYSTEM DELINEATION RECORD SHEET	
Gaps/limitations	While the notion of identifying different core elements for different values was explored, this could not be translated into a mapping product. This was due both to insufficient data resolution and availability as well as knowledge gaps with respect to the ecology of the system. Improvements to the delineation of the Coongie Lakes HEVAE could be made if there was more comprehensive mapping of habitats from across the site. A combined vegetation and aquatic ecosystem map across the assessment units may have been useful in defining key habitat areas for waterbird feeding and breeding. However, as current vegetation mapping is at a relatively coarse resolution and does not extend across the entire site this was not feasible. In addition, there are comprehensive waterbird data available for this site, although they are not currently in a spatial form that might provide indicators of diversity such as number of different feeding/ breeding guilds and abundance (based on mean or maximum counts) for individual waterbodies within the Coongie Lakes. Whether this would be valuable in terms of delineating the HEVAE, however, is not known.
HEVAE criteria met	☑ Criteria 1 ☐ Criteria 2 ☑ Criteria 3 ☐ Criteria 4 ☐ Criteria 5 ☐ Criteria 6 Other criteria: Ramsar criteria 1, 2, 3, 4, 5, 6.
Summary of Values	Criteria related: • aquatic ecosystem types (diversity, permanent water) • fish (species richness, endemic species) • waterbirds (species richness, abundance, breeding, threatened species) • plant species richness. Identified by experts: As above.
Description/ Justification	The EFZ for this system is based on hydrological connectivity and geomorphology (informed by Julian Reid with agreement by Expert Reference Panel members). The EFZ boundary corresponds to the 1 in 10 year inundation extent of the Coongie Lake complex and extends from Cullyamurra waterhole, following the Cooper flood out and lakes to just below Lake Hope.
Presence in other listing	☑ Ramsar ☐ World Heritage Areas ☐ Flyways ☑ EPBC threatened species.

2.4 Assessment Units 4779, 5088, 5093, 5094—Chewings Range spring-fed pools

Step 1 Identify/review values, aquatic ecosystem classification, and components and processes for the high ecological value aquatic ecosystems or assessment units

Chewings Range spring-fed pools span four assessment units: 4779, 5088, 5093 and 5094, which scored very highly for criteria 1 (Diversity) and 4 (Evolutionary History) (Table 11). In particular the assessment units scored highly for:

- fish species (diversity and endemic)
- high diversity of plants
- high diversity of aquatic ecosystems
- refuge (permanent water).

Table 11 Outputs of LEB HEVAE trial for assessment units 4779, 5088, 5093 (highest rank shown)

CRITERIA	RANK	ATTRIBUTES	RANK
1. Diversity	Very High	Diversity of aquatic ecosystem type	Very High
		Diversity of native aquatic ecosystem-dependent spp. fish	Very High
		Waterbirds	Medium
		Reptiles	Null
		Frogs	High
		Mammals	Null
		Woody plants	Very High
		Non-woody plants	Very High
		Diversity of aquatic ecosystem vegetation types (QLD only)	Not applicable
2. Distinctiveness	Medium	Threatened species	Low
		Priority species	Very High
		Migratory bird species (East Asian–Australasian Flyway)	Low
		Threatened aquatic ecological community	Null
		Conservation status of aquatic regional ecosystems (QLD only)	Not applicable
3. Vital habitat	Medium	Waterbird abundance	Null
		Significance of site for waterbird breeding (large colonial breeding events)	Null
		Refugia (permanent water)	Very High
4. Evolutionary History	Very High	Endemic species.	Very High

Step 2 Identify the core elements

This region of the Northern Territory has very little standing water limited to a small number of isolated spring systems. Core elements were defined as the point location of springs provided by Angus Duguid from the NT Department of Natural Resources, Environment, The Arts and Sport (NRETAS) (Figure 38). The wetted extent of most springs has not been mapped. The springs are an important source of permanent and near-permanent water in an otherwise arid landscape. The high scores for endemic species and refugia are attributed to fish living in the spring-fed pools. However, there are also endemic macroinvertebrates within these springs (A Duguid 2010, pers. comm.) that were not included in the LEB HEVAE Trial. The springs have low discharge volumes and resultantly small areas of surface water (typically less than 50 m in the channel) that supports clearly dependent 'riparian' vegetation.

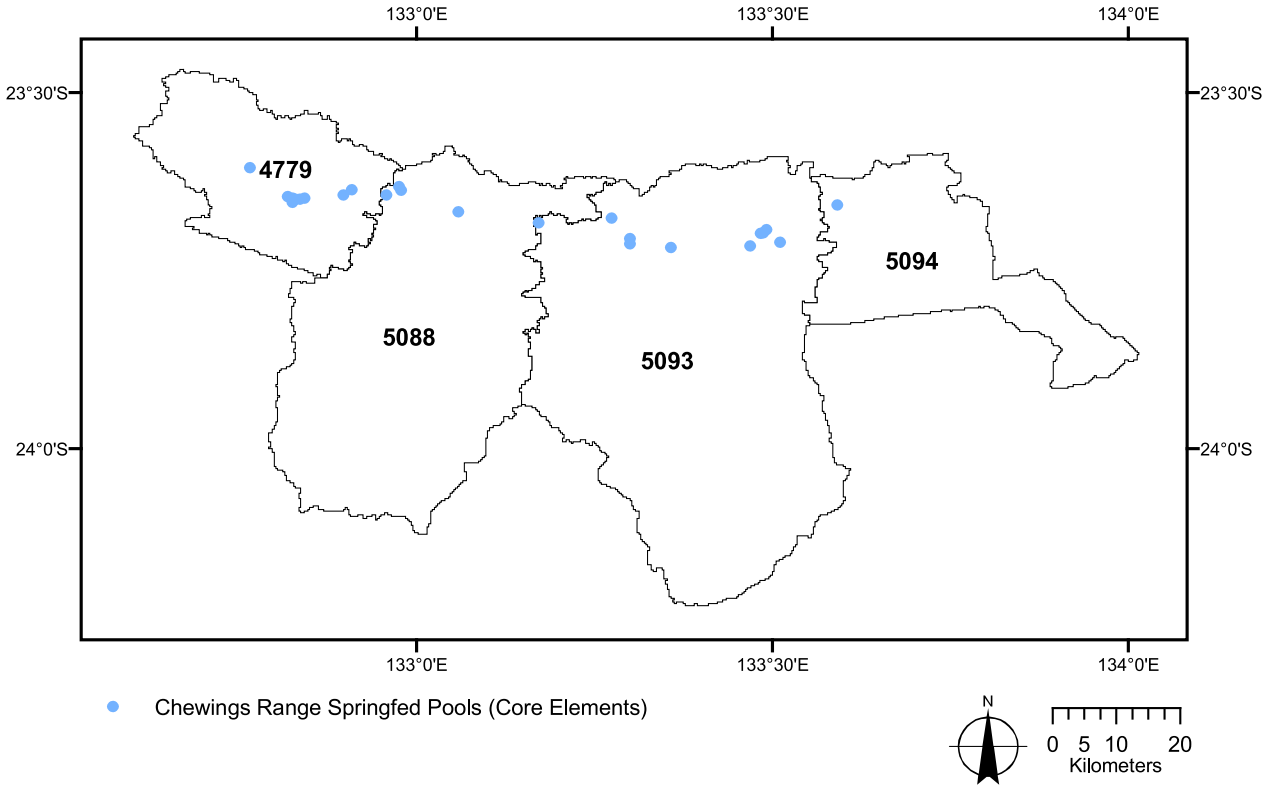


Figure 38 **Aquatic ecosystems that contribute significantly to the values of assessment units 4779, 5088, 5093 and 5094.**
The Chewings Range spring-fed pools are the core elements to be used for delineating the ecological focal zone.

Step 3 Identify and summarise the critical components and processes

An ecological description was not undertaken as part of this trial, thus critical components and processes were not identified.

Step 4 Identify the ecological focal zones (EFZ) and delineate the overall EFZ

Available data layers that were assessed for the purpose of objectively delineating the EFZ with comments on their applicability are provided in Figures 39, 40.

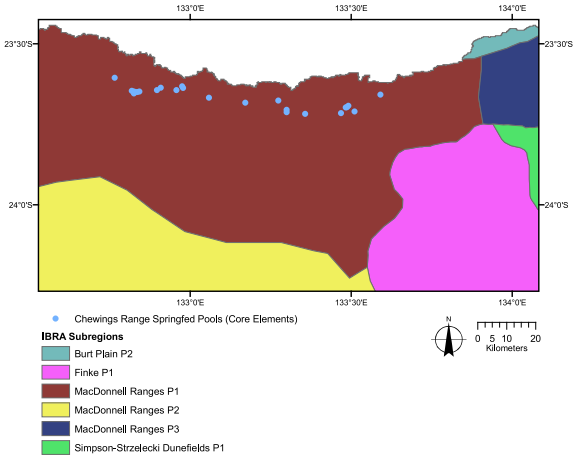


Figure 39 IBRA subregions surrounding the core elements (Chewings Range spring-fed pools) identified within assessment units 4779, 5088, 5093 and 5094

The core elements (the Chewing Ranges spring-fed pools) are highly constrained habitats that support values immediately within and adjacent to the pools and extending downstream no more than a few hundred meters (50m typical). The MacDonnell Ranges P1 IBRA subregion encompasses the core elements but is at a much larger scale than the potential EFZ for the springs.

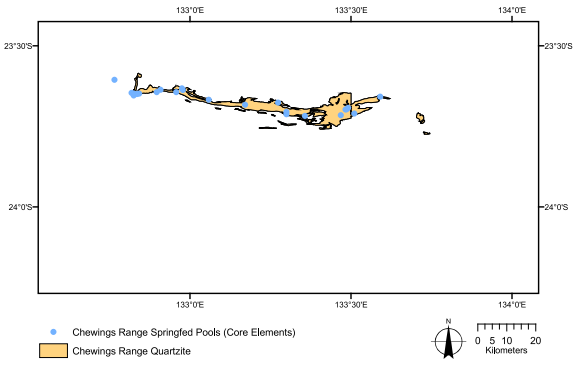


Figure 40 Distribution of the Chewings Range quartzite formation (Digital Geology of the Northern Territory)

The 1:250 000 map series was used to delineate the extent of the Chewings Range quartzite formation. The Chewings Range is a tall range and rainfall generated by orographic uplift yields both runoff and infiltration through cracks in the quartzite formation. The springs arise from fractures in the Chewings Range quartzite along drainage lines. The extent of the quartzite formation provides a geological basis for defining the extent of the EFZ.

The delineation of the EFZ was informed by expert opinion. Twenty-six individual springs were identified. Two alternative approaches for defining the EFZ were considered:

- Define an EFZ individually for each spring. The springs are isolated both longitudinally within the same drainage line, and across the multiple channels that drain the Chewings Ranges. The key ecological values are constrained to the pools (fish) and wetted-soil perimeter that supports relic ferns, the endemic *Acacia dolichophylla* and river red gums. The EFZ for each spring could be delineated using high-resolution aerial photography where the riparian zone is typically clearly visible and distinct from the surrounding landscape. Imagery to date has not been digitised and mapping the EFZ in this manner was beyond the scope of this trial.
- Define an EFZ that encompasses all springs as a complex. Using the extent of the Chewings Range quartzite formation as the basis for the EFZ (Figure 41) includes important infiltration and recharge areas in the HEVAE. Following the delineation process one core element, Possum Spring to the far west of the spring group, was not located within the EFZ defined by the Chewings Range quartzite. The identification of core elements was reconsidered after the EFZ was delineated. This single spring is therefore not considered to be a core element of the HEVAE.

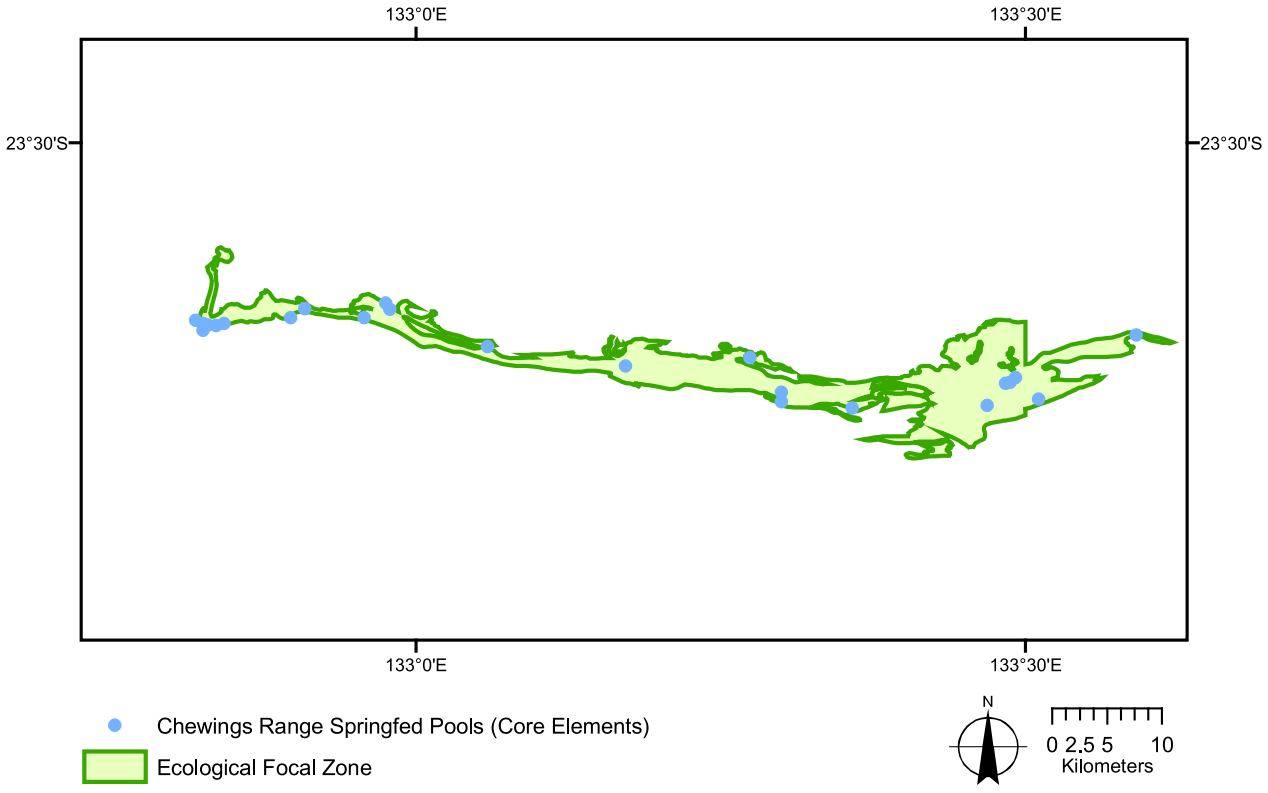


Figure 41 Delineated HEVAE ecological focal zone containing Chewings Range spring-fed pools

Step 5 Identify/develop conceptual models

An ecological description was not undertaken as part of this trial, thus conceptual models were not identified or developed.

Step 6 Identify threats

An ecological description was not undertaken as part of this trial, thus risks were not identified.

Output—Aquatic Ecosystem Delineation Record Sheet

AQUATIC ECOSYSTEM DELINEATION RECORD SHEET	
Name of aquatic ecosystem	Chewings Range spring-fed Pools
Date of Delineation	January 2011
Purpose for delineation (e.g. water planning)	Case study
Ecosystem description	Chewings Range spring-fed pools are a system of springs within drainage lines that incise the quartzite of the tall steep range. They have low discharge volumes, resulting in small areas of surface water and clearly dependent 'riparian' vegetation.
Ecosystem types	Upland, non-floodplain, surface water, non-permanent, fresh
Land use	Unknown
Land tenure	Unknown
Scale	HEVAE criteria were applied at the 500 km^2 nested catchment scale, site was delineated at the aquatic ecosystem scale (i.e. the springs and associated EFZ).
Experts involved	Angus Duguid (NRETAS).
Datasets used	Lake Eyre Basin Aquatic Ecosystem Mapping (2010) developed for the Lake Eyre Basin HEVAE Trial; held by SEWPaC (ERIN). Digital Geology of the Northern Territory. 1:250 000 map series. Location data for springs (x, y coordinate only) from Angus Duguid (NRETAS).
Gaps/limitations	This site in particular suffers from a paucity of data and ecological understanding. The delineation of this site could certainly be improved with greater field-collected data from the site. Little is known of the springs, and sampling has been limited. Satellite or aerial imagery may have helped inform the process, but a greater knowledge and understanding of this unusual system is required before delineation of the HEVAE could be completed with confidence. In particular, the location and extent of the recharge zone for the springs would perhaps be a better indication of the EFZ than the geology selected. In addition, the likely distribution of Acacia dolichophylla using buffered drainage lines to a set distance from the Chewings Range is another possibility that could be explored.
HEVAE criteria met	☑ Criteria 1 ☐ Criteria 2 ☐ Criteria 3 ☑ Criteria 4 ☐ Criteria 5 ☐ Criteria 6

AQUATIC ECOSYSTEM DELINEATION RECORD SHEET	
Summary of values	Criteria related: • fish species (diversity and endemic) • high diversity of plants • high diversity of aquatic ecosystems • refuge (permanent water). Identified by experts: • relict flora and fauna
Description/ justification	Expert opinion and local knowledge provided by Angus Duguid (NRETAS) informed the choice of a suitable data layer for the delineation of the EFZ and identification of core elements within. The EFZ corresponded to Chewings Range quartzite and the core elements were the springs within this EFZ.
Presence in other listing	☐ Ramsar ☐ World Heritage Areas ☐ Flyways ☐ EPBC threatened species.

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Horseshoe Bend on the Finke River near Alice Springs, Northern Territory (Allan Fox & DSEWPaC)

Australian Government