Framework for mapping, classification and evaluation of wetlands in Western Australia

Acknowledgments

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Objectives of this framework

This framework outlines a statewide process for the mapping, classification and evaluation of wetlands in Western Australia (WA).

The ultimate objective of wetland mapping, classification and evaluation is to document the wetland resource, identify wetland values and ensure the preservation and improved management of wetlands in the long-term.

Loss of wetland habitat and values is occurring to varying degrees across the state. Direct wetland loss from filling, draining, and indirect modification and degradation from activities such as water abstraction and grazing are currently not quantified. Increased knowledge of the wetland resource is integral to understanding and preventing further loss of wetland values.

Wetland mapping, classification and evaluation have previously been conducted by various experts in different regions of the state using a variety of methodologies. The state and federal Natural Resource Management (NRM) process is expected to instigate additional wetland mapping, classification and evaluation projects and a number of these have already been funded. This framework will provide guidance to NRM groups, local and state government agencies, non-government organisations and consultants considering undertaking wetland mapping, classification and evaluation. The framework is applicable at a range of scales. It is expected to provide the following benefits:

- coordination and consistency across the state in the approach to wetland mapping, classification and evaluation
- certainty that data is collected using valid methodologies
- avoidance of repetition in project planning
- achievable aims in terms of scope and detail
- a mechanism for ensuring that data is made publicly available
- a mechanism to endorse the results at a state level.

Wetlands Conservation Policy for Western Australia

The *Wetlands Conservation Policy for Western Australia* (Government of WA 1997) outlines the Government's commitment to identifying, maintaining and managing the state's wetland resource, including the full range of wetland values, for the long term benefit of the people of WA.

The *Wetlands Conservation Policy for Western Australia* establishes five principal objectives with respect to the conservation of wetlands. This framework relates to Objective 1:

> *To prevent the further loss or degradation of valuable wetlands and wetland types, and promote wetland conservation, creation and restoration.*

Under each objective, the *Wetlands Conservation Policy for Western Australia* lists actions as the means by which the state government will endeavour to achieve that objective. This framework contributes to the implementation of Actions 1.10 and 1.13:

> *Develop and promote the use of a single classification system, including vegetation classification, for the wetlands of Western Australia*
>
> *Develop a wetland evaluation process, including identification of "beneficial uses" and management objectives, with statewide applicability, that will assist in ensuring that planning and management decisions concerning wetlands and their catchments are based upon as complete a knowledge as possible of current and foreseen wetland values.*

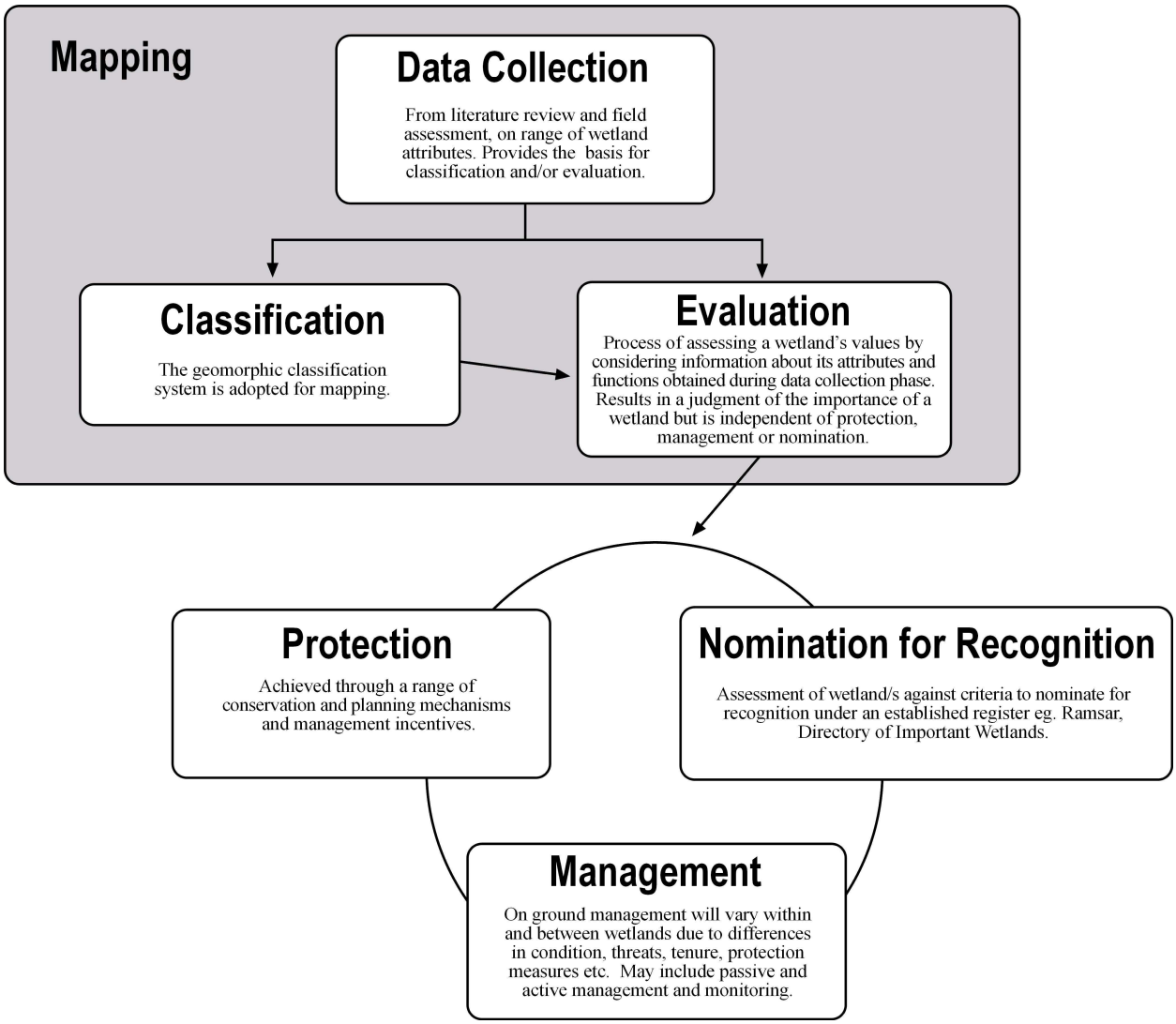
Scope of application

The *Wetlands Conservation Policy for Western Australia* has adopted the wetland definition used by the Ramsar Bureau (UNESCO 1971). This framework applies only to wetland habitats that are non-tidal and natural, including self-emergent wetlands (e.g. mound springs, sinter mounds, raised bogs) and those non-emergent wetlands which occur on hills, slopes, flats, and in basins (i.e. palusmonts, paluslopes, floodplains, barlkarras, palusplains, lakes, sumplands, playas, and damplands as defined in Semeniuk & Semeniuk (1995)). This is consistent with the strategy for implementation of the *Wetlands Conservation Policy for Western Australia* by excluding channel wetlands, *ie*. rivers, creeks, and coastal wetlands maintained by marine processes such as tidal flat wetlands, estuarine flats, and coral reefs.

Process of mapping, classification and evaluation of wetlands

The process of mapping, classification and evaluation of wetlands is demonstrated by the flowchart below (Figure 1). The information collated during the data collection phase is used to classify and/or evaluate wetlands and this information can all be represented spatially through mapping. The primary purpose of the classification system endorsed by this framework is to gain information about the range of different wetland types present within the state. Evaluation is the process of identifying the values of a wetland and is a separate process from classification. The wetland classification system can, however, contribute to the evaluation process. Evaluation information can then be used to plan for wetland management, protection and nomination for recognition under established registers.

Figure 1. Process of mapping, classification and evaluation of wetlands



Different levels of detail

Mapping, classification and evaluation of wetlands can be undertaken as separate or parallel processes at different levels of detail according to available resources. For simplicity, this framework describes 3 stages, from broad to detailed.

Stage 1 refers to broadscale identification of the occurrence of wetlands within a study area and provides a basis for guiding further work. Wetland boundaries will generally not be defined and wetlands may either be represented as points in space (with an indication of approximate size) or with an approximate boundary. The objectives at this stage are basic mapping of wetland distribution and data collection.

Stage 2 assessment of wetlands within a study area will include identification of preliminary wetland boundaries, classification of wetlands into geomorphic types and identification of groups of wetlands (such as consanguineous suites or wetlands within a biogeographic region). This Stage may include detailed evaluation of selected representative wetlands to infer the values of other similar wetlands. Incorporated into this stage is data collection, mapping of individual wetlands, site specific wetland classification, regional wetland groupings and preliminary regional wetland evaluation.

More accurate boundaries and wetland values can be defined by a detailed Stage 3 assessment of each individual wetland. Stage 3 involves collection of information on wetland attributes and functions at all wetlands and incorporates detailed mapping of wetland boundaries and site specific evaluation.

Each Stage from 1 to 3 may be undertaken independently, however, the information collated at each Stage can support a subsequent Stage. For example, a Stage 1 survey will provide valuable preliminary information for a Stage 2 and then Stage 3 survey. A Stage 3 assessment of the values of an individual wetland for a specific purpose eg. environmental impact assessment, can provide data that can be extrapolated to other similar wetlands in a Stage 2 survey at a regional scale.

The 3 stages of wetland mapping, classification and evaluation are summarised in Table 1.

Expertise and application

Wetland mapping, classification and evaluation require specialised field, laboratory and desktop investigations skills. Wetland assessments should be coordinated and led by professionals with specific expertise and experience in wetland processes eg. wetland ecology, hydrology and sedimentology. An understanding of the dynamic nature of wetlands and their response to seasonal conditions and longer term climate variability is particularly important.

Mapping

Mapping the presence of a wetland is the first step in planning for wetland conservation. Wetlands are identified on the basis of wetland vegetation, the presence of permanent, seasonal or intermittent waterlogging or inundation, and/or the occurrence of hydric soils. Table 3 provides a more detailed list of attributes that may be associated with wetlands.

When determining an appropriate mapping scale, consideration should be given to the level of detail required. The preliminary identification of wetlands (Stage 1) is possible through an analysis of topographic maps and orthophotographs. The location of wetlands can be denoted at a 1:250,000 or 1:100,000 map scale.

The delineation of preliminary boundaries (Stage 1 or 2) requires a finer map scale of 1:50,000 to 1:10,000. For this level of detail, finer topographic and stereoscopic aerial photograph analysis is utilised. Other mapping resources may also be required to supplement this information.

A detailed assessment of wetland attributes occurs at Stage 3. The detailed information captured by the Stage 3 mapping should not be represented at scales broader than 1:25,000. It may be necessary to use scales as large as 1:5,000 where high resolution detail of wetland features is required.

Table 1 – Levels of detail

Stage	Purpose/objective	Scale	Approach	Mapping	Mapped classification	Evaluation	Outcome
1	Broad wetland distribution	Regional	Reconnaissance Desktop 'Drive by'	Satellite imagery, aerial photographs, topography Map 'centroid' or approximate boundary 1:250,000 to 1: 100,000 scale	Wetland vs dryland	Existing data only No further evaluations	Quantify wetland resource
2	Asset evaluation, priority setting	Group of wetlands	Field sampling of sub-set and extrapolation of information	Aerial photograph Precise or approximate boundaries 1:50,000 to 1:10,000 scale	Geomorphic wetland type	Preliminary indication of conservation value	Preliminary evaluation and prioritisation for future detailed assessment
3	Protection, management, environmental impact assessment	Individual	Individual wetland assessment in field	Aerial photographs (stereoscopic analysis) Precise boundaries 1:25,000 to 1:5,000 scale	Geomorphic wetland type	Detailed assessment of conservation value	Identification of values of individual wetlands as basis for protection, management and/or nomination.

Data collection

The data collection phase provides the information necessary for the classification and evaluation of wetlands, and will also enable identification of potential threats to wetland condition. Information can be obtained from a variety of sources including literature review (eg. reports, journal articles, databases, maps), aerial photography and/or satellite imagery interpretation and analysis, consultation with community members and field assessment.

Important aspects of a wetland for data collection include its landform, water regime, sediments, approximate boundary, water quality, extent and condition of all wetland vegetation, use by aquatic and terrestrial fauna (both vertebrate and invertebrate), degree of naturalness, and proximity to other wetlands and natural bushland. Information should also be collected on the surrounding land uses and drainage.

The following are examples of recognised publications and datasets that identify natural areas of international, national and regional significance. These publications and datasets also provide useful guidance about the type of information to collect:

- Ramsar Convention (international) (UNESCO 1971)
- Biosphere Reserve (international) (UNESCO 2006)
- *A directory of important wetlands in Australia* (national) (Environment Australia 2001)
- National Estate listings (national) (Australian Heritage Commission 1990)
- National Parks, Nature Reserves and Conservation Reserves (state)
- Threatened Ecological Communities (national and state)
- State Register of Heritage Places (state) (Heritage Council of Western Australia 2001)
- *Bush Forever* (regional) (Government of Western Australia 2000)
- *Nature conservation reserves in the Kimberley, Western Australia* (regional) (CALM 1991)
- *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002* (regional) (CALM 2003).

Classification

The geomorphic classification system described by Semeniuk & Semeniuk (1995) has been adopted as the primary classification system for mapping wetlands in WA. This hierarchical system is based on the shape of the host landform and the wetland water regime (see Table 2) and the nomenclature of the wetland types recognised by the system (eg. palusplain, dampland) indicates these characteristics. The geomorphic classification system is based on the underlying structure of a wetland and, therefore, can be applied to the full range of wetlands across the state, and the world. It can also be applied to substantially altered wetlands, for example, where vegetation has been cleared or soils disturbed. Further differentiation of water quality, size, shape and vegetation is possible by using wetland descriptors. Before the geomorphic classification system is applied, the first step is to recognise the presence of a wetland and at Stage 1 that may be all that is recorded.

Table 2. Geomorphic wetland types[1] formed by combining landform and hydroperiod attributes, excluding channel wetlands (from Semeniuk & Semeniuk 1995)

Water permanence	Landform			
	Basin	Flat	Slope	Highland
Permanent inundation	Lake	-	-	-
Seasonal inundation	Sumpland	Floodplain	-	-
Intermittent inundation	Playa	Barlkarra	-	-

Seasonal waterlogging	Dampland	Palusplain	Paluslope	Palusmont

[1]The framework also applies to self-emergent wetlands such as raised bogs, mound springs and sinter mounds. For detailed description of these and the above wetland categories refer to Semeniuk & Semeniuk (1995).

In addition to applying the geomorphic classification system, wetlands may also be classified into groups that reflect shared biological or chemical attributes. Unlike the geomorphic classification system, these groups may not always be predetermined. For example, Halse *et al.* (2004) used floristic, aquatic invertebrate and waterbird use to classify Wheatbelt wetlands into groups with particular conservation values. *Ad hoc* classification systems of this kind are widely used to order information and provide context for wetland evaluation.

Evaluation

Evaluation of wetlands is the process of assessing and documenting a wetland's values by considering information about its attributes and functions obtained during the data collection phase. The process of evaluation is independent of protection, management or nomination and results in a description of values. However, subsequent protection or management decisions should be based on evaluation results.

There are benefits in simultaneously collecting sufficient data to enable both geomorphic wetland classification and evaluation. Examining landform directs attention to landscape setting, which can provide information about the types of hydrological processes which are likely to be operating; the origin of the wetland; and the type of wetland sediment which is likely to be present. From water regime, information about the hydrological processes; hydrochemistry; distribution of plant assemblages; and broad assemblages of plants and animals may be deduced. Consequently, the geomorphic classification approach assists an understanding of wetland processes which, in turn, facilitates evaluation of wetland values such as naturalness, representativeness and rarity. In this way, the geomorphic classification system may be used to identify wetlands likely to have important conservation values and help predict how wetlands might respond to changes in surrounding land use, water regime or disturbance factors.

The methods of evaluation are not described in this framework because wetland values need to be interpreted within a regional context and may differ between regions of the state. In addition, the approach to determining wetland values will vary between regions depending on availability of information on wetland attributes. However, the range of attributes and types of questions that an evaluation methodology should address are listed in Table 3. In order to provide a consistent statewide approach, it is recommended that the Wetlands Coordinating Committee endorses proposed methodologies for wetland evaluation. Existing endorsed methodologies that provide guidance as to what is suitable will be listed on the Department of Environment and Conservation (DEC) website under http://wetlands.environment.wa.gov.au. (See 'Evaluation methodology endorsement process' presented below for more detail.)

It is emphasised that a Stage 3 evaluation will require considerable information about the attributes of the wetland being evaluated. Such information will require field studies as well as desktop collation of information. Wetlands that have been recognised by existing evaluation methodologies for wetlands of international, national or state importance require no further evaluation, unless a higher level of recognition is being proposed or the wetland no longer meets the criteria of that methodology.

So that the values of an individual wetland are not considered in isolation, the extent of degradation and loss of wetlands within a region should also be considered to provide a context. In this way, a wetland that is determined to have low or medium value may be found to be more important when considered in relation to the region. For example, a wetland with naturally low flora or fauna species diversity, or a wetland which is highly degraded, may be an important representative of a regional wetland type.

Table 3. Wetland evaluation: attributes and functions to assess

Attributes and functions	Evaluation questions
Geomorphology	Is the wetland a good example of its geomorphic type? (Ie. representative of its consanguineous suite). Is the wetland geomorphic type scarce? (Ie. using the full suite of descriptors available). Is the wetland type unusual in its setting? Has the wetland type changed? (Eg. from dampland to lake). Has the wetland geomorphology been altered? (Eg. by changes to inflow or outflow channels or erosion/sedimentation).
Wetland processes (eg. recharge and discharge mechanisms, hydroperiod, sedimentary processes)	Does the wetland exhibit representative wetland processes? (Ie. representative of its consanguineous suite and geomorphic setting). Does the wetland have a role in natural flood mitigation? Does the wetland have a role in a subregional hydrological system? Does the wetland exhibit unusual hydrological wetland processes? (Eg. upwelling; reverse flows at the margins or between seasons). Does the wetland exhibit unusual sedimentological wetland processes? (Eg. lateral expansion by weathering; vertical deepening by dissolution). Are the current wetland processes natural?
Water quality	Is the natural water chemistry unusual in the region? Does the water chemistry appear to have been altered?
Linkages	Is the wetland contiguous with vegetated dryland areas? (Ie. maximising benefit to terrestrial species and aquatic species that spend time in terrestrial habitats). Does the wetland function as part of an ecological linkage? Is the wetland a significant component of hydrological cycles? (Eg. floodplain wetland linked to river ecology). Does the wetland form part of a wetland network used by mobile animals? (Ie. the current population size is dependent on access to all of the network). Is the wetland a nursery for species that spend adult life elsewhere? (Eg. floodplain wetland and fish).

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Attributes and functions	Evaluation questions
Flora	Is the wetland vegetation representative of wetlands in this setting? (Eg. species, composition, arrangement). Is flora species richness high? Does the wetland support significant plant communities or species? How widespread is the plant community? Is the plant community a good example of its type? Has the wetland vegetation been altered?
Fauna	Does the wetland support native faunal communities? Is the faunal community a good example of its setting? Is fauna species richness high? Does the wetland support significant faunal communities or species? How widespread is the faunal community? Does the wetland provide habitat during an important stage of the lifecycle for some species? (Eg. dry season refuge for waterbirds and insects; breeding habitat of crocodiles). Is the wetland an important site for listed migratory bird species?
Scientific or educational value	Does the wetland have high scientific or educational value? For example: Does the wetland contain palaeohistory of its development? Does the wetland contain climate history reflected in its sedimentary sequence? Is the wetland in an important evolutionary phase? Does the wetland contain significant pollen records? Do unusual wetland sediments underlie the wetland? Does the wetland represent unusual geomorphology or geological sites? Is the wetland the result of unusual earth forming processes? Does the wetland support unusual plant communities associated with underlying causes (e.g. stratigraphy, hydrology)?
Cultural value	Does the wetland have Aboriginal or European cultural significance? (Note: excludes for commercial use).

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Evaluation methodology endorsement process

Once a methodology has been endorsed for a study area it should be applied to any further inventory work within that same study area. Endorsed methodologies will be made available on the DEC website under http://wetlands.environment.wa.gov.au.

For areas where a methodology has not been endorsed, new evaluation methodologies should be submitted to the DEC's Wetlands Program in the first instance. The DEC will provide the proposed methodology to the Wetland Status Working Group (a subcommittee of the Wetlands Coordinating Committee) for assessment before final endorsement of the Wetlands Coordinating Committee. Endorsement should ideally be sought at the start of the project and prior to data collection.

Wetland conservation

The information obtained to classify and evaluate wetlands can be used to plan for wetland conservation actions including on ground management, non-statutory and statutory protection and recognition under registers.

Management

On ground management may vary within a wetland due to differences in values, condition, threats, landowners and funding. Management may be passive or involve active intervention, such as stock exclusion, weed control, revegetation or control of water levels. It will often include monitoring of wetland condition to verify that management is causing wetland condition to be maintained or improved. Prioritisation for management is not discussed in this framework, however, an NRM group may wish to prioritise wetlands for on-ground works (for example). The Wetlands Coordinating Committee is currently developing *A guide to managing and restoring wetlands in Western Australia* and an accompanying training course. More details are available from the DEC's Wetlands Program.

Protection

Once a detailed evaluation of wetlands has occurred via a Stage 3 survey, or of representative wetlands as part of a Stage 2 survey, the mechanisms for recognising the importance of wetlands and ensuring their protection should be considered. Criteria for protection will depend on the group and project utilising the evaluation information. As an example, the DEC utilises 3 broad categories to provide guidance on the nature of management and protection a wetland should be afforded in environmental assessment and planning: Conservation, Resource Enhancement and Multiple Use.

The Swan Coastal Plain example

Detailed (Stage 3) wetland mapping, classification and evaluation on the Swan Coastal Plain has been undertaken over the past 10 or so years and is presented in the *Geomorphic Wetlands Swan Coastal Plain* dataset (DEC). The dataset has been endorsed by the Wetlands Coordinating Committee, the Environmental Protection Authority, the Western Australian Planning Commission, the Conservation Commission and the Water and Rivers Commission board as the basis for identifying 'valuable' wetlands for protection under the *Wetlands Conservation Policy for Western Australia*. This endorsement process has led to the identification of Conservation category wetlands as 'environmentally sensitive areas' within the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*; and as a trigger for referral of subdivisions to the DEC by the Department of Planning and Infrastructure. It is expected that these mechanisms will greatly improve the protection of valuable wetlands on the Swan Coastal Plain.

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Voluntary conservation covenants are another protection mechanism that may be utilised. They are an agreement between the landowner and either The National Trust or DEC to protect and enhance the natural, cultural and/or scientific values of the land. The covenant is permanently registered on the property and has the force of statute and binds all future owners.

Nomination and recognition

Evaluation information can be used to assess a wetland against nomination criteria for recognition under a register, such as the Ramsar Convention or the Directory of Important Wetlands registers. In WA, DEC is the agency responsible for identifying and proposing wetland sites to the Commonwealth Department of Environment and Heritage for inclusion on national and international registers.

Geographical information system data collation

In order to ensure compatibility with existing wetland mapping, all data should be spatially recorded using the following geographical information system (GIS) format:

- Arcview shapefile format
- geographic projection
- GDA94 datum.

A metadata statement should be attached in accordance with ANZLIC/ISO 190115 guidelines.

A web based statewide wetlands database has recently been developed by DEC and can be accessed at www.naturebase.net/projects/wetlands_database.html. This database displays wetlands and their associated biophysical data spatially through a map viewer delivery system. The first stage of the database is to collate and display existing data relating to wetlands. Later stages of the database project may provide an opportunity for additional data storage and distribution, and will allow for cross regional comparison.

It is recommended that the following fields be recorded in the GIS table:

Field	Information to include
Wetland identifier	Use site code from DEC statewide wetlands database (Alpha Numeric format) or create new identifier
Wetland name	If known
Area	In hectares
Perimeter	In metres
Map sheet no.	E.g. 2034 II NW
Geomorphic classification	E.g. sumpland, palusmont
Classification groundtruthing	Yes/No and date
Management category (if determined)	Conservation, Resource Enhancement or Multiple Use
Evaluation method	Citation/publication
Attributes assessed	List (refer to DEC statewide database for parameters and units of measurement)
Values	List as summary (refer to DEC statewide database for parameters and units of measurement)

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Evaluation score	Number
Evaluation groundtruthing	Yes/no and date
Consanguineous suite	Name
Scale of capture	E.g. 1:4 000
References	List if applicable
Comments	Optional

Glossary

Consanguineous suite – area/s defining a group of wetlands with common or interrelated features. Identified on criteria of wetland type, wetland geometry, stratigraphy, inferred origin and water characteristics (Semeniuk 1988).

Conservation category wetland – Wetlands which support a high level of attributes and functions Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including:

• reservation in national parks, crown reserves and State owned land,

• protection under Environmental Protection Policies, and

• wetland covenanting by landowners.

No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate (from Hill *et al*. 1996 and WRC 2001).

Environmentally sensitive area – area of the state specified in a notice, or an area of the state of a class specified in a notice, declared by the Minister for the Environment under s.51B of the *Environmental Protection Act 1986* to be an environmentally sensitive area. The exemptions for prescribed purposes outlined in the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* from the requirement for a clearing permit do not apply in environmentally sensitive areas, and thus these areas have a higher level of protection.

Hydric soil – soil that has formed under conditions of saturation, flooding or ponding long enough to develop anaerobic conditions in the upper part. The concept of hydric soils includes soils developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation (adapted from <www.soils.usda.gov>).

Region – geographical area of context which should be defined. Eg. bioregion; natural resource management region.

Resource enhancement wetland – Wetlands which may have been partially modified but still support substantial attributes and functions Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category. This can be achieved by restoring wetland attributes and functions, and biodiversity. Protection is recommended through a number of mechanisms (from Hill *et al*. 1996 and WRC 2001).

Significant fauna – include but are not necessarily limited to species protected by international agreements or treaties (for example, JAMBA and CAMBA migratory bird agreements), Specially Protected Fauna, Priority Fauna, short range endemic species, species with declining populations or declining distributions, species at the extremes of their range, isolated outlying populations and undescribed species (EPA 2005).

Significant flora – includes but is not limited to flora with any of the following characteristics:

(a) Declared Rare Flora or Priority Flora

(b) keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species

(c) relic status

(d) anomalous features that indicate a potential new discovery

(e) representative of the range of a species including the extremes of the range, recently discovered range extensions, or isolated outliers of the main range

(f) a restricted subspecies, variety or naturally occurring hybrid

(g) local endemism or a restricted distribution.

Significance may apply at any level (for example, local, regional, national and international)(EPA 2005).

Multiple use wetland – Wetlands with few remaining important attributes and functions Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare. (from Hill *et al*. 1996 and WRC 2001)

Wetland vegetation – vegetation which is adapted to inundated or waterlogged conditions that often forms overlapping zones along an elevational gradient from the deepest part of a wetland. Wetland vegetation is essential to the ecological functioning of a wetland (and includes fringing and riparian vegetation) (Balla 1994).

Obligate wetland species (ie. those plants generally restricted to wetland habitats) are considered reliable wetland indicators (Tiner 1999). However, facultative species (ie. those plants that can occur in wetland and dryland habitats) can be common, notably in dampland and palusplain wetlands, or peripheral to sumpland and lake wetlands. It is therefore important to recognise the opportunism and longevity of species, both obligate and facultative, in response to disturbance and changing environmental conditions where annual rainfall is variable. It is also important to consider flora species in the context of the vegetation community and the density of species occurrence.

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Information sources

Biosphere Reserves (UNESCO) available from: http://www.unesco.org/mab/mabProg.shtml

Bush Forever (Government of Western Australia 2000)

Volume 1: Policies, Principles and Processes available from: www.dpi.wa.gov.au > City and regional planning > City planning > Bush Forever

Volume 2: Directory of Bush Forever Sites is in the process of being digitised, however, in the interim it is available from: DEC library.

WetlandBase – The Western Australian Wetlands Database (DEC) available from: www.naturebase.net

Directory of Important Wetlands in Australia (Department of the Environment and Heritage) available from: www.deh.gov.au > Inland Waters > Wetlands > Databases and Information > Australian Wetlands Database.

Evaluation of Wetlands of the Southern Swan Coastal Plain (V & C Semeniuk Research Group 1998) available from: DEC library.

Geographic Data Atlas available from : www.environment.wa.gov.au > Tools, systems and data > Geographic Data Atlas

Perth Groundwater Atlas available from: www.water.wa.gov.au > Tools, systems and data > Perth Groundwater Atlas.

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Ramsar List of Wetlands of International Importance available from: www.ramsar.org and www.deh.gov.au > Inland Waters > Wetlands > Databases and Information > Australian Wetlands Database.

Register of the National Estate available from: www.ahc.gov.au > Register of the National Estate

State Register of Heritage Places available from: http://register.heritage.wa.gov.au/

The *Wetlands of the Swan Coastal Plain* series are available at wetlands.environment.wa.gov.au > Publications > Wetlands of the Swan Coastal Plain

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