

Aquatic ecosystems toolkit

MODULE 1: Guidance Paper



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Citation

The Aquatic Ecosystems Toolkit is a series of documents to guide the identification of high ecological value aquatic ecosystems. The modules in the series are:

Module 1: Aquatic Ecosystems Toolkit Guidance Paper

Module 2: Interim Australian National Aquatic Ecosystem (ANAE) Classification Framework

Module 3: Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)

Module 4: Aquatic Ecosystem Delineation and Description Guidelines

Module 5: Integrated Ecological Condition Assessment (IECA) Framework

National Guidelines for the Mapping of Wetlands (Aquatic Ecosystems) in Australia

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

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Abbreviations

AETG	Aquatic Ecosystems Task Group
ANAE	(Interim) Australian National Aquatic Ecosystems (Classification Framework)
AquaBAMM	Aquatic Biodiversity Assessment Mapping Methodology
AUSRIVAS	Australian River Assessment System
AVIRA	Aquatic Values Identification and Risk Assessment Tool
CFEV	Conservation of Freshwater Ecosystem Values Framework
CEWO	Commonwealth Environmental Water Office
DERM	(Queensland) Department of Environment and Resource Management
DIWA	Directory of Important Wetlands in Australia
ECAF	Estuarine Condition Assessment Framework
ECD	Ecological Character Description
EFZ	Ecological Focal Zone
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwlth)
EWP	Environmental Watering Plan
FARWH	Framework for Assessing River and Wetland Health
GDE	Groundwater-dependent ecosystems
HEVAE	High Ecological Value Aquatic Ecosystems
IECA	Integrated Ecological Condition Assessment
KEA	Key Environmental Assets
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
NES	National Environmental Significance
NRM	Natural Resource Management
NRMMC	Natural Resource Management Ministerial Council
NRPPC	Natural Resources Policies and Programs Committee
NRS	National Reserve System
NSW DPI	New South Wales Department of Primary Industries
NVA	Natural Values Atlas
NWC	National Water Commission
NWI	National Water Initiative
NWQMS	National Water Quality Management Strategy
SAAE	South Australian Aquatic Ecosystem Typology
SA DENR	South Australian Department of Environment and Natural Resources
SA DFW	South Australian Department for Water
SCP	Systematic Conservation Planning
SoE	State of Environment
SWIRC	South West Index of River Condition
WA DEC	Western Australia Department of Environment and Conservation
WA DoW	Western Australia Department of Water
ZoI	Zone of Influence



1 Introduction

There are currently a number of approaches used at the jurisdictional level for mapping and classifying aquatic ecosystems, assessing and identifying high ecological value aquatic ecosystems (HEVAE) and determining their condition. However, to date, no nationally consistent framework has been established. To address this gap, work has been undertaken in collaboration with states and territories to develop a nationally agreed Aquatic Ecosystems Toolkit that can be used for these purposes across a range of scales and ecosystem types. The original driver for the development of the toolkit was to assist jurisdictions in benchmarking approaches to meeting commitments under the National Water Initiative. However, the tools that were developed have broader applicability in achieving natural resource management outcomes. Many of the tools also build on existing state and territory initiatives.

1.1 National Water Initiative

The National Water Initiative (NWI) is a comprehensive strategy to improve water management across Australia. The NWI has been signed by the Australian Government and all of the states and territories, and is Australia's blueprint for national water reform. The overall objective of the NWI is to achieve a nationally compatible regulatory and planning-based system to manage surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes.

NWI Clause 25(x) states that water access entitlements and planning frameworks will 'identify and acknowledge surface and groundwater systems of high conservation value and manage these systems and to protect and enhance those values'. This was the driver for the development of what was originally referred to as the High Conservation Value Aquatic Ecosystem Framework and is now the *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)* module within the Aquatic Ecosystems Toolkit.

1.2 Aquatic Ecosystems Task Group

The Aquatic Ecosystems Task Group (AETG), established by the former Natural Resources Policies and Programs Committee (NRPPC)¹, commenced work in 2006 to develop a draft national approach to identifying and classifying High Ecological Value Aquatic Ecosystems (HEVAE). The AETG comprises representatives from the state, territory and Australian governments. The primary objectives of the AETG are to:

- provide a nationally coordinated approach to policy development for relevant cross-jurisdictional issues within the aquatic ecosystems context
- develop a national framework for the identification and classification of high ecological value aquatic ecosystems.

1.3 Purpose of the Aquatic Ecosystems Toolkit

The Aquatic Ecosystems Toolkit is a set of good practice tools designed for:

- mapping aquatic ecosystems
- classifying aquatic ecosystems
- identifying HEVAE through the systematic application of ecological value criteria
- delineating and describing aquatic ecosystems
- assessing the ecological condition of aquatic ecosystems.

Although the tools were developed to assist jurisdictions to identify HEVAE for the purposes of achieving the commitments under the NWI, they also provide a vehicle to facilitate the management of HEVAE under other natural resource management programs.

¹ A subcommittee of the former Natural Resource Management Ministerial Council (NRMMC):
<<http://www.mincos.gov.au/background#nrmmc>>



**Karijini National Park, Western Australia
(Cathy Zwick & DSEWPaC)**

Broadly, use of the tools can also:

- inform environmental flow allocation and water management
- inform planning, investment and management decisions for aquatic ecosystems
- inform the identification of HEVAE of national, regional and local importance
- improve knowledge of the extent, distribution and characteristics of HEVAE
- encourage cross-jurisdictional coordination and cooperation
- encourage information sharing between NRM bodies, governments and other stakeholders
- assist in meeting national and international obligations for the protection of aquatic ecosystems.

1.4 Development of the Aquatic Ecosystems Toolkit

The concepts and approach for many of the tools developed in this toolkit had their origins in state and territory initiatives, such as the South Australian Aquatic Ecosystem Typology (SAAE), the Queensland Wetland Program, the Conservation of Freshwater Ecosystem Values (CFEV) and others. However, such jurisdictional initiatives can only inform a national approach to HEVAE as they are limited to application at a jurisdictional level and related to the policy drivers in that jurisdiction. The Aquatic Ecosystems Toolkit provided a unique opportunity to build on existing programs and establish commonalities in approaches across jurisdictions with a 'common language' for aquatic ecosystems.

The AETG commissioned several projects to provide guidance and information to develop and trial the Aquatic Ecosystems Toolkit.

Two discussion papers were produced in 2007 (Dunn 2007; Nevill & Finlayson 2007), which guided the selection of criteria that could be used in the identification of HEVAE. Hale and Butcher

(2008) also produced a paper describing current and potential methods for developing aquatic bioregionalisation and classification systems, which guided the adoption of an appropriate regionalisation for the identification of HEVAE. The HEVAE methodology was initially trialled in select aquatic ecosystems: mound springs in Western Australia (Shanahan & Coote 2008), on rivers in Victoria (Peters 2009), on estuaries in NSW (Stephens 2008), and in the northern Murray–Darling Basin (NSW DPI 2008). Following further development the draft guidelines (AETG 2009a, 2009b) were then trialled more broadly in several drainage divisions: northern Australia (Kennard 2010), the Lake Eyre Basin (Hale 2010), and Tasmania (DPIPWE 2011).

Guidelines for the delineation and classification of aquatic ecosystems were also developed (Auricht, Hale & Brooks 2011; Auricht 2011). The delineation guidelines were trialled in the Lake Eyre Basin (Hale & Brooks 2011), and then combined with description guidelines and trialled in the Northern Territory (Duguid 2012) and Tasmania (Gooderham 2012).

The *Interim Australian National Aquatic Ecosystem Classification Framework* (Module 2), a nationally consistent methodology for classifying aquatic ecosystem types, was trialled (in principle) in the Lake Eyre Basin and northern Australia HEVAE trials, in the mid-west WA coast, and a full trial was undertaken in south-eastern South Australia (Butcher et al. 2011). The trials formed an important part of the development of the Interim ANAE Classification Framework, which was based on existing jurisdictional work in NSW, Queensland and South Australia, to apply attribute-based classification systems on lacustrine and palustrine ecosystems. The Interim ANAE Classification Framework has also informed other programs undertaken by various agencies (NWC's GDE Atlas; update of classification of Victorian wetlands; Murray–Darling Basin classification of wetlands).

The Integrated Ecological Condition Assessment (IECA) Framework aims to provide a methodology for cost-effective condition assessments of aquatic ecosystems.

The tools that were developed and trialled in the course of developing the HEVAE framework are useful for a number of purposes and have been brought together in the Aquatic Ecosystems Toolkit. Further details of the development of the Aquatic Ecosystems Toolkit are provided in Appendix A.

1.5 Other tools for classifying, identifying and assessing aquatic assets

The Aquatic Ecosystems Toolkit has relevance to a number of complementary policies and programs, and can provide a strategic and systematic process for assessing and identifying aquatic ecosystems of high ecological value. It is recognised that other tools for systematically assessing ecological values, such as conservation planning methodologies, may be more appropriate for some purposes.

Examples of foundation or complimentary techniques are outlined in Table 1 and Appendix B.

2 The Aquatic Ecosystems Toolkit

The Aquatic Ecosystems Toolkit consists of:

- *National Guidelines for the Mapping of Wetlands (Aquatic Ecosystems) in Australia*
- the Interim Australian National Aquatic Ecosystems (ANAE) Classification Framework
- Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)
- Aquatic Ecosystem Delineation and Description Guidelines
- the Integrated Ecological Condition Assessment (IECA) Framework.

Whilst the Aquatic Ecosystems Toolkit is not designed to replace existing tools or systems for identifying and classifying potential aquatic ecological assets, it has been developed to complement and build on other systems, and is flexible in its application.

A number of stakeholders may have a use for the Aquatic Ecosystems Toolkit as outlined below.

- States and territories may incorporate elements of the toolkit into a coordinated jurisdictional approach between state agencies and regional NRM bodies to guide investment and research.
- The Australian Government may use the toolkit to help guide investment, natural resource management initiatives, and regional planning under the EPBC Act, for example.
- Organisations working across jurisdictional boundaries e.g. the Murray–Darling Basin Authority.
- Non-government organisations may use elements of the toolkit to identify, classify, and/or assess HEVAE.

The toolkit can be applied in its entirety, or individual modules can be used for specific

purposes. For instance, Module 3: *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)* can be applied without undertaking a condition assessment; or Module 4: *Aquatic Ecosystem Delineation and Description Guidelines* can be applied to any aquatic ecosystem. In all cases, application of the Aquatic Ecosystems Toolkit should be undertaken with regard to existing and agreed jurisdictional processes.

The Aquatic Ecosystems Toolkit does not have a 'one size fits all' purpose, because it is non-prescriptive and flexible in its application. Thus, the outcomes will vary, depending on the purpose of the assessment and those components of the toolkit that are applied. However, the toolkit has the capacity to assist with:

- articulating processes for identifying and classifying HEVAE to meet agreed commitments under the NWI
- identifying priority HEVAE (at an appropriate scale) for investment
- identifying areas where data is absent or poor for the focus of future data collection
- recording aquatic ecosystem types (that can be translated into existing systems)
- understanding aquatic ecosystem components, processes, connectivity and condition
- providing strategic direction for research priorities to build knowledge and capacity for water planning and management.

The toolkit has five modules, each providing guidance on the application of the major toolkit components. In addition, guidelines published under the Ramsar Guidance Series, *National Guidelines for the Mapping of Wetlands (Aquatic Ecosystems) in Australia*, developed by the Wetlands and Waterbirds Task Force, are included in the toolkit. An overview of how the modules might be implemented to identify, classify and assess aquatic ecosystems in an adaptive management context is provided in Figure 1.

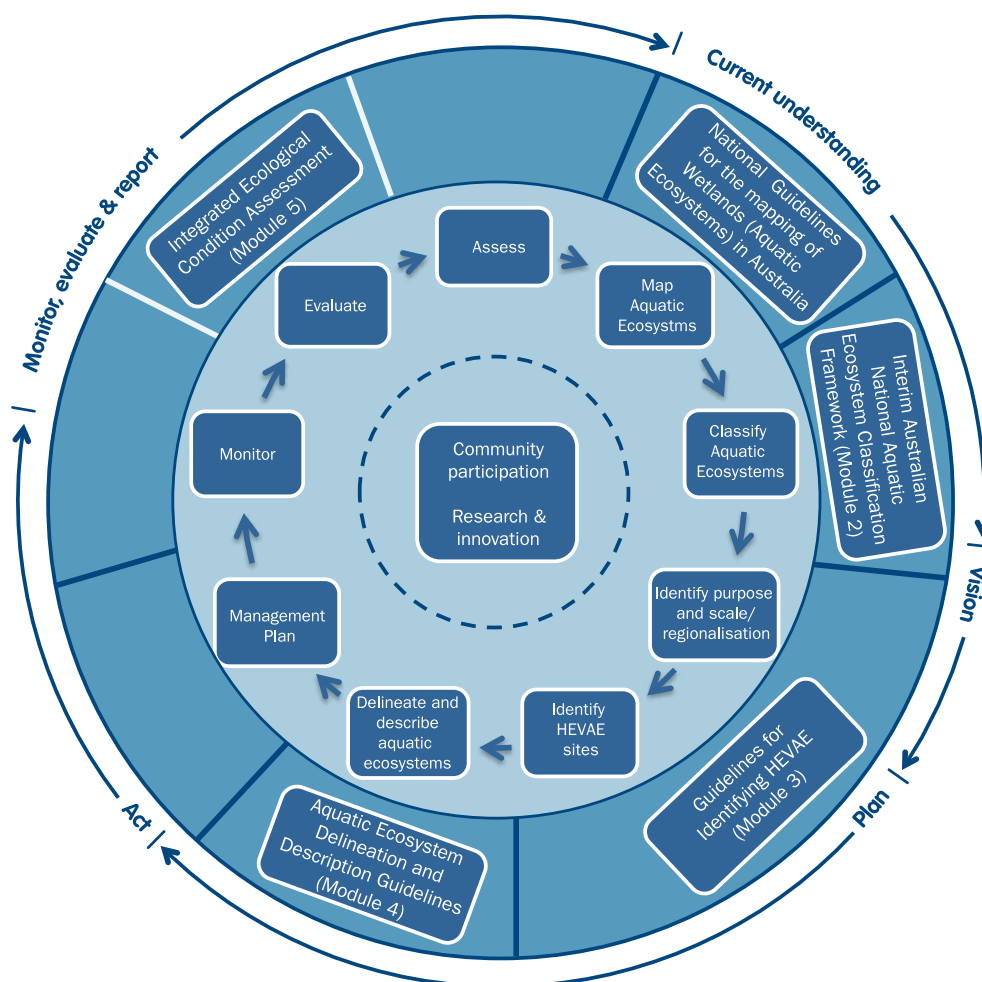


Figure 1 Potential process for implementing the Aquatic Ecosystems Toolkit within an adaptive management framework (outer and inner circles)

Module 1: Aquatic Ecosystems Toolkit Guidance Paper

The first module is this overarching document which provides background material about the development of the Aquatic Ecosystems Toolkit and guidance on its purpose and possible applications.

Module 2: Interim Australian National Aquatic Ecosystems Classification Framework (ANAE)

The Interim ANAE Classification Framework provides a nationally consistent framework that can be used to classify different aquatic ecosystems and habitats including rivers, floodplains, lakes, palustrine wetlands, estuaries and subterranean ecosystems. A major driver for producing the

ANAE is to support the classification of aquatic ecosystems and identification of those of high value. The Interim ANAE Classification Framework is also designed to be flexible for multiple uses, and may also be used to inform national aquatic ecosystem mapping and inventory processes.

Module 3: Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)

This module provides guidance to identify HEVAE across a range of scales and ecosystem types. The tool is flexible according to the needs of the investigation, and can complement and build on existing jurisdictional initiatives. It includes descriptions of the five HEVAE criteria and guidance

on applying those criteria to identify ecosystems of high ecological value. Case studies are used to provide guidance on implementing the modules.

Module 4: Aquatic Ecosystem Delineation and Description Guidelines

This module can be applied to any aquatic ecosystem, including high ecological value systems identified through either the application of the HEVAE criteria (Module 3) or a similar process. It also has been designed to be flexible, and complementary to existing jurisdictional methods, whilst acknowledging that management responsibilities will remain with the appropriate land managers. Case studies are used to provide guidance on implementing the modules.

Module 5: Integrated Ecological Condition Assessment Framework

The Integrated Ecological Condition Assessment (IECA) Framework provides the capacity to assess and report on condition at the individual aquatic ecosystem scale or on a number of connected aquatic ecosystem types at a range of scales, based on a hierarchical approach. It provides an assessment technique that identifies risk and incorporates a diagnostic capacity to inform adaptive management.

National Guidelines for the Mapping of Wetlands (Aquatic Ecosystems) in Australia

The *National Guidelines for the Mapping of Wetlands (Aquatic Ecosystems) in Australia* provide the minimum standard for data quality required to support the inclusion of spatial data within a national wetland inventory. The guidelines provide background information, and set out principles and the minimum specifications for mapping wetland extent and direction to the Interim ANAE Classification Framework for classifying wetlands in Australia based on hydrological and ecological characteristics. The guidelines also outline the standards for data capture and data management for wetlands at a national scale and are intended to provide guidance to those who have a role in project management, data collection and

preparation of projects for mapping and classifying wetlands. These national guidelines are intended to support the development and implementation of more detailed state/territory aquatic ecosystems mapping methodologies.

2.1 From HCVAE to HEVAE

Whilst the NWI Clause 25(x) specifically refers to high conservation value aquatic ecosystems, the AETG agreed that the focus of the Aquatic Ecosystems Toolkit would be ecological, and that cultural, social and economic values would be considered in subsequent planning processes (AETG 3, March 2007). This decision was endorsed by the NRPPC (NRPPC 13, May 2007). The term 'conservation' was used until October 2010, when the AETG proposed, and the NRPPC endorsed, changing the name to High *Ecological* Value Aquatic Ecosystems (HEVAE). The impetus for this change was concern that the Guidelines for Identifying HEVAE were being mistaken as a 'conservation planning' tool.

'Conservation' planning relates to the preservation of ecosystems to maintain biodiversity. It also has implications for social, cultural and economic values, which are beyond the scope of the HEVAE modules and would be addressed as part of a water allocation or management plan. The decision to limit the *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)* only to ecological values was also made with regard to the responsibility that jurisdictions have in the management of aquatic ecosystems and water resources which include social, cultural and economic values. Thus conservation and management issues have been excluded from the HEVAE modules for identifying aquatic ecosystems of high ecological value.

2.2 Definitions

Ecosystems

An ecosystem is a dynamic combination of plant, animal and micro-organism communities and their non-living environment (e.g. soil, water and the climatic regime) interacting as a functional unit. Examples of types of ecosystems include forests, wetlands, grasslands and tundra (Natural Resource Management Ministerial Council 2010a).

Aquatic ecosystems

No single definition of aquatic ecosystems exists, however, for the purposes of identifying High Ecological Value Aquatic Ecosystems, the AETG has defined 'aquatic ecosystems', as those that are:

dependent on flows, or periodic or sustained inundation/waterlogging for their ecological integrity e.g. wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes, estuaries and areas of marine water the depth of which at low tide does not exceed 6 metres.

Depending on the purpose of the assessment, the inclusion of artificial waterbodies (e.g. sewage treatment ponds, canals, impoundments) may be appropriate if they are considered to provide significant ecological value (for example, through the criteria application process), although their importance may be weighted differently.

Ecological value

Ecological value is the perceived importance of an ecosystem, which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem. In the Aquatic Ecosystems Toolkit, ecological values are those identified as important through application of the criteria and identification of critical components and processes in describing the ecological character of the ecosystem (or another comparable process).

A more comprehensive glossary can be found in section 5 of this document.



**Merri River at Stringray Bay near Warrnambool Victoria
(John Baker & DSEWPaC)**

3 National relevance

The Aquatic Ecosystems Toolkit can be used consistently at a national scale and for cross-jurisdictional assessments to identify, classify, delineate and describe aquatic ecosystems. The AETG has considered the potential use of the toolkit at a national scale, recognising that, as components were developed, the understanding of and use for the tools has evolved over the life of the program. This section details that evolved understanding.

3.1 Addressing the National Water Initiative

The identification and management of high conservation value aquatic ecosystems is a commitment under Clause 25(x) of the NWI. As such, jurisdictions are required to report on progress in implementing this commitment through the National Water Commission's (NWC) biennial assessments.

The Aquatic Ecosystems Toolkit could assist jurisdictions to benchmark approaches to meeting NWI commitments by providing a nationally consistent approach to the identification and classification of ecosystems, particularly in regions that cross jurisdictional boundaries. The toolkit also promotes the management of aquatic ecosystems for natural resource outcomes beyond the water management obligations identified through the NWI.

The NRM performance indicators were developed pursuant to Clause 104ii of the NWI for use by the NWC in undertaking its 3rd Biennial Assessment in 2010–11. Indicator 3.4 requires jurisdictions to report on the number and proportion of water systems for which:

- high conservation value aquatic ecosystems have been identified
- plans or other instruments addressing high conservation value components have been completed

- actions consistent with the plan have been undertaken.

The NWC considers that other instruments may include any relevant state or territory policies, legislation or strategic plans that recognise high ecological value systems and provide for this management.

3.2 Relevance to other national programs

The Aquatic Ecosystems Toolkit has potential relevance to a number of programs including, but not limited to the:

- Murray–Darling Basin Plan
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Ramsar and other international obligations
- National Biodiversity Strategy
- National Reserve System (NRS)
- State of the Environment (SoE) Reporting
- National Water Quality Management Strategy (NWQMS).

Appendix C provides details on the potential relevance of the toolkit to these other programs.

4 Jurisdictional use

In applying all or some components of the Aquatic Ecosystems Toolkit, consideration should be given to existing agreed jurisdictional processes that can be used to achieve similar outcomes. The toolkit should not replace those existing processes, but where appropriate, can build on or complement them. As many of the tools in the

toolkit build on existing state and territory tools, the Aquatic Ecosystems Toolkit should provide for better consistency across jurisdictions. Guidance has been provided by the jurisdictions on the appropriate application of the toolkit in each state and its link to existing jurisdictional tools (Table 1).



Mullawoolka Basin and surrounding landscape, near Wilcannia NSW (Dragi Markovic & DSEWPac)

Table 1 Existing tools and guidance on the use of the identification, delineation and description modules, and the Interim ANAE Classification Framework in each jurisdiction

TASMANIA		
EXISTING TOOLS		
<ul style="list-style-type: none"> • Conservation of Freshwater Ecosystem Values (CFEV) database • Natural Values Atlas (NVA) 		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
<p>Use of the Aquatic Ecosystems Toolkit would only be considered on a case-by-case basis for identification of aquatic ecosystems of high national ecological value if a specific purpose or policy driver at the national scale was defined.</p> <p>The Guidelines for Identifying HEVAE module is not appropriate for the identification of High Ecological Value Aquatic Ecosystems within Tasmania given the application of existing tools in a suite of state planning frameworks. Therefore, it should not be used independently of existing processes or tools currently used in Tasmania.</p>	<p>The Aquatic Ecosystem Delineation and Description Guidelines are not appropriate for use within Tasmania given the application of existing tools in a suite of state planning frameworks. Therefore, it should not be used independently of existing processes or tools currently used in Tasmania.</p>	<p>The Interim ANAE Classification Framework is not appropriate for use within Tasmania given the application of existing tools in a suite of state planning frameworks. Therefore, it should not be used independently of existing processes or tools currently used in Tasmania.</p>

NORTHERN TERRITORY		
EXISTING TOOLS		
<p>The Northern Territory has no specific tools equivalent to those in the Aquatic Ecosystems Toolkit. However, in terms of identification:</p> <ul style="list-style-type: none"> • Between 2006 and 2009 the Northern Territory government conducted an inventory of sites of international and national significance for biodiversity values in the Northern Territory. This included aquatic systems. • Sites were rated against five values: threatened species, endemic species, wildlife aggregations, wetlands and botanical significance. • Sites were rated on explicit criteria and thresholds, often using previously defined criteria such as Ramsar and the directory of important wetlands. 		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
<p>The Northern Territory does not plan on specifically using the HEVAE identification module in full. The main reason being a lack of available resources, including both staff and data.</p> <p>However, the Northern Territory does plan to produce a list of HEVAE based on the current Sites of Conservation Significance classification and some of the HEVAE criteria.</p>	No current identified uses.	No current identified uses.

NEW SOUTH WALES		
EXISTING TOOLS		
<p>The NSW Office of Water uses a value and risk assessment methodology in the development of water sharing plans. The methodology is based on some of the same sources as the Aquatic Ecosystems Toolkit, and therefore has much in common with those tools.</p> <ul style="list-style-type: none"> • River classification uses the Riverstyles approach of identifying geomorphic types at the reach scale, which provides a guide to recovery potential and management needs. • Wetland delineation and classification are based on vegetation communities where possible. Where such information is not available, satellite data on flooding history may be used to provide a broad-scale indication of the location of floodplain wetlands. • Marine bioregional assessments used for the selection of marine parks in NSW by the NSW Government include data to assess estuarine ecosystems. 		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
No current identified uses.	No current identified uses.	Application of the Interim ANAE Classification Framework in NSW would require feasibility trials and NSW is in discussion with the Australian Government in this regard.



Dragonfly (Diane Conrick)

SOUTH AUSTRALIA**EXISTING TOOLS****South Australian Aquatic Ecosystem Typology (SAAE)**

- This methodology is based on attributes identifying the functional processes driving wetland character and is used by the South Australian Department For Water (SA DFW), the South Australian Department of Environment and Natural Resources (SA DENR) and applied by the South East NRM Board. Currently, this methodology has been applied to the South East NRM region of South Australia.
- It has application in attributing a wetland type to wetlands in the south-east through identifying similarities in the functional processes driving different wetland character; modelling across wetlands that have not had detailed assessment; and in water management planning (identifying surface and groundwater dependency of wetlands). Also, in identifying those wetland types that are most sensitive to climate change impacts from changes to rainfall, runoff and sea level rise.
- Modelling across biodiversity values (from DIWA) for different wetland types e.g. threatened ecological communities seasonal grassy ecosystems.

South Australian Wetland Inventory Database (SAWID)

- Essentially a geodatabase containing attributes of flora and fauna lists, condition, threats, land use/tenure and water quality, which is used for the storage and retrieval of wetlands data.
- In-house product for SA DENR/SA DFW. Fleurieu and South East regions only.

Directory of Important Wetlands of Australia (DIWA)

- Describing the type of wetlands, and useful for separating wetlands into broad categories, based on a range of criteria including geographic, geomorphology, water chemistry etc.
- Approach is too qualitative and subjective; difficulty in repeatability of classification.
- Used by SA DENR, but site information requires a comprehensive update to assure spatial and textural accuracy.

Water-dependent ecosystem Risk Assessment Tool (WaterRAT)

- A spatial risk assessment tool in the form of a geographic information system workspace and framework for evaluating cumulative impacts on water-dependent ecosystems and assets from water-affecting activities and developments. The risk assessment relies on the identification of Assets, Likelihood of impact, and existing Threats to these assets.
- This methodology has been applied to the Mount Lofty Ranges NRM region and the South East NRM region of South Australia, and is used by SA DFW, Mount Lofty Ranges NRM, South East NRM and SA DENR.

SOUTH AUSTRALIA (continued)		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
<p>Can provide a process for collective wetland planning as a method to pool information on aquatic ecosystem attributes under a range of different values themes.</p> <p>The ranges of criteria themes need to remain transparent so they can be reassessed based on a range of management outcomes required, i.e. management for waterbird abundance, migratory species, endemic species, conservation/ complementarity.</p> <p>Has useful application at the state, cross jurisdictional and national level.</p> <p>Not to use</p> <p>Is not a substitute for conservation planning approaches but can provide supporting information either directly or via a database of attributes.</p> <p>Caution should be used in applying rankings to aquatic ecosystems unless the purpose of the assessment is clearly identified and articulated.</p>	<p>Process clearly articulates the values and ecological processes occurring at different scales around wetlands.</p> <p>Can provide a process for collective wetland planning i.e. wetland complexes rather than based on individual site values.</p> <p>Useful for defining different management boundaries e.g. direct wetland impact (fencing), diffuse wetland impact from water planning (groundwater and surface water resources), diffuse wetland impact from landscape modification through NRM and state government planning (i.e. vegetation clearance and land use change).</p>	<p>This is of primary use:</p> <ul style="list-style-type: none"> • to identify the functional driving attributes of wetland ecosystems • where no functionally based classification system has been applied to wetland ecosystems • where there is poor spatial data available and modelling based on ANAE (or other classification systems) can be used to identify similar functional processes of different wetland ecosystems • to use as a tool to cross walk between different wetland classification systems to identify the similar functional processes of similar wetland ecosystems. <p>Precautions for use</p> <p>Anticipated as a classification tool to supersede DIWA. Currently, this classification method is at a higher level than those functional wetland classifications that are currently used by some jurisdictions e.g. South Australia.</p> <p>Development of the lower level classification or integration with other wetland classifications is required for a more functional application.</p>

AUSTRALIAN CAPITAL TERRITORY		
EXISTING TOOLS		
<p>Tools similar to those in the Aquatic Ecosystems Toolkit are not used in the ACT and are not necessary given the small size of the jurisdiction.</p> <p>Monitoring is conducted on fish, macroinvertebrates using AUSRIVAS, and water quality. No overall condition assessment process is utilised.</p>		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
Other than for national-level purposes, the tool is not required at an ACT scale. All significant aquatic ecosystems are protected to some degree in the ACT.	Has not been used previously, potentially could be if contributing to a national assessment.	Would probably be more relevant at a national level rather than within the ACT.



Pelicans (Jeanette Muirhead & DSEWPac)

QUEENSLAND

EXISTING TOOLS

Queensland has used a range of tools for the classification, assessment and delineation of aquatic ecosystems of high conservation significance for natural resource management purposes. The methods have evolved over time as knowledge of ecosystems and assessment processes have improved. Many of these tools have been developed through the Queensland Wetlands Program, a joint initiative of the Australian and Queensland governments.

Existing Queensland tools which align with the Aquatic Ecosystems Toolkit include:

- **HEVAE identification**—The primary Queensland tool which aligns with the HEVAE is the Aquatic Biodiversity Assessment Mapping Methodology (AquaBAMM) (Clayton et al. 2006) which uses similar criteria to the HEVAE, which can be queried to provide HEVAE outputs and has been used in both the MDB and northern Australia trials. A range of other assessment methods which are applicable are available through the assessment toolbox on the WetlandInfo website <<http://wetlandinfo.derm.qld.gov.au/wetlands/>> which provides users with current wetland assessment methods.
- **Delineation**—The Queensland Wetland Mapping and Classification Methodology—Overall Framework—A Method to Provide Baseline Mapping and Classification for Wetlands in Queensland, Version 1.2, provides a method for mapping wetlands (aquatic ecosystems) and has been used to map and classify the wetlands' systems in Queensland. This method is supported by the [Queensland Wetland Definition and Delineation Guidelines \(A and B\)](#) (DERM 2011a), a guide to existing wetland definitions and how to apply the Queensland Wetlands Program wetland definition. This tool helps decision makers and planners, such as government agencies, landowners, conservationists or natural resource managers, to identify whether a feature is a wetland and its extent at a site scale. The [Queensland Wetland Buffer Planning Guideline](#) (DERM 2011b), was one of the documents used to develop the concepts and approaches in the HEVAE delineation module and provides the steps for designing a wetland buffer and using a values-based approach that recognises potential impacts from external threats. This document was a key input to the HEVAE delineation document.
- **Classification and typology**—Queensland has been using an attribute-based classification scheme and derived typologies for its wetlands for many years. This classification scheme has been used to attribute all lacustrine and palustrine wetlands in Queensland and similar methods are presently being applied to the groundwater-dependent ecosystem mapping being undertaken in combination with the Australian Government <<http://wetlandinfo.derm.qld.gov.au/wetlands/WetlandDefinitionstart/WetlandDefinitions/Typologyintro/Typology.html>>.

QUEENSLAND (continued)		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
<p>As most of the modules developed through the Aquatic Ecosystems Toolkit align with the ones developed previously in Queensland there will be significant opportunities to ensure that any works conducted in Queensland will be consistent with national processes. This provides significant opportunities for the translation of Queensland work to national agendas and will ensure that work conducted in Queensland will be complimentary with any work to be conducted between jurisdictions.</p> <p>As outlined in the existing tools section, Queensland already has a tool which broadly aligns with the HEVAE criteria and as such would be used in any national programs should such a need arise. Where Aquatic Conservation Assessments, using AquaBAMM have been run, the results could be used as input to any HEVAE process.</p>	<p>The delineation and description guidelines have the potential for application in a number of Queensland state-wide processes. While the Queensland Wetland Buffer Planning Guideline (DERM 2011b), was one of the documents used to develop the concepts and approaches in the aquatic ecosystem delineation module, other concepts and approaches such as nested assets at different scales and approaches to combining individual components into broader assets have been significantly advanced. This thinking would be very useful should asset delineation be required for HEVAE.</p>	<p>As outlined in the existing tool section, Queensland has been using the attribute-based method of classifying lacustrine and palustrine wetlands for many years and this approach is presently being used for the groundwater-dependent ecosystem mapping process.</p> <p>Queensland will continue to use the attribute-based classification approach, on which the ANAE is based, for aquatic ecosystem classification in Queensland. It provides a good robust method for classification while also providing for flexibility in the applications for which it can be used. The potential for the system to allow for translation of existing classification systems to the ANAE and the corresponding opportunities which this provides for working across jurisdictions is significant. Refinement and modification of the system as it is applied is essential.</p>

VICTORIA**EXISTING TOOLS**

Victoria uses an eight year adaptive management cycle to deliver the Victorian Waterway Health Program. The cycle will be documented in a state policy for rivers, estuaries and wetlands (waterways) which is currently being developed. Prioritisation, monitoring, reporting, evaluation and strategic research are key components of this adaptive management cycle. Used together, they provide the information to continuously improve the management of rivers, estuaries and wetlands and to determine if the Victorian Waterway Health Program is meeting its targets and achieving long-term improvements in waterway health. The key elements and tools in delivering this cycle are:

- comprehensive state-wide geospatial inventories of river reaches, estuaries and wetlands
- a wetland classification system which is being updated to align with the Interim ANAE Classification Framework and an estuary classification system (not aligned to the Interim ANAE Classification Framework)
- an asset-based approach which is based on river reaches, estuary reaches, individual wetlands or wetland complexes
- a regional priority setting process which:
 - is based on the environmental, social and economic values of waterways to the community
 - identifies high value rivers, estuaries and wetlands using the Aquatic Value Identification and Risk Assessment (AVIRA) tool
 - conducts a risk analysis for threats to environmental, social and economic values, using AVIRA
 - sets management objectives for rivers, estuaries and wetlands and desired outcomes for key values
 - selects priority management actions to form the regional work program
- intervention monitoring and resource condition assessment which:
 - uses logic models to select the management actions required to achieve waterway health outcomes and to set targets, and monitors the long-term health of rivers, estuaries and wetlands through the Index of Stream Condition, Index of Estuary Condition and Index of Wetland Condition
 - uses logic models to set priorities for research by targeting areas where there is low knowledge or low confidence in the relationships between management actions and waterway health outcomes
 - makes long-term monitoring data easily accessible and publicly available.

USE OF THE AQUATIC ECOSYSTEMS TOOLKIT

Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
The environmental values used in AVIRA broadly align with the HEVAE criteria. AVIRA will be used within Victoria at the regional level for identifying high value aquatic ecosystems. Those aquatic ecosystems in AVIRA with high environmental values will be regarded as potential HEVAE for the purposes of any national or cross-border value assessment programs.	<p>Aquatic ecosystem delineation and description in Victoria in the next eight year adaptive management cycle will continue to be on the basis of river reaches, estuary reaches, individual wetlands or wetland complexes as used in AVIRA.</p> <p>The Aquatic Ecosystems Toolkit will be used to inform any future investigation of aquatic ecosystem delineation in Victoria.</p>	<p>Victoria will use a wetland classification framework based on the Interim ANAE Classification Framework (currently under development).</p> <p>Victoria will assess the need for river and updated estuary classification to support the adaptive management cycle. If required, the Interim ANAE Classification Framework will be used to inform the state classification.</p>

WESTERN AUSTRALIA**EXISTING TOOLS**

No tool similar to those in the Aquatic Ecosystems Toolkit exists in WA which is readily useable in water planning, although the Western Australia Department of Environment and Conservation (WA DEC) use a classification system for wetlands

WA DEC has used similar tools to identify wetlands of high ecological value in some regions of the south-west of WA. Mapping layers exist for selected areas across the south-west. Current methods classify into three value levels termed 'management categories'. Those wetland sites identified as highest value category are currently recognised within state legislation as Environmentally Sensitive Areas. So the HEVAE will form the basis for assessing aquatic ecosystems in terms of water planning.

Several methodologies for delineation of wetlands in the south-west of WA have been published, but are not comprehensive for channel systems.

Note: two tools are available which will inform the HEVAE process—the FARWH-derived South West Index of River Condition (SWIRC), and the Estuarine Condition Assessment Framework (ECAF) (in development). These will meet the ecological requirements of the HEVAE process.

WA has a wetland classification system, termed Geomorphic Classification Scheme, which has been endorsed by the state's Environmental Protection Authority and Wetlands Coordinating Committee. It does not include channel systems. Publically available mapping layers exist for wetlands that are attributed with 'geomorphic class' and 'management category'.



Karijini National Park, Western Australia (Cathy Zwick & DSEWPac)

WESTERN AUSTRALIA (continued)		
USE OF THE AQUATIC ECOSYSTEMS TOOLKIT		
Guidelines for Identifying HEVAE	Aquatic Ecosystem Delineation and Description Guidelines	Interim ANAE Classification Framework
<p>The Western Australia Department of Water (WA DoW) develops regional and subregional allocation plans, the first stage of which is to identify all water assets and those for which allocation needs to be taken into account. The HEVAE module would be used to provide structure to this stage in addition to the current process of assessing existing reports and the WA DEC wetlands database.</p> <p>WA DEC has mapped, evaluated and classified wetlands in many sectors of the south-west of WA but until recently have not included comprehensive identification of channel systems. The HEVAE module could be a way to include all aquatic systems in the water allocation planning process.</p>	<p>Several methodologies for delineation of wetlands in the south-west of WA have been published but hitherto there has been no formal system for delineating channel systems in WA and so the Aquatic Ecosystems Toolkit is most welcome. The SWIRC and the ECAF are compatible with the HEVAE logic and language.</p>	<p>The ANAE is important in terms of the HEVAE as there is no standardised assessment of river classes in WA to meet the Representativeness criterion. The ANAE will also provide value for state water planning and allocation where further classification is necessary. Trials to date indicate that all water assets can be included in the ANAE including wetlands, although this will be a different classification than that used by WA DEC for listing wetlands for conservation.</p> <p>WA DEC has trialled the Interim ANAE Classification Framework against its geomorphic classification to determine compatibility between the two classification systems in Western Australia. Results indicate that compatibility is limited to Level 2/3 and that the Geomorphic classification and mapping will provide information that can be used for the one attribute in Level 4 'hydroperiod'. Many attributes within the ANAE will not be able to be populated, including 'vegetation' as comprehensive data layers are not available at appropriate scales and coverage. Further discussions will be required across WA DoW and WA DEC to provide an agreed determination of how floodplain wetlands will be identified within the Interim ANAE Classification Framework.</p>

5 Glossary

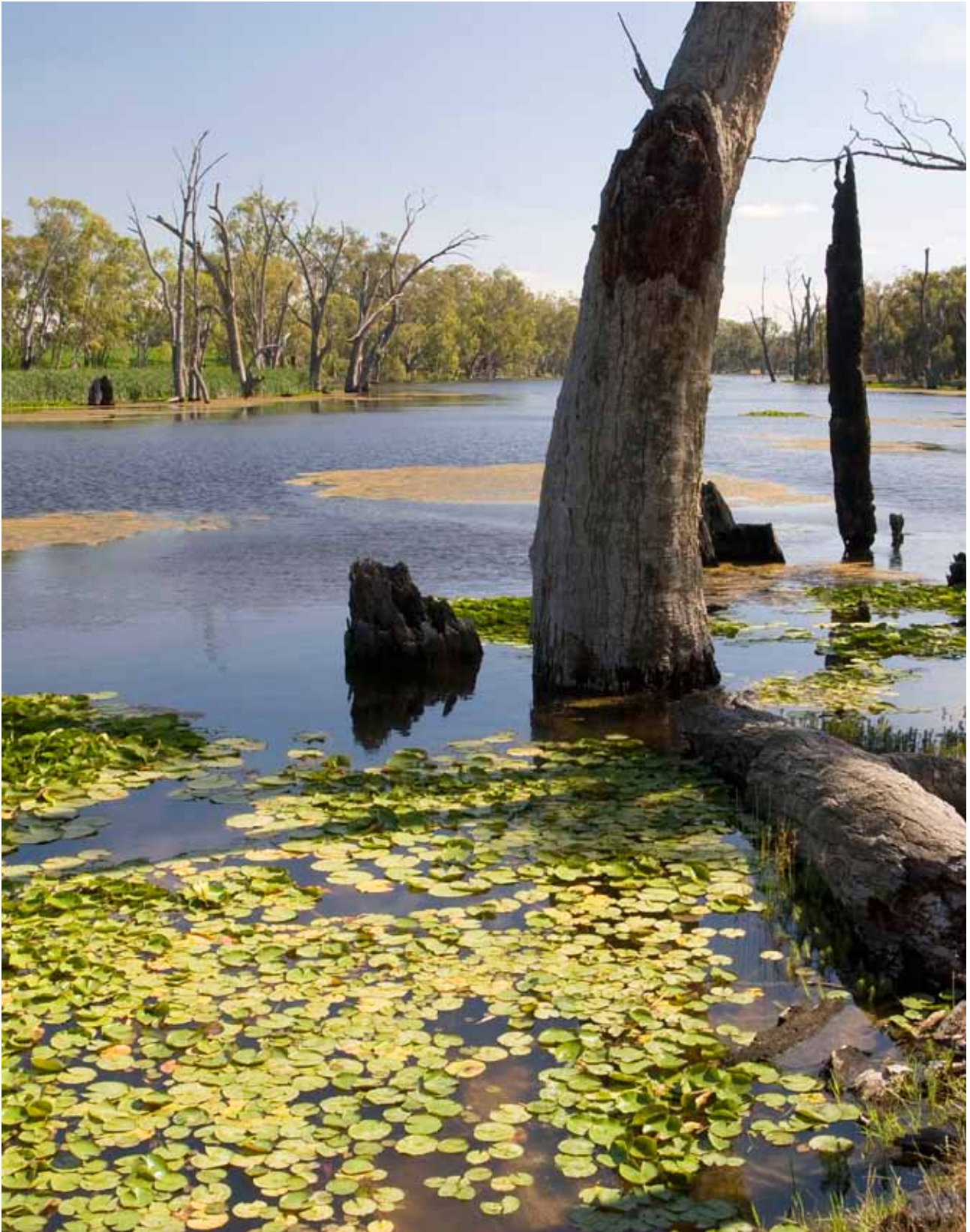
The following terms and their definitions are specifically for the purposes of the Aquatic Ecosystems Toolkit.

Abiotic features	Non-living chemical and physical factors in the environment.
Aggregation	<p><i>Delineation:</i> a grouping together or clustering of core elements to form a single entity.</p> <p><i>Statistical:</i> the grouping of data combined from several measurements that provide information on a broader level than the level at which the detailed data was collected.</p>
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Method (Clayton et al. 2006) is a comprehensive method that identifies relative wetland conservation values within a specified study area (usually a catchment). < http://wetlandinfo.derm.qld.gov.au/wetlands/SupportTools/AssessmentMethods/AquaBAMM/Method.html >
Aquatic ecosystem-dependent species	Those species that depend on aquatic ecosystems for a significant portion or critical stage of their lives (fauna) or are dependent on inundation or waterlogging for maintenance or regeneration (flora).
Aquatic ecosystems	Ecosystems that depend on flows, or periodic or sustained inundation/waterlogging for their ecological integrity (e.g. wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes and estuaries) but do not generally include marine waters (defined as areas of marine water the depth of which at low tide exceeds 6 metres, but to be interpreted by jurisdictions). For the purpose of the Aquatic Ecosystems Toolkit, aquatic ecosystems may also include artificial waterbodies such as sewage treatment ponds, canals and impoundments.
Assessment unit	The spatial unit at which the attributes and criteria for identifying HEVAE are applied.
Attribute	An attribute is a mathematical or statistical indicator, or characteristic of a HEVAE criterion that provides the basis for scoring. An attribute may contain several metrics that are aggregated to provide an attribute score. It is also used in the Interim ANAE Classification Framework to describe characteristics of aquatic ecosystems in order to classify them.
Biodiversity	Biodiversity (or biological diversity) is the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species (genetic diversity), between species (species diversity), of ecosystems (ecosystem diversity), and of ecological processes.
Biodiversity surrogate	Commonly used to optimally represent multiple components of unmeasured biodiversity. Biodiversity surrogates include taxa (e.g. species), the characters they represent (e.g. phylogenetic relationships), assemblages or environmental habitats (different types of environments are assumed to support different combinations of species).
CFEV	The Conservation of Freshwater Ecosystem Values Framework in Tasmania < www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/CGRM-7JH6CM?open >.

Community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another.
Components	The physical, chemical and biological parts of an aquatic ecosystem e.g. habitat, species, genes etc.
Condition	The state or health of individual animals or plants, communities or ecosystems. Condition indicators can be physical-chemical or biological and represent the condition of the ecosystem. They may also be surrogates for pressures and stressors acting within the ecosystem.
Connectivity	Environmental connectivity consists of links between water-dependent ecosystems that allow migration, colonisation and reproduction of species. These connections also enable nutrients and carbon to be transported throughout the system to support the healthy functioning and biodiversity of rivers, floodplains and wetlands. Hydrologic and ecological links are between upstream and downstream sections of river (longitudinal connectivity) and between rivers and their floodplains (lateral connectivity).
Core element	An aquatic ecosystem (e.g. a lake or river) that is considered to be related to one or more of the values as identified through the application of an assessment process (e.g. HEVAE criteria).
Delineation	Delineation is the spatial identification, mapping and recording of an identified ecosystem, including its core elements and ecological focal zones.
Ecological character	The combination of the ecosystem components, processes and benefits/services that characterise an identified aquatic ecosystem at a given point in time.
Ecological description	An ecological description documents the critical components and processes that underpin the ecological values of the site.
Ecological Character Description (ECD)	A systematic method of documenting ecological character. Ramsar guidelines for undertaking an ECD are available in the <i>National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands. Module 2 of the National Guidelines for Ramsar Wetlands—Implementing the Ramsar Convention in Australia</i> . (DEWHA 2008) < http://www.environment.gov.au/water/publications/environmental/wetlands/module-2-framework.html >
Ecological Focal Zone (EFZ)	Equates to the boundary of the aquatic ecosystem, and is the area that maintains and supports the values of that ecosystem in terms of function and connectivity. This may be a single core element or aggregate of core elements, plus the surrounding supporting areas related to the values.
Ecological value	Ecological value is the perceived importance of an ecosystem, which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem. In the Aquatic Ecosystems Toolkit, ecological values are those identified as important through application of the criteria and identification of critical components and processes in describing the ecological character of the ecosystem (or another comparable process).
Ecosystem	An ecosystem is a dynamic combination of plant, animal and micro-organism communities and their non-living environment (e.g. soil, water and the climatic regime) interacting as a functional unit. Examples of types of ecosystems include forests, wetlands, grasslands and tundra (Natural Resource Management Ministerial Council 2010a).

Ecosystem function	Activities or actions which occur naturally in ecosystems as a product of the interactions between the ecosystem structure and processes e.g. floodwater control, nutrient, sediment and contaminant retention, food web support, shoreline stabilisation and erosion controls, storm protection, and stabilisation of local climatic conditions, particularly rainfall and temperature.
Ecosystem response	The way in which ecosystems respond to changing circumstances.
Ecosystem services	<p>Benefits that people receive or obtain from an ecosystem (Ramsar Convention (2005), Resolution IX.1 Annex A). The components of ecosystem services (MEA 2005) include:</p> <p><i>Provisioning</i> services such as food, fuel and fresh water.</p> <p><i>Regulating</i> services are the benefits obtained from the regulation of ecosystem processes such as climate regulation, water regulation and natural hazard regulation.</p> <p><i>Cultural</i> services are the benefits people obtain through spiritual enrichment, recreation, education and aesthetics.</p> <p><i>Supporting</i> services are the services necessary for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans or a direct benefit in the long term.</p>
Endemic species	A species or higher taxonomic unit found only within a specific area.
Estuarine systems	Are those with oceanic water sometimes diluted with freshwater runoff from the land.
Floodplain	Those aquatic systems that are either seasonally or intermittently flooded flat areas that are outside the riverine channels or palustrine/lacustrine systems but that display characteristics of hydric soils or vegetation that are characteristically adapted to the seasonal or intermittent presence of water.
Flow regime	The characteristic pattern of a river's flow quantity, timing and variability.
Groundwater	Subsurface water located in the zone of saturation in pores, fractures and cavities in rocks.
Groundwater-dependent ecosystem (GDE)	Natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
Habitat	The environment where an organism or ecological community exist and grows for all or part of its life.
High Ecological Value Aquatic Ecosystems (HEVAE)	For the purposes of the toolkit, HEVAE are sites, comprising one or more aquatic ecosystems, that are considered to be of high ecological value as determined by a consistent and objective process such as that provided by Module 3: <i>Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)</i> .
HEVAE criteria	The HEVAE criteria are the five core biophysical characteristics that have been agreed by the Aquatic Ecosystems Task Group as appropriate for the identification of HEVAE: diversity, distinctiveness, vital habitat, naturalness and representativeness.

Lacustrine	Lacustrine systems (or lakes) are open-water dominated systems, characterised by deep, standing or slow-moving water with little or no emergent vegetation.
Metric	A metric is a specification for how an attribute will be measured. It may be binary ('yes' or 'no', 'present' or 'absent'), a ranking (high, medium, low), or a number.
Palustrine	Palustrine systems are primarily shallow, vegetated, non-channel environments, including billabongs, bogs, swamps, springs, soaks etc.
Precautionary principle	States that a lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage.
Pressure	Activities and processes which act on the environment and bring about environmental change.
Processes	Are the dynamic forces within an ecosystem. They include all processes that occur between organisms and within and between populations and communities, including interactions with the non-living environment that result in existing ecosystems and that bring about changes in ecosystems over time.
Ramsar Convention	<p><i>Convention on Wetlands of International Importance especially as Waterfowl Habitat.</i> Ramsar (Iran), 2 February 1971. UN Treaty Series No. 14583. As amended by the Paris Protocol, 3 December 1982, and Regina Amendments, 28 May 1987. The abbreviated names 'Convention on Wetlands (Ramsar, Iran, 1981)' or 'Ramsar Convention' are used more commonly.</p> <p>The Ramsar Convention, is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the 'wise use', or sustainable use, of all of the wetlands in their territories.</p> <p>Based on information found at http://www.ramsar.org.</p>
Refugia	A place where organisms can survive during periods of stress.
Riverine	Those systems that are contained within a channel and its associated streamside vegetation. This definition refers to both single channel and multi-channel systems e.g. braided channel networks. The beds of channels are not typically dominated by emergent vegetation, may be naturally or artificially created, periodically or continuously contain moving water, and may form a connecting link between two bodies of standing water. See Module 2 for more information.
Subterranean	Subterranean aquatic systems comprise all underground areas containing water.
Surface water	Includes water in a watercourse, lake or wetland, and any water flowing over or lying on the land after having precipitated naturally or after having risen to the surface naturally from underground.
Zone of Influence (Zoi)	The area surrounding the Ecological Focal Zone in which pressures and management actions might impact on the state and/or condition of the ecosystem. These may be spatially or temporally variable depending on which influences are being considered.



Gunbower Creek, a tributary of the Murray River (John Baker & DSEWPaC)

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Peters, G. (2009). *Application of HCVAE Criteria to Victorian River Reaches*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and The Arts. Riverness Protection and Restoration Services, Belmont.

Peters, G. (2010). *Review of HCVAE Trials*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Riverness Protection and Restoration Services, Belmont.

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Shanahan, A., and Coote, M. (2008). *A report on the application of draft criteria for identification of High Conservation Value Aquatic Ecosystems (HCVAE) on mound springs in Western Australia*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Western Australia Department of Environment and Conservation, Perth.

SKM (2007). *High Conservation Value Aquatic Ecosystems Project—identifying, categorising and managing HCVAE*. Report prepared for the Aquatic Ecosystems Task Group and the Australian Government Department of Environment and Heritage. Sinclair Knight Merz, Armadale, Victoria, verified June 2012, <www.environment.gov.au/water/publications/environmental/ecosystems/hcvae.html>.

Stephens, K. (2008). *High Conservation Value Aquatic Ecosystems—NSW Estuaries Pilot Project*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. NSW Department of Environment and Climate Change, Sydney.

Storer, T., Forbes, V., Thomson, C., Calvert, T., Alexander, K. (2010). *Development of an integrated ecological condition assessment framework for High Conservation Value Aquatic Ecosystems: Case study: Walpole-Nornalup aquatic ecosystem*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Western Australia Department of Water, Perth.

Western Australian Planning Commission (2005). *Guideline for the Determination of Wetland Buffer Requirements for Public Comment (Draft)*. Western Australian Planning Commission, verified June 2012, <www.planning.wa.gov.au/dop_pub_pdf/Wetland_Text.pdf>

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Appendix A: Development History

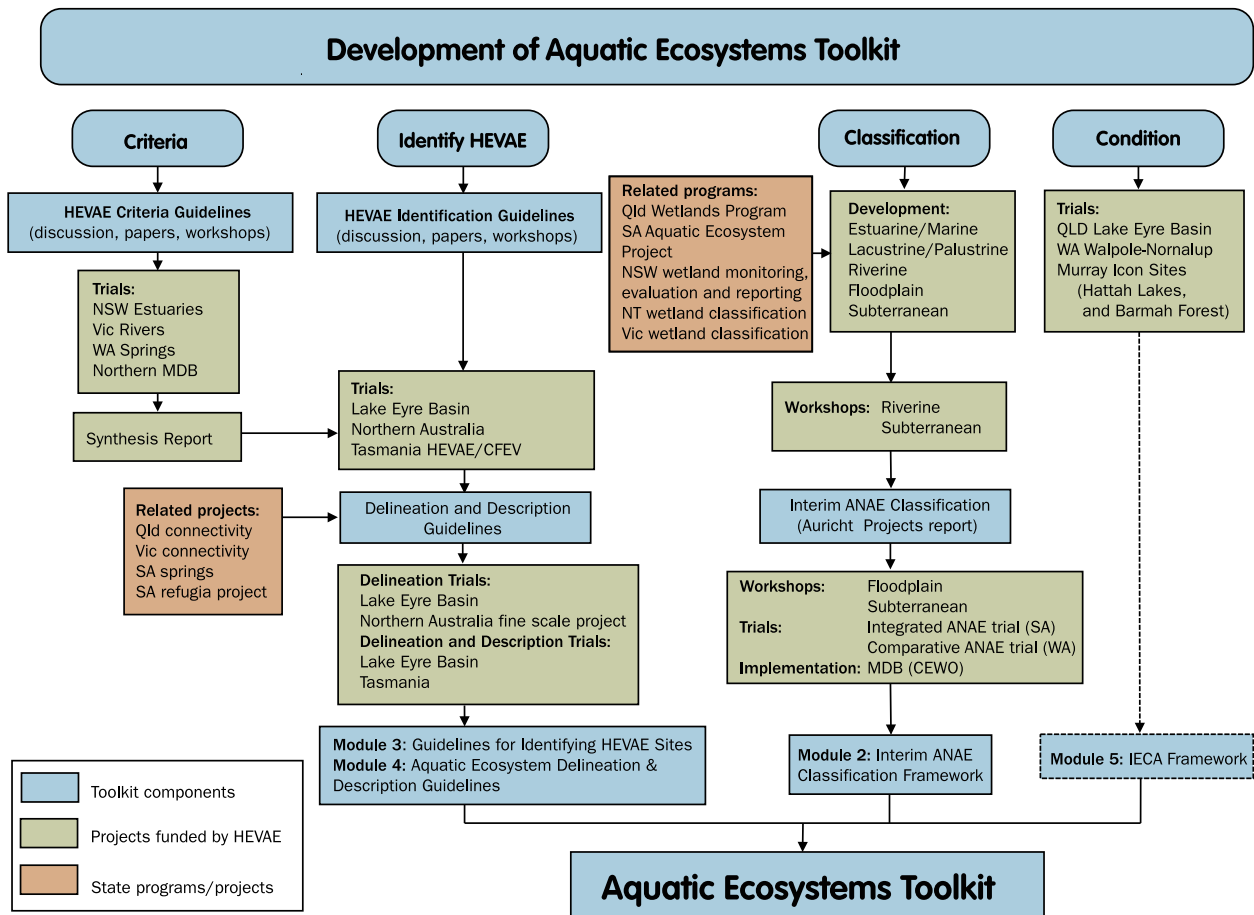


Figure A1 Illustration of the Aquatic Ecosystems Toolkit development

Tools to identify, delineate and describe aquatic ecosystems

A range of parties have previously argued the need for a nationally consistent approach to the identification, classification and management of aquatic assets. These arguments were increasingly supported by studies which highlighted gaps in existing state frameworks and proposed the development of a national approach (Dunn 2000; Nevill & Phillips 2004). The need for such an

approach was substantiated in 2004 when the NWI parties agreed to Clause 25(x)—to identify and protect high conservation value aquatic ecosystems (Council of Australian Governments 2004).

Identification of HEVAE initiation

To initiate the process of developing draft guidelines for identifying HEVAE, Sinclair Knight Merz (SKM) were commissioned in 2007 to review existing policy, planning and legislative approaches

used to identify, categorise and manage HEVAE in Australia (SKM 2007). The primary objective of the work was to document and describe existing approaches in each jurisdiction, and provide an analysis of similarities across jurisdictions. An important finding of the project was that while jurisdictions use different approaches, tools and terminology to identify HEVAE, there was some consistency in the broad ecological criteria used, including naturalness, representativeness, diversity, and importance for other systems/species.

Criteria development

Two discussion papers were also produced in 2007 (Dunn 2007; Nevill & Finlayson 2007), which proposed principles to guide the selection of criteria, identified and analysed existing criteria, and provided possible draft criteria that could be used to identify HEVAE. The authors of both papers proposed draft criteria associated with naturalness, representativeness, diversity, rarity, critical habitat and evolutionary history.

Bioregionalisation and classification

A description and analysis of current and possible methods for developing aquatic ecosystem bioregionalisation and classification systems was presented by Hale and Butcher (2008) in their report *Summary and review of approaches to the bioregionalisation and classification of aquatic ecosystems within Australia and internationally*. While the report did not make recommendations for the adoption of a particular classification or bioregionalisation system, the review provided the basis for a bioregionalisation approach to be recommended to the Natural Resources Policy and Programs Committee, and to guide working groups in further examining a potential classification system. As a result, drainage divisions have been adopted as the appropriate regionalisation at a national level for applying the *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)*.

Draft criteria trials

Four initial trials of the application of the draft methodology for the identification of HEVAE, with an emphasis on the criteria, were commissioned by the AETG and the then Murray–Darling Basin Commission (now Murray–Darling Basin Authority) to assist in the finalisation of the criteria (NSW DPI 2008; Stephens 2008; Shanahan & Coote 2008; Peters 2009).

The draft criteria trialled included international recognition, representativeness, diversity, distinctiveness, critical habitat, and two supplementary criteria: evolutionary history and naturalness. The trials provided an assessment of the suitability of the criteria and application, and recommendations for finalising the criteria. The results of these trials were synthesised into one report (Peters 2010) and recommendations based on the overall results of the trials further informed the development of the guidelines for identifying HEVAE.

Draft HEVAE identification and delineation guideline trials

Following the initial trials, a pilot of the draft guidelines for identifying HEVAE was recommended. Trials were undertaken at the drainage division scale in the Lake Eyre Basin, northern Australia and Tasmania.

The Lake Eyre Basin (Hale 2010) and northern Australia (Kennard 2010) trials tested the application of the tools to identify, map and classify HEVAE in a range of environments. The Tasmanian trial (DPIPWE 2011) tested the compatibility of the Conservation of Freshwater Ecosystem Values Framework (CFEV) with the draft HEVAE identification guidelines.

The delineation and description guidelines build on the concepts developed in Western Australia's Guideline for the Determination of Wetland Buffer Requirements (Western Australia Planning Commission 2005), the Queensland Wetland Buffer Planning Guidelines (DERM 2011b) and the *National Framework and Guidance for Describing the Ecological Character of Ramsar Wetlands* (DEWHA



Echuca wetlands (Diane Conrick)

2008). These documents provide similar principles for identifying values and threats, and defining core elements and focal zones.

The delineation guidelines were developed (Auricht, Hale & Brooks 2011) through consultation with jurisdictional officers and other stakeholders and trialled (Hale & Brooks 2011) in HEVAE identified in the Lake Eyre Basin trial. The delineation and description guidelines were together trialled in HEVAE identified in Lake Eyre Basin (Duguid 2012) and Tasmania (Gooderham 2012).

The trials provided recommendations to further develop the criteria and guidelines for application, and the delineation and description guidelines. These reports form the basis of Module 3 (*Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)*) and Module 4 (*Aquatic Ecosystem Delineation and Description Guidelines*) of the Aquatic Ecosystems Toolkit.

Interim Australian National Aquatic Ecosystem (ANAE) Classification Framework

The Interim ANAE Classification Framework has been developed to support the identification and description of different aquatic ecosystems and habitats across Australia including surface waters (rivers, lakes, palustrine wetlands (swamps), estuarine and marine), and subterranean.

The ANAE builds on the attribute-based classification systems that have been applied at a jurisdictional level for lakes and swamps in NSW, Queensland and South Australia. This flexible approach to classification, which allowed for translation across jurisdictions, and attribution with limited data, formed the basis for the subsequent Interim ANAE Classification Framework, which can be applied to other aquatic ecosystems, not only lakes and swamps².

² For example see Wetlandinfo <<http://wetlandinfo.derm.qld.gov.au/wetlands/WetlandDefinitionstart/WetlandDefinitions/Typologyintro/Typology.html>>

The further development of the Interim ANAE Classification Framework has been an iterative process, whereby workshops, discussions and research have directed subsequent phases. An interim report was developed, which established the structure of the ANAE Classification Framework, and identified attributes that could be applied to each aquatic ecosystem type (Auricht 2011). This report is the basis of Module 2 (*Interim Australian National Aquatic Ecosystem (ANAE) Classification Framework*).

Interim ANAE Classification Framework trials

Several trials of the Interim ANAE Classification Framework were undertaken at various stages of its development. Principles and components of the developing ANAE were applied in trials of the HEVAE tools in both the Lake Eyre Basin and northern Australia, concentrating on the riverine, palustrine and lacustrine components. A trial in south-eastern South Australia, which is data rich and contains a number of different aquatic ecosystem types, provided evidence that the framework could be implemented, and identified issues that hampered its implementation (Butcher et al. 2011). The framework was also tested in Western Australia, to provide a comparison to the existing classification methods employed by Western Australia (Kruger, Coote & Shanahan 2012).

These trials identified gaps in the framework, and recommended further development and testing to refine attributes and guidelines for the implementation of the ANAE.

Integrated Ecological Condition Assessment (IECA) Framework

The IECA Framework aims to provide the capacity to rapidly and cost-effectively assess and report on an aquatic ecosystem site. It will use an ecosystem approach which incorporates and allows for comparability between different aquatic ecosystem types (e.g. rivers, floodplains, wetlands, groundwater-dependent ecosystems and estuaries) as connected functioning units at a range of scales. It will provide a technique to link management actions to environmental outcomes

and incorporate a capacity to diagnose likely risks or threats to assets in order to inform adaptive management.

Condition may be reported in the context of natural variability, connectivity and resilience; and in relation to management objectives, actions, targets and triggers; and ecological thresholds as well as threats and pressures. The IECA Framework can also assist management of, and reporting on, key aquatic ecosystems and key ecosystem functions at multiple scales, an important feature for those ecosystems that cross jurisdictional boundaries.

An alternative framework for assessing condition, the Framework for Assessing River and Wetland Health (FARWH), has recently been developed. In comparison to the IECA Framework, the Framework for Assessing River and Wetland Health is focused on broad-scale condition assessments. It establishes a national assessment and reporting system for river and wetland health that will allow comparable assessments within and between jurisdictions for future national reporting.

IECA Framework trials

'Proof of concept' projects have been undertaken to develop and test the framework, including a trial in the temperate Walpole-Nornalup region of south-west Western Australia (Storer et al. 2010), and another in the arid Cooper Creek catchment in the Queensland portion of the Lake Eyre Basin (Negus, Blessing & Clifford 2012), encompassing river, wetlands and GDEs. Other projects are also being undertaken at Murray Icon sites (Barmah and Hattah Lakes) in the Murray-Darling Basin.

Appendix B: Systematic Conservation Planning versus Aquatic Ecosystems Toolkit

Conservation is the sustainable and cost-effective preservation of highly significant or biodiverse regions and assets. In the past the selection of priority conservation areas has been undertaken using subjective and *ad hoc* methodology (e.g. Pressey 1994), or by ranking sites based on biodiversity features, which may not adequately represent all conservation features (Williams et al. 1996). Often conservation areas have been identified because they are remote or are unsuitable for commercial purposes (Margules & Pressey 2000) and thus may under-represent biodiversity.

Systematic conservation planning (SCP) has evolved as a method to identify an optimum set of areas that cost-efficiently represent desired conservation features. SCP involves compiling biodiversity data, reviewing existing conservation areas and selecting additional areas for conservation, implementing conservation actions, and maintaining the values of the area. SCP also has a strong socio-economic component to address competition for scarce resources (Margules & Pressey 2000; Margules & Sarkar 2007). Although the majority of SCP processes to date have focused on marine and terrestrial environments, SCP studies targeting freshwater ecosystems have started to appear in the literature (e.g. Nel et al. 2007; Linke et al. 2007; Linke, Turak & Nel 2010; Moilanen, Leathwick & Elith 2008; Hermoso et al. 2010).

A major difference between the Aquatic Ecosystems Toolkit and SCP tools is that the latter involve setting conservation targets and estimating the socio-economic costs associated with conservation management actions. Unlike SCP tools, the Aquatic Ecosystems Toolkit is focused on identifying and classifying aquatic ecosystems of significance based on ecological values only. The Aquatic

Ecosystems Toolkit does not include a mandate to manage any identified HEVAE, instead it provides a set of tools to assist jurisdictions in identifying and classifying important aquatic ecosystems.

Data and outputs obtained through the application of the Aquatic Ecosystems Toolkit, including the identification of threats and important components and processes, could ultimately be fed into a management plan if required. The IECA Framework may also provide a method for assessing and reporting on condition that could contribute to management and planning processes. A range of tools, such as SCP, could be used to fulfil the next step of actually identifying conservation targets and assessing the socio-economic costs of different conservation assessment processes, if the relevant manager of an area containing an identified HEVAE chose to do so. Therefore, SCP tools, while having a different purpose from the Aquatic Ecosystems Toolkit, may be complimentary if used within a process to identify appropriate management actions for an identified HEVAE. Both types of tools could also be considered for use in guiding future management decisions, rather than the tools forming a management or conservation plan.

Appendix C: Other potential uses of the Aquatic Ecosystems Toolkit

Wise use of all wetlands

The Ramsar Convention (1971), of which Australia is a contracting party, defined the concept of 'wise use of wetlands' as 'the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development'³. This concept 'applies to all wetlands and water resources in a Contracting Party's territory, not only to those sites designated as Wetlands of International Importance'.

The identification of significant aquatic ecosystems is a partial fulfilment of Australia's obligations under the wise use of wetlands concept. The wise use of wetlands emphasises the:

- adoption of national wetland policies, involving a review of existing legislation and institutional arrangements to deal with wetland matters (either as separate policy instruments or as part of national environmental action plans, national biodiversity strategies, or other national strategic planning)
- development of programs of wetland inventory, monitoring, research, training, education and public awareness
- taking of action at wetland sites, involving the development of integrated management plans covering every aspect of the wetlands and relationships with their catchments.

Murray–Darling Basin Plan

The Murray–Darling Basin Authority (MDBA) is preparing the Basin Plan, as required by the *Water Act 2007* (Cwlth). The plan will provide an integrated approach to managing the water resources of the Murray–Darling Basin in a way that can be sustained through time and in the national interest. This includes extensive scientific analysis of the Basin's ecology, identification of the key environmental assets (KEAs) within the Basin, and the key ecosystem functions and their water requirements. To select the KEAs, aquatic ecosystems were assessed against five criteria, which were informed by the HEVAE criteria. The Interim ANAE Classification Framework also informed the selection of KEAs in the Draft Basin Plan.

The Basin Plan will include an Environmental Watering Plan (EWP) setting out the framework for the use of environmental water in the Murray–Darling Basin. The EWP will require Basin states to prepare a long-term watering plan for each catchment that identifies the environmental assets and ecosystem functions that require environmental watering. Components of the Aquatic Ecosystems Toolkit, combined with locally relevant criteria, can assist in developing the method for this identification and assessment process for the Basin Plan.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

In October 2008 the then Minister for the Environment, Heritage and the Arts commissioned an independent review (Hawke 2009) of the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (the EPBC Act). In response to the recommendations of the review a new matter of national environmental significance (NES) for 'ecosystems of national significance' was announced.

The review found that environment legislation could be more effective if it could protect biodiversity at an ecosystem level, rather than focus on individual species. Through the process of ecosystem identification, classification and delineation, it is

³ <http://www.ramsar.org/pdf/about/info2007-07-e.pdf>

intended that sites are identified to encompass critical ecosystem components and linkages.

Ramsar and other international obligations

The HEVAE identification process will not replace existing Ramsar processes for identifying internationally significant aquatic ecosystems. However, it will be compatible because there is an overlap in the nature of the criteria and in the scope of wetland types.

The Ramsar Convention promotes the concept of 'wise use of all wetlands'. Components of the Aquatic Ecosystems Toolkit could contribute to the development of these policies.

The *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)* could also assist in meeting other international obligations. By selecting attributes under criterion appropriately it could help identify sites that may be considered under international conventions such as World Heritage.

National Biodiversity Strategy

Since the adoption of the *National Strategy for the Conservation of Australia's Biodiversity* in 1996 there have been a number of significant changes to the policy, legislative and regulatory environments for biodiversity conservation in Australia. A review was undertaken and a new strategy, *Australia's Biodiversity Conservation Strategy 2010–2030* (NRMMC 2010a), was developed. This review identified that further work is required to include marine and freshwater ecosystems, which are currently under-represented. A nationally consistent set of tools to identify aquatic assets could assist this process.

Target 5 of Australia's Biodiversity and Conservation Strategy 2010–2030 is '...that by 2015, 1,000 km² of fragmented landscapes and aquatic systems are being restored to improve ecological connectivity'. The Aquatic Ecosystems Toolkit could assist in identifying important aquatic ecosystems within a landscape context, including critical connectivity linkages.

National Reserve System

Australia's Strategy for the National Reserve System 2009–2030 (NRMMC 20010b) recommended that aquatic ecosystems need to be better protected in the National Reserve System. A review of the *Australian Guidelines for Establishing the National Reserve System* (ANZECC 1999) will better account for the needs of aquatic ecosystems including water requirements, the impact of climate change, and integrated landscape management. A nationally consistent set of tools to identify aquatic ecosystems could assist this process.

National State of the Environment (SoE) reporting

The SoE process is driven by legislative requirements as set out in section 516B of the *Environment Protection and Biodiversity Conservation Act 1999*. National State of the Environment (SoE) reports provide information about environmental and heritage conditions, trends and pressures for the Australian continent, surrounding seas and Australia's external territories. 'Inland waters' is one of the themes of SoE, and covers a range of issues such as the use of surface and groundwater resources, water quality, pressures on aquatic ecosystems, aquatic biodiversity, and investment in inland waters. Jurisdictions are also required to undertake SoE reporting, which may include information about aquatic ecosystem types, condition and pressures. The tools within the Aquatic Ecosystems Toolkit could assist in gathering this information.

National Water Quality Management Strategy (NWQMS)

The NWQMS provides a national approach to improving water quality in Australia's waterways. Participants in the NWQMS are working to protect the nation's water resources by improving quality, reducing pollutants and at the same time supporting the businesses, industry and communities that depend on water for continued development⁴. Under the NWQMS, national

⁴ <http://www.environment.gov.au/water/policy-programs/nwqms/>

guidelines exist for water quality benchmarks and groundwater protection.

A discussion paper regarding the implementation of the NWQMS was prepared in 2008 (Bennett 2008). This paper identified that ‘the current NWQMS processes include a higher level of protection to waterways with high ecological values and the outcomes of the AETG work [regarding HEVAE identification] need to be incorporated into updates of the principles, policies and processes in the NWQMS documents’. The NWQMS is undergoing a review, the findings of which will inform the development of the strategic direction of the strategy in the years ahead.

Investment programs

To assist the jurisdictions in the management of aquatic ecosystems for natural resource management outcomes, the Australian Government has used the principles of the *Guidelines for Identifying High Ecological Value Aquatic Ecosystems (HEVAE)* to identify sites for investment under the Caring for Our Country program. The national tools could assist governments to jointly identify HEVAE as a basis for determining priorities for investment.

Other possible applications

The tools of the Aquatic Ecosystems Toolkit, either together or individually, could provide a systematic approach to discovering important areas where data is deficient as well as identifying the type of information that is needed. The results could then be used to guide research to fill these gaps and build our knowledge and capacity for management. For example:

- The Interim ANAE Classification Framework could provide an understanding of aquatic ecosystem types that are currently under-researched.
- The systematic application of criteria could show areas where little or no data exists, or particular types of data are lacking.
- The delineation process could help guide research priorities at specific sites, and drive the need to consider the site as a functioning system rather than just the wetted area.
- The IECA Framework could guide research into improved understanding of ecosystem components, functions, processes, connectivity and ecosystem health and inter-dependencies.



Banded stilts in flight (Brian Furby Collection)

Appendix D: List of project reports

Draft toolkit documents

AETG (2009). *Draft guidelines for applying the criteria for the HCVAE assessment process*. Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts, Canberra.

AETG (2009). *High Conservation Value Aquatic Ecosystems, Draft National Framework*. Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts, Canberra.

Completed project reports (post-draft toolkit documents)

Auricht, C. (ed.) (2011). *Towards an Australian National Aquatic Ecosystem Classification. Initial report on an attribute based classification scheme. Version 1.2*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Auricht Projects, Brighton.

Auricht, C. (ed.) (2010). *Towards an Australian National Aquatic Ecosystem Classification. Initial report on an attribute based classification scheme. Version 1.1*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Auricht Projects, Brighton.

Auricht, C. (ed.), Hale, J., and Brooks, S. (2011). *Draft Guidelines for the Delineation of High Ecological Value Aquatic Ecosystems (HEVAEs). Final Report*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Auricht Projects, Brighton.

Butcher, R., (ed.), Farrington, L., Harding, C., and O'Connor, P. (2011). *An integrated trial of the Australian National Aquatic Ecosystem Classification Scheme in south-eastern South Australia*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Water's Edge Consulting, Mooroolbark.

DPIPWE (2011). *A draft method for identifying High Ecological Value Aquatic Ecosystems for Tasmania using CFEV data*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Department of Primary Industries, Parks, Water and Environment, Hobart.

DPIPWE (2010). *Identifying High Conservation Value Aquatic Ecosystems for Tasmania using the National Framework. A scoping paper*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Department of Primary Industries, Parks, Water and Environment, Hobart.

Duguid, A. (2012). *Delineation and description of ecological character of the mid-Finke Waterholes: A trial of guidelines for High Ecological Value Aquatic Ecosystems*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Northern Territory Department of Natural Resources, Environment, The Arts and Sport, Alice Springs.

Gooderham, J. (2012). *Tasmanian HEVAE delineation and description trial: North-eastern Flinders Island*. Report prepared for the Department of Primary Industries, Parks, Water and Environment, the Aquatic Ecosystems Task Group, and the Department of Sustainability, Environment, Water, Population and Communities. The Waterbug Company, Hobart.

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, Canberra.

Kennard, M.J. (ed.) (2010). *Identifying high conservation value aquatic ecosystems in northern Australia*. Report prepared for the Department of Environment, Water, Heritage and the Arts and the National Water Commission. Tropical Rivers and Coastal Knowledge (TRaCK) Commonwealth Environmental Research Facility, Australian Rivers Institute, Griffith University, Nathan.

Kruger, M., Coote, M., and Shanahan, A. (2012). *Trial of the Australian National Aquatic Ecosystem (ANAE) Classification Scheme (Module 2 v0.4) in the mid-west of Western Australia*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Western Australia Department of Environment and Conservation, Perth.

Negus R.M., Blessing J., & Clifford S. (2012). *Developing an Integrated Ecological Condition Assessment (IECA) framework for High Ecological Value Aquatic Ecosystems in an arid landscape: The Cooper Creek catchment trial*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Queensland Department of Environment and Resource Management, Brisbane.

Storer, T., Forbes, V., Thomson, C., Calvert, T., Alexander, K. (2010). *Development of an integrated ecological condition assessment framework for High Conservation Value Aquatic Ecosystems: Case study: Walpole-Nornalup aquatic ecosystem*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Sustainability, Environment, Water, Population and Communities. Western Australia Department of Water, Perth.

Completed project reports (pre-draft toolkit)

Dunn, H. (2007). *Criteria for High Conservation Value Freshwater Ecosystems*. A discussion paper for HCVAE working group workshop, Darwin.

Hale, J., and Butcher, R. (2008). *Summary and review of approaches to the bioregionalisation and classification of aquatic ecosystems within Australia and internationally*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Jennifer Hale, Kinglake; Water's Edge Consulting Mooroolbark.

Neville, J., and Finlayson, C.M. (2007). *Discussion Paper: Assessing the importance of Australia's aquatic ecosystems*. Paper prepared for the Aquatic Ecosystems Task Group and the Department of Environment and Water. OnlyOnePlanet, Hampton.

NSW DPI (2008). *Murray-Darling Basin Commission, Identification of High Conservation Value Aquatic Ecosystems in the Northern Murray-Darling Basin—Pilot Project, Discussion Report*. (Plus additional reports on assessments in the Barwon-Darling, Border Rivers, Gwydir, Lachlan, Macquarie, Namoi-Peel, Paroo and Warrego catchments.) Report prepared for the Department of Environment, Water, Heritage and the Arts and the Murray-Darling Basin Commission. Department of Primary Industries, Port Stephens.

Peters, G. (2009). *Application of HCVAE Criteria to Victorian River Reaches*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Riveriness Protection and Restoration Services, Belmont.

Peters, G. (2010). *Review of HCVAE Trials*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Riveriness Protection and Restoration Services, Belmont.

Shanahan, A., and Coote, M. (2008). *A report on the application of draft criteria for identification of High Conservation Value Aquatic Ecosystems (HCVAE) on mound springs in Western Australia*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. Western Australia Department of Environment and Conservation, Perth.

SKM (2007). *High Conservation Value Aquatic Ecosystems Project—identifying, categorising and managing HCVAE*. Report prepared for the Aquatic Ecosystems Task Group and the Australian Government Department of Environment and Heritage. Sinclair Knight Merz, Armadale, Victoria, verified June 2012, <www.environment.gov.au/water/publications/environmental/ecosystems/hcvae.html>.

Stephens, K. (2008). *High Conservation Value Aquatic Ecosystems—NSW Estuaries Pilot Project*. Report prepared for the Aquatic Ecosystems Task Group and the Department of Environment, Water, Heritage and the Arts. NSW Department of Environment and Climate Change, Sydney.



Barmah Forest Ramsar site (Diane Conrick)



Australian Government

