Department of
Environment and Conservation

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Methodology:

Rapid Indicator Assessment of Western Australian Inland Aquatic Ecosystems

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Table of Contents

1 Introduction

The Rapid Indicator Assessment of Western Australian Inland Aquatic Ecosystems Methodology (The Methodology) provides procedures for completing a survey of key natural components and threatening processes at wetlands in Western Australia. The Methodology was prepared by the Inland Aquatic Integrity Resource Condition Monitoring (IAI RCM) project, delivered by the Department of Environment and Conservation (DEC) with funding from the Natural Heritage Trust (NHT2).

The IAI RCM project undertook a survey of forty-four significant wetlands across Western Australia. The Methodology enables the continuation of surveillance of those sites by providing instruction in the replication of survey methods. Applying the recommended methods at other wetlands will allow direct comparison to the IAI RCM study sites.

2 Definitions

Assessment: the identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities (Ramsar Convention 2002).

Baseline Condition: condition at a starting point. For Ramsar wetlands, it will usually be the time of listing of a Ramsar site (Lambert and Elix 2006).

Benchmark: a standard or point of reference (ANZECC and ARMCANZ 2000a). A predetermined state (based on the values that are sought to be protected) to be achieved or maintained (Lambert and Elix 2006).

Benefits: the economic, social and cultural benefits that people receive from ecosystems (Ramsar Convention 2005). These benefits often rely on the underlying ecological components and processes in the wetland (Department of the Environment 2008).

Ecological character: the sum of the wetland's biotic and non-biotic components, functions, drivers and processes, as well as the threatening processes occurring in the wetland, catchment and region (Finlayson *et al.* 2005).

Ecosystem components: include the physical, chemical and biological parts of a wetland (from large scale to very small scale, e.g. habitat, species and genes) (Ramsar Convention 2005).

Ecosystem processes: dynamic forces within an ecosystem. They include all those processes that occur between organisms, and within and between populations and communities, including interactions with the nonliving environment, that result in existing ecosystems and that bring about changes in ecosystems over time (Australian Heritage Commission 2002). They may be physical, chemical or biological (Department of the Environment 2008).

Ecosystem services: benefits that people receive or obtain from an ecosystem (Ramsar Convention 2005). These services will generally have an indirect benefit to humans or a direct benefit in the long term (Department of the Environment 2008).

Inventory: a catalogue of natural resources in a given area.

Limits of acceptable change: variation that is considered acceptable in a particular component or process of the ecological character of the wetland without indicating change in ecological character that may lead to a reduction or loss of the criteria for which the site was Ramsar listed (Department of the Environment 2008).

Monitoring: the systematic collection of data or information over time to ascertain the extent of compliance with a predetermined standard or position (Hellawell 1991).

Objective: provides the basis for collecting the information. Objectives must be attainable and achievable within a reasonable time period (Hale and Butcher 2007).

Rapid assessment: "*a synoptic assessment, which is often undertaken as a matter of urgency, in the shortest timeframe possible to produce reliable and applicable results for its defined purpose*" (Anonymous 2006)

Sampling site: refers to a particular wetland being sampled.

Sampling location: refers to the specific point of sampling within a wetland (sample site). There may be multiple sampling locations within each sample site.

Surveillance: a time series of surveys to ascertain the extent of variability and/or range of values for particular parameters (Hellawell 1991).

Survey: an exercise in which a set of qualitative observations are made but without any preconception of what the findings ought to be (Hellawell 1991).

Wetland: '*areas of marsh, fen, peatland or water, whether natural or artificial, permanent of temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*' (Environment Australia 2001).

Wetland condition: *The relative integrity of the wetland ecosystem compared to a reference state. It includes being able to maintain key ecological and physical processes, ecosystem services, and communities of organisms. (Note: wetland health is taken to have the same meaning as wetland condition).*

3 Background and Objectives

3.1 Background and history

The Inland Aquatic Integrity Resource Condition Monitoring (IAI RCM) project developed a standard set of methods for assessing and reporting on key indicators of condition at significant wetlands in Western Australia. Methods were tested at sites in each of the state's non-metropolitan Natural Resource Management regions between May and December 2008. Forty-four wetlands were assessed, representing the range of geomorphic and functional wetland types found in the state. Surveys undertaken at the test sites may form the basis of ongoing monitoring of the impacts of threatening processes, including climate change.

It is important that Western Australia has a standard approach to wetland condition assessment and monitoring. Monitoring allows early detection of changes in ecological character. The use of standard methods facilitates comparisons between sites and the interpretation of data in a regional, or broader, context.

The methods recommended in the current document require a moderate understanding of wetland ecology and associated vegetation. They are suitable for use by DEC field staff and NRM practitioners, but the assistance of a suitably experienced botanist and wetland ecologist is recommend. These methods may also prove useful to other state and local government officers, Non-Government Organisations, academics and consultants, provided they have the requisite knowledge of wetland ecosystems. The recommended methods allow the collection of data that are statistically rigorous and scientifically defensible.

3.2 Rationale for selecting this resource to study

Wetlands have three characteristics that make them an important target for biological survey and ongoing monitoring. Firstly, wetlands are an integral and highly productive part of the natural environment and play an important role in maintaining biodiversity. Many ecosystem services are delivered by wetlands, including (Environment Australia 2001; Millennium Ecosystem Assessment 2005):

- climate regulation;
- water regulation (hydrological flows);
- water purification and waste treatment;
- erosion regulation and shoreline stabilisation,
- maintenance of water tables;
- groundwater recharge;
- natural hazard regulation (flood mitigation, storm protection);
- pollination (by providing habitat for pollinators);
- drought refuge for fauna and flora;
- soil formation; and
- nutrient cycling and retention.

Wetlands are complex systems that are often poorly understood. Numerous interactions between climate, topography, groundwater, surface water, substrates and biota create a myriad of unique wetland types.

Finally, Wetlands are also amongst the most threatened ecosystems worldwide, due largely to practices such as draining, infilling, pollution and overexploitation of their resources (Environment Australia 2001). The unfortunate result of the combination of these three factors, is that highly valuable aquatic ecosystems are being degraded or lost, even before their values can be documented or understood.

Many of Western Australia's significant wetlands are experiencing degradation due to land management practices. Usually, there are insufficient biological data to determine the rate of condition decline, or to be confident in the implementation of management actions to ameliorate the decline. In most cases, it is too late for us to determine the natural ecological character of these sites. However, establishing monitoring programs will allow wetland managers to detect future change and will provide a reference point for restoration activities.

The conservation of wetlands requires an understanding of each site's unique ecological character. Ecological character is the sum of the wetland's biotic and non-biotic components, functions, drivers and processes, as well as the threatening processes occurring in the wetland, catchment and region (Finlayson *et al.* 2005). Collecting this information is the objective of The Methodology.

3.3 Measurable objectives

The objective of rapid indicator assessment is to take quantified measurements of the components, processes and services of a wetland (modified from Department of the Environment 2008):

- that are key determinants of the site's unique character;
- for which baseline data is available to specify the component or process (where quantitative data is unavailable estimates may be made by an expert panel);
- for which change is reasonably likely to occur over short or medium time scales;
- which will cause significant negative consequences if change occurs; and
- which are practical to monitor and may be assessed rapidly in the field.

The initial survey of these components, processes and services will assist the wetland manager to more definitively:

1. *Identify the benefits/services delivered by wetlands.*
    - In a survey focused on wetland conservation, wetland benefits/services should be considered in an ecosystem services value context. A list of ecosystem services is provided in section 3.2.3.2

2. *Identify the key components and processes at each wetland that contribute to benefit/service delivery.*

    Wetlands consist of four main components: physical form (wetland area, shape and bathymetry), wetland soils, physiochemical (e.g. water pH, turbidity, temperature, nutrients) and biota (vegetation, vertebrates, invertebrates and phytoplankton).

    Assessment of significant wetlands involves collection of data on those components and processes that indicate a wetland's condition. It must allow for the considerable natural changes that wetlands experience as a result of localised and catchment scale processes and in response to natural climatic variation.

    Ecosystem processes are the dynamic forces that occur between the components of an ecosystem. The main processes operating within a wetland ecosystem may include (Department of the Environment 2008):

    - climate (precipitation, temperature, evaporation, wind);
    - geomorphology (topography/morphology, connectivity of surface waters, water source, soils, sedimentation, erosion);
    - hydrology (water balance, groundwater infiltration and seepage, surface-groundwater interactions, tidal regime, inundation regime);
    - energy and nutrient dynamics (primary production, nutrient cycling, carbon cycling, decomposition, oxidation-reduction);
    - processes that maintain animal and plant populations (reproduction, regeneration, dispersal, migration, pollination);
    - species interactions (competition, predation, succession, herbivory, diseases and pathogens); and

- physical processes (stratification, mixing, sedimentation, erosion, evaporation, infiltration).

3. *Determine the current status of key components and processes against relevant benchmarks (if available) or quantify to create a benchmark (Time=0 site).*

   An appropriate benchmark is essential to understanding the condition of a study site as 'condition' must be assessed in reference to some standard. A benchmark may be a similar site that is known to be in a natural condition (actual benchmark) or, if such a site is unavailable, a virtual benchmark may be constructed from historical data, desktop research and/or expert opinion.

4. *Identify the key threats to each wetland and quantify the impacts on key components of ecosystem function.*

   Threats to wetlands are identified through a combination of ecological modelling and on-ground site assessment. Information gathered from surveys and existing references may be used to construct a conceptual model of each wetland system, which shows the points at which threats are most likely to disrupt system functionality. These conceptual models are useful tools for determining important points for management intervention.

5. *Develop a monitoring program for detecting changes in ecological character, including limits of acceptable change (LAC).*

   The Methodology is applicable at a range of wetland types over a large geographic area. Wetlands face different threats and pressures, and so require different management strategies. Site-specific monitoring and management objectives must be developed on a case-by-case basis. Where applicable, recommendations for future monitoring programs for the IAI RCM study sites are detailed in the site Resource Condition Report.

3.4 Benchmarks

A benchmark is a standard point of reference that is to be achieved or maintained. The purpose of a benchmark is to provide a point of reference for 'naturalness' against which the condition of a wetland may be compared. Ideally, this would be the state of the wetland prior to European settlement. However, it is important to note that the condition of a wetland may not have been pristine in pre-European times, and also that the ecological components and processes of a wetland may be dynamic with natural fluctuations occurring (Michaels 2006). A benchmark should be based on, or indicative of, the values that are to be protected (ANZECC and ARMCANZ 2000b; Lambert and Elix 2006).

Benchmarks should be quantified by consideration of:

1. the historical condition of a wetland (preferably pre-European settlement) where historical data is available;
2. the condition of a wetland at the time when it was first surveyed. In the case of Ramsar sites this will be the condition of the wetland at the time of listing and will be recorded in the Ecological Character Description (if available) for that site;
3. the condition of a comparable wetland (of the same wetland type and with similar ecosystem components and processes) known to be in good condition; or
4. expert opinion, where none of the above is applicable.

Although it is not possible to return all wetlands to a pristine state, benchmarks do indicate the trend required for improvement in condition. Benchmarks provide guidance in implementing recovery actions and facilitate adaptive management.

Benchmarks are yet to be developed for Western Australian wetlands. However, once benchmarks are available, the information collected for the wetlands surveyed by the IAI RCM project will be used to compare the condition of each of the wetlands to the relevant benchmarks. The relevant Resource Condition Reports should then be updated to include this information.

4 Sampling Design

4.1 Rationale for selecting this sampling design over others

The methods employed by the IAI RCM project allow a rapid assessment of the components, processes and threats of inland aquatic ecosystems. Rapid assessment is defined by the Ramsar

Convention as: "*a synoptic assessment, which is often undertaken as a matter of urgency, in the shortest timeframe possible to produce reliable and applicable results for its defined purpose*" (Anonymous 2006).

The use of rapid assessment methods overcomes resource constraints by allowing the assessment of a large number of wetlands in a relatively short survey period. The need for rapid assessment must be balanced against the requirement to collect consistent, reliable and accurate data, thereby allowing comparison of results over time, between individual wetlands or between regions.

Rapid assessment falls into five categories based on the purpose and desired output of a particular assessment project: baseline inventory, specific-species assessment, change assessment, indicator assessment and economic resource assessment. The Methodology refers to indicator assessment, which aims to determine the overall ecosystem health or condition by collecting data relating to water quality, hydrological, biological and biotic indicators (Anonymous 2006).

The parameters included in The Methodology are consistent with the National Indicators for Wetland Ecosystem Extent, Distribution and Condition. Those indicators were developed in a collaborative project by the National Land & Water Resources Audit (NLWRA), Department of the Environment and Water Resources (DEWR) and the Wetlands & Waterbirds Taskforce (WWTF). The project was initiated and funded by the Australian Government in an attempt to facilitate consistent nationwide reporting on wetland health. It developed nationally consistent and coherent wetland indicators, and is currently developing protocols and methodologies to inform national natural resource management processes, including the Australian Wetland Inventory, State of the Environment reporting, Ramsar Convention implementation, and NRM national and regional monitoring and evaluation.

The Methodology recommends methods to monitor the indicators most commonly used in benchmarking and condition assessment at Australian wetlands. However, where management goals for individual wetlands require it, these methods may be adapted to focus on a particular aspect of a wetland's ecology. Alternatively, additional parameters may be included in a monitoring program.

The indicators of biological integrity assessed by the IAI RCM survey are:

- Physical Indicators - soil disturbance
- Chemical Indicators
  - salinity
  - pH
  - turbidity
  - water colour[1]
  - nutrient concentration[1]
  - total dissolved solids
- Biological Indicators
  - aquatic and riparian vegetation composition and structure
  - disturbance to vegetation
  - richness and diversity of aquatic invertebrates, water birds, fish and amphibians
  - presence and impacts of invasive species

A brief description of the methods used to measure these indicators, as well as limited justification for the use of the recommended methods is provided here.

Aquatic and Riparian Vegetation Composition

A search of the sampling location was conducted by a suitably qualified botanist. All taxa were identified, with unknown specimens collected for later identification.

Aquatic and Riparian Vegetation Structure

Prior to arrival at each wetland, aerial photographs were used to identify likely boundaries of the vegetation communities. Once at the site, a 50 m transect was established within each distinct community and methods employed to measure structure that are consistent with the National Vegetation Information System (NVIS) (Hnatiuk *et al.* 2008). NVIS was developed to underpin the

[1] Not an indicator included in The National Indicators of Wetland Ecosystem Extent, Distribution and Condition, however, this indicator is commonly used in wetland monitoring programs and has biological significance.

National Land and Water Resources Audit (NLWRA) assessment of vegetation in Australia. It is intended to resolve data and information differences across administrative boundaries, thus providing comparable and consistent data Australia-wide. The transect method provides quantified data which reduces inter-operator variability when compared to estimates of percentage cover.

Water Quality

Water quality was measured according to the methods described by the American Public Health Association, American Water Works Association and Water Environment Federation (1995), which are considered to be best practice.

Water quality parameters were measured using the following methods:

- Salinity (total dissolved solids) – method 2540C;
- Turbidity (lab measured) – method 2130B;
- Hardness – method 2340B;
- Chlorophyll – method 1020;
- Nitrogen (total persulfate and total soluble) – method 4500D; and
- Macrophyte biomass – one of methods listed under 10400D

Aquatic Invertebrates

Identification of aquatic microinvertebrates is a time-consuming process requiring expert knowledge and, as such, is not consistent with rapid assessment methods. Therefore, collection of aquatic invertebrates was limited to macroinvertebrates. Macroinvertebrates were collected for post-processing in the laboratory rather than using live-picking techniques. The rationale for this was that live picking is a time consuming process, which would significantly increase the time spent sampling each wetland. Since the aim of the project was to survey a large number of wetlands in a short period of time, it was preferred to preserve the invertebrates and store these for sorting after the completion of each field trip.

Waterbirds

Waterbird counts were made by viewing the wetland through binoculars or a telescope and sighting waterbirds while walking a portion of the wetland if required. This simplified method was considered a balance between a rigorous and a rapid approach.

Threat Assessment

Knowledge of threats to a wetland is essential when planning and implementing appropriate management practices. Threat assessment is therefore a vital component of surveys for biodiversity conservation (Wallace *et al.* 2003).

Threat assessment is difficult to achieve with accuracy and is sensitive to operator subjectivity. The quantification of threats is frequently imprecise and provides little more than rough estimates (Wallace *et al.* 2003). However, Bailey *et al* (1992) postulate that the identification of an environmental impact, even if not accurately quantified, can provide the basis for effective environmental management. This suggests that even a simple threat assessment is a valuable tool in wetland management.

The threat assessment presented in The Methodology provides for quantification of the area of the site affected by a number of categories of threat and an estimate of the severity of the impact. The assessor is also encouraged to take notes that provide additional context.

4.2 Site Selection

The methods recommended in the current document are appropriate to apply at any non-marine, non-channel wetland in Western Australia. They have been tested at sites throughout the state and found to be effective in many different climatic, hydrologic and geomorphologic settings.

4.2.1 Location of sites and criteria for selection

Based on differences in climate, geomorphology, vegetation type, geology and biota, the state has been divided into six major NRM regions and a number of sub-regions (Figure 1). These are:

- Rangelands
  (subregions: Kimberley, Pilbara, Gascoyne-Murchison, Goldfields-Nullarbor, Ord Catchment)
- Northern Agricultural
- Avon

- South Coast
- South West
- Perth

Wetlands sampled as part of the IAI RCM project were selected to be representative of each of the non-metropolitan NRM regions - that is, all regions expect Perth.

The IAI RCM project undertook surveys of wetlands considered to be ‘significant’. A significant wetland is one that is listed under the International Convention on Wetlands (Ramsar Convention) or the Directory of Important Wetlands of Australia (DIWA), is complimentary to existing wetland survey and condition monitoring programs or is considered, by local ecologists, to be critical to regional biodiversity.

Sites were selected to represent the geographic, climatic and morphological diversity of wetlands within the state. A total of forty-four wetlands throughout WA were selected for sampling as part of the IAI RCM project (Figure 1). A full list of the wetlands and their locations is provided in Appendix 1. The criteria for selection of each wetland are provided in Table 1. This diversity of test-sites is important to ensure that the proposed monitoring techniques will be effective across the state and in all of its wetland types.

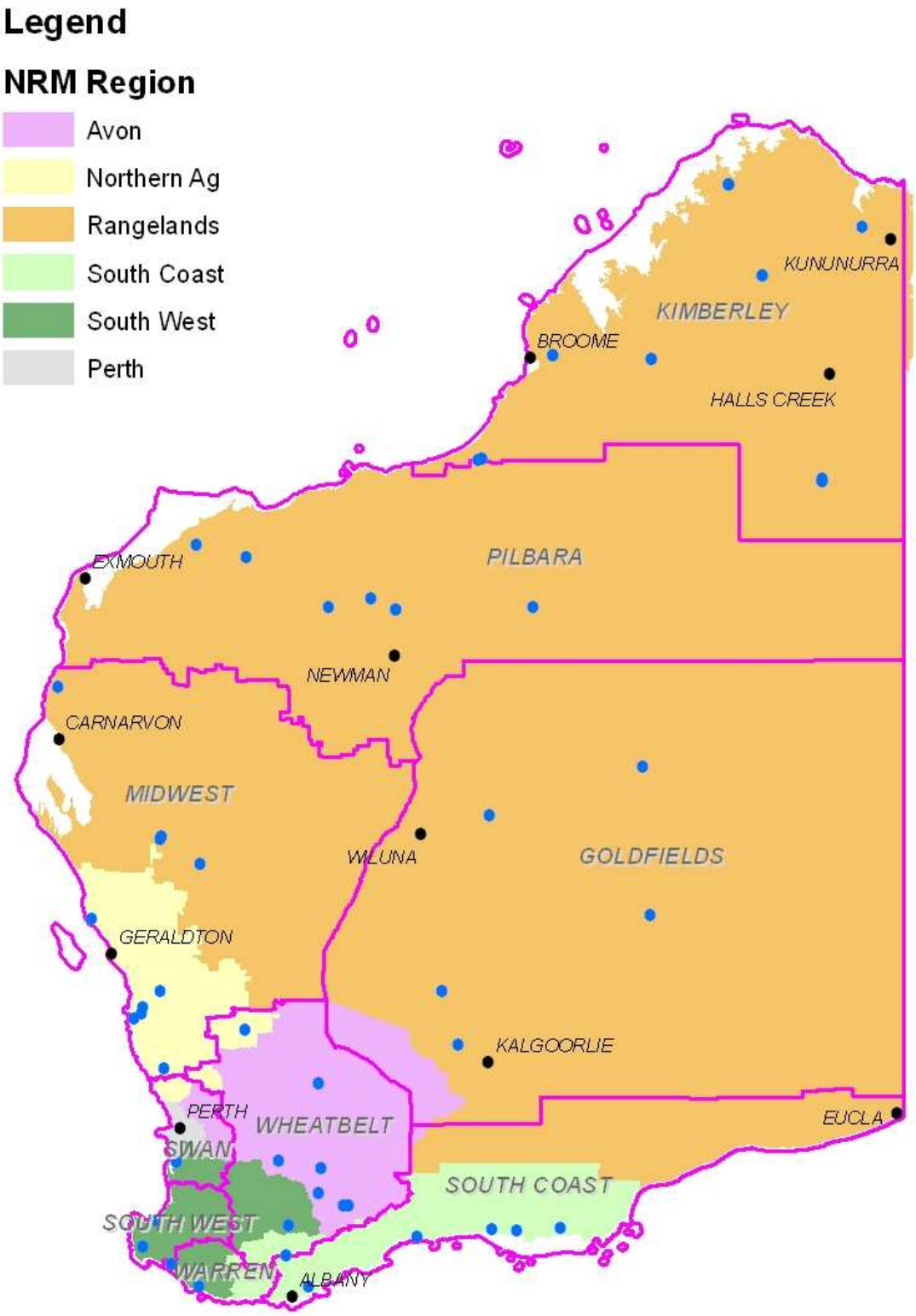

Figure 1: Location of wetlands (blue dots) sampled as part of the Inland Aquatic Integrity Resource Condition Monitoring project. Department of Environment and Conservation regional boundaries are outlined in pink and labelled in grey text.

Table 1: Criteria for selection of wetlands in WA for monitoring as part of the Inland Aquatic Integrity Resource Condition Monitoring project.

Site Code	Site Name	Justification for Site Selection
RCM001	Dales Gorge	Regionally significant site with heavy visitation pressure.
RCM002	Fortescue Marsh West	Ramsar
RCM003	Mooroobinia	Ramsar
RCM004	Lower Fortescue Pool	River pool on regionally significant system
RCM005	Palm Pool	Ramsar
RCM006	Fortescue Marsh East	Ramsar
RCM008	Desert Queen Baths	Good representative of characteristic wetland type
RCM008	Saunders Spring	Ramsar, representative of mound springs found in area
RCM009	Lake Eda	DIWA, highly threatened but currently high integrity
RCM010	Ngallagunda Swamp	Good representative of characteristic wetland type
RCM011	Airfield Swamp	National Heritage Register, pristine, unique perched freshwater system
RCM012	Parry Lagoons	Ramsar, threatened and experiencing degradation
RCM013	Lake Gregory	Proposed Ramsar and historical monitoring site. Aboriginal custodians concerned with management.
RCM014	Le Lievre Swamp	DIWA
RCM015	Rowles Lagoon	DIWA, heavy visitor pressure and altered hydrology
RCM016	Lake Ballard	Ramsar
RCM017	Yeo Lake	DIWA
RCM018	Mungilli Claypan	Characteristic of arid zone freshwater claypan
RCM019	Lindsay Gordon Lagoon	Complementary to comprehensive terrestrial monitoring program
RCM020	Muggon Lake	Opportunistic sampling of semi-arid zone saline system in freshwater phase
RCM020b	Muggon Claypan	Opportunistic sampling of semi-arid zone freshwater claypan
RCM021	Lake Wooleen	DIWA, land manager instituting management changes, highly degraded
RCM022	Lake Goorly	Characteristic degraded primary saline system with altered hydrology
RCM023	Lake Guraga	DIWA
RCM024	Lake Logue	DIWA, extensive historical data available.
RCM025	Leeman Lagoon	Characteristic inter-dunal lagoon system
RCM026	Arro Lake	Previously returned very high diversity aquatic invertebrate samples
RCM027	Nebroo Mound Spring	Complementary to ongoing TEC monitoring program.
RCM028	Hutt Lagoon	DIWA, proposed NDRC
RCM029	Lake MacLeod	DIWA, proposed Ramsar, expected to experience increased visitation, threatened by mining.
RCM030	Lake Campion	Recommended by DEC regional ecologist
RCM031	Paperbark Swamp	Recommended by DEC regional ecologist
RCM032	Lake Bryde	DIWA, NDRC
RCM033	East Lake Bryde	NDRC
RCM034	Lake Grace system	DIWA
RCM035	White Water Lake	DIWA
RCM036	Coyrecup Lake	DIWA
RCM037	Balicup Lake	DIWA
RCM038	Howick Swamp	Regionally significant site, previously sampled by DoW
RCM039	Lake Gore	Ramsar
RCM040	Ewans Lake	Ramsar, NDRC
RCM041	Dunns Swamp	Regionally significant site, previously sampled by DoW
RCM042	Lake Pleasant View	DIWA
RCM043	Vasse Estuary	Ramsar
RCM044	Spearwood Creek	Proposed Ramsar
RCM045	Lake Marringup	Ramsar
RCM046	Lake Jasper	DIWA
RCM047	Barraghup Swamp	DIWA

4.2.2 Procedures for selecting sampling locations

The siting of sampling locations at a wetland is dependant upon the ecological and geomorphological characteristics of the wetland. Important factors to consider are the size of the wetland, the diversity of habitats present and the nature of threats to the system.

In the IAI RCM surveys, vegetation transects were sited to be representative of the vegetation communities present at the wetland. A vegetation community was defined as a discrete assemblage of vegetation measuring at least 10 m in width and 100 m in length (length is parallel to the wetland's shoreline).

Water quality and aquatic invertebrate samples were collected in the vicinity of the vegetation transect. This allows consideration of the interaction between water quality and vegetation variables. Where more than one aquatic habitat type was present in the wetland, invertebrate collections and water quality measurements were taken in each of the habitats to allow a better understanding of the systems functioning. For example, where a wetland contained areas of deep water with a bare substrate, and shallow water with macrophytes growing on the substrate, separate invertebrate collections and water quality measurements were taken within each of these areas.

4.3 Sampling frequency and timing of sampling

The methods described in the current document have been applied at significant wetlands across Western Australia as an initial assessment of wetland condition indicators. That survey collected data that may form the basis of an ongoing surveillance of the site. The IAI RCM project is developing management recommendations and monitoring programs for many of the surveyed sites. The aim is to extend the project to allow ongoing monitoring and funding is currently being sought to facilitate this.

The wetlands sampled as part of the IAI RCM project cover a vast geographical spread and therefore experience a range of climates and weather conditions (Figure 2). As such, the timing of sampling varied from region to region. Wetlands were sampled at the end of the wet season in each of their respective regions. Sampling was timed to correspond with the presence of surface water in the wetlands, and a time when a time when roads were dry enough to allow access to the wetlands.

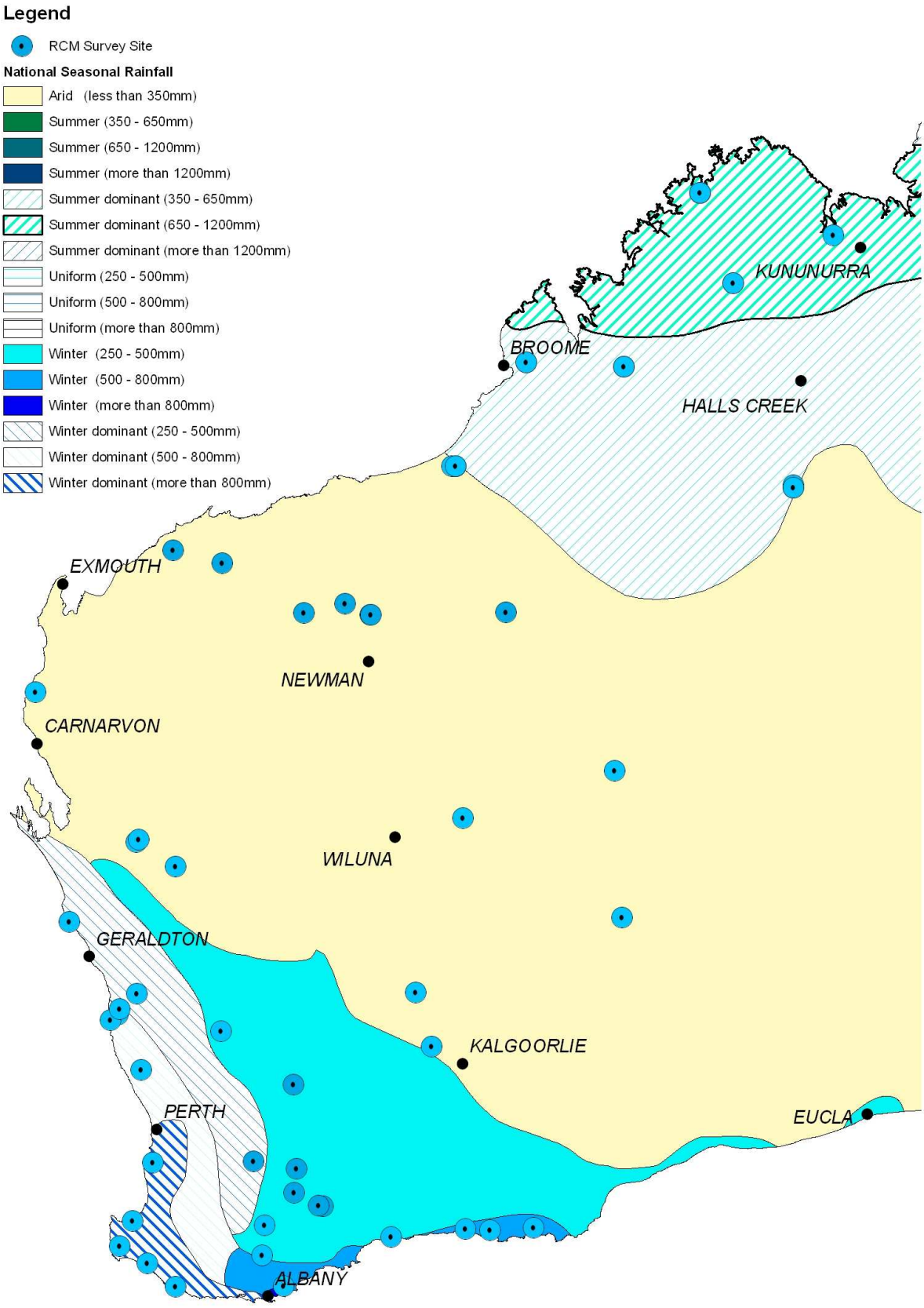

Figure 2: Location of wetlands sampled as part of the Inland Aquatic Integrity Resource Condition Monitoring project in relation to climatic zones in Western Australia

5 Field Methods

5.1 Field trip preparations and equipment setup

Field work was scheduled and organised prior to the start of each field season. DEC Regional and District staff were contacted to schedule field trip dates and make access arrangements. Sites not located on conservation estate required contact with the relevant land manager. Many wetlands are significant to Aboriginal people and contact with the local claimant group or representative land council is also required.

Prior to commencing field work, aerial photographs were prepared to provide information on access to each wetland and the nature of vegetation at the site. During the field trip, this information was built upon by sketching detailed access and vegetation maps for each sampling site.

Prior to every field trip all necessary equipment was checked for availability and condition. Suitable vehicles were acquired well in advance, via Departmental booking procedures or through hire companies. The driving range of vehicles to be used on remote trips is an important consideration. Vehicles were serviced prior to undertaking remote area work and a maintenance check conducted prior to shorter trips. Communications equipment was checked and suitable spares and recovery equipment prepared.

An adequate number of single use supplies (e.g. pots for water samples) was ordered and supplied well in advance of fieldwork, taking into account spares.

5.2 Sequence of events during field trip

The following were undertaken during the field season:

- prior to visiting the sites, DEC district staff were contacted;
- a field advice form was completed and copies sent to the relevant people;
- all equipment required for sampling was assembled and checked;
- the vehicle was checked for safety and packed with the relevant equipment, including communications equipment, a first aid kit, vehicle recovery equipment, spare fuel and food supplies;
- sufficient travel time was allowed to reach accommodation destinations and to allow for meals;
- sufficient time was allowed for meetings with landholders if necessary and to undertake field work;
- sampling sites were visited and all necessary observations were thoroughly recorded on-site;
- all samples collected were labelled with the site code, date and type of sample;
- water samples for colour, ionic composition and chlorophyll were stored in a freezer in the vehicle or, if not available, in a freezer at accommodation; and
- plant specimens were correctly pressed on return to the vehicle or accommodation.

5.3 Details of taking measurements, with example field forms

At each site, information was collected pertaining to hydrology, water chemistry, aquatic invertebrates, waterbirds, other fauna, aquatic and riparian vegetation, and threatening processes. Based on these data, an assessment was made of the site's current condition and recommendations for future management and monitoring were developed. The sequence of events involved in evaluating these parameters at each wetland is outlined below. Example field forms are provided in Appendix 2.

Note: Vegetation and water quality/biota sampling were undertaken concurrently by two teams of field personnel.

Water Quality/Biota

1. Approach the wetland quietly. Record presence and abundance of any waterbirds at the wetland.
2. Collect water samples and take measurements with water meter (pH, temperature, conductivity, salinity and turbidity).
3. Sweep for macroinvertebrates, rigorously disturbing the substrate (x3).
4. Take sediment samples.
5. Photograph the wetland;.

6. Record any opportunistic observations of mammals, reptiles, frogs, fish or birds made by identifying scats, tracks, calls or habitat modification.
7. Complete field forms (Appendix 2), including GPS location, access maps, numbers of photographs taken and habitat descriptions.

Note: It is important that steps 1-4 are taken in the order stated to prevent disturbance of waterbirds and to minimise disturbance of sediment, which could affect turbidity measurements.

Vegetation

1. Select area of representative vegetation and set-up a 50 m transect.
2. Complete field forms (Appendix 2), including site description, condition of vegetation, and perceived threats to the wetland.
3. For each stratum (e.g., ground cover, mid storey, upper storey), record the percentage foliage cover, calculated using the point intercept method.
4. Record dominant species for each stratum, listing in order of dominance.
5. Collect samples of all plant species recorded and label adequately.
6. Take photographs every 10 m along the length of the transect. Photographs should be aligned to show the nature of ground cover and vegetation structure. Additional photos may be taken perpendicular to the transect if appropriate.

Threats

1. Remain vigilant for any evidence of threats or degradation when travelling to the sampling location and moving around it. At small wetlands, the threat analysis may incorporate the entire wetland. At larger sites, threats will be recorded per sampling location. Additional, site-scale data may be recorded in the 'Notes' section of the field forms (Appendix 2).
2. Consider each category of threat and record any evidence of it impacting on the site, based on observations in the catchment and at the site.
3. Photograph any evidence of impacts. If appropriate, permanent photo points could be established to monitor changes in the severity or area of the impact.

5.4 End of field trip procedures

The following tasks were completed on return to the office:

- Vehicles are cleaned and serviced if required (note that vehicles should always be serviced following a remote area trip).
- Equipment was stored and made available for the next season.
- All data from the GPS and digital camera were uploaded and stored on PC and on local server.
- Data was transcribed from field sheets into a database and verified.
- All electronic data were backed-up and hard copies archived safely.
- Sediment samples were analysed for composition.
- Water samples were analysed for water chemistry.
- Aquatic invertebrates were sorted and identified, and species presence and log abundance recorded.
- New maps were created using ARCGIS 9 after the initial site visit to reflect the vegetation transects and water sampling locations.
- Plant specimens were processed, mounted, boxed and sent to the WA Herbarium.
- Photographs were correctly labelled reflecting the site at which the photographs were taken.
- Site reports were written for each wetland containing all the available information, including all data collected and analyses conducted, and any maps and photographs of the wetland.
- Data and site reports made publicly available via WetlandBase.

6 Data Handling, Analysis and Reporting

6.1 Data entry, verification and editing

In the field, data were entered on the field sheets (Appendix 2). Upon return from the field, data were transferred from the field sheets to an electronic database as soon as possible. Data were entered into a Microsoft Access database in a format suitable for data analysis. The database was backed up in a safe location and hard copies of all field sheets were archived.

Following completion of all data collation, data will be stored in the publicly available WetlandBase (see section 6.4).

6.2 Recommended methods for long-term statistical analysis

Currently, the IAI RCM project has collected data from only one sampling event for each wetland. This provides baseline information or a snapshot in time of each wetland's components at the time of sampling. No analyses to detect change in condition over time may be conducted at present.

Some of the wetlands have previously been sampled by other projects. This may allow comparison with the IAI RCM data, provided comparable indicators were measured. Interpretation of such data must consider potential differences in sampling methodology between the projects.

Regional wetland data are available for the Pilbara and the Wheatbelt (which includes the Avon region and parts of the Northern Agricultural, South West and South Coast regions). In those regions, a survey site can be compared to regional 'averages' for similar wetland types.

In order to detect change in wetland condition and to assess trends in biodiversity, one-off surveys of wetlands must be extended to surveillance or monitoring. This requires regular time-series data. Such studies should be planned for the long-term as several sampling dates are required to produce statistically significant analyses.

6.3 Reporting procedures and routine data summaries

A resource condition report was prepared for each of the forty-four wetlands assessed by the IAI RCM project. These reports collate current and historical data relevant to the site, and identify the key drivers and processes at each wetland. They also describe the critical relationships between elements of the wetlands' ecosystem. The nature and functionality of these elements, as well as the presence of threats to these elements, form the basis of management recommendations for each site, including requirements for ongoing monitoring. The resource condition reports will be provided to the relevant NRM groups, DEC regions and other stakeholders. They will also be publicly available via 'WetlandBase' and through the Wetlands Section of DEC.

It is recommended that the Resource Condition Reports be updated with the most recent data if the initial survey conducted as part of the IAI RCM project is extended into continued surveillance or monitoring. Ideally, this would occur following every data collection event or on an annual basis.

6.4 Data archival procedures

Data collected during the assessment of significant sites, and links to the current document and the site Resource Condition Reports will all be made available to the general public via the online database application 'WetlandBase'. Site reports may also be sourced by contacting the Wetlands Section, Department of Environment and Conservation, Kensington.

'WetlandBase' is a spatially linked database maintained by the Wetlands Section of the Department of Environment and Conservation, Western Australia. It houses an array of monitoring data collected by the Department and is accessible to the public via the Department's website (http://www.dec.wa.gov.au).

These publicly available data will assist academics, NRM groups and community groups to improve their knowledge of wetland function and management and of resource condition reporting. The provision for centralised data storage will mean that the information collected by any group can be used as part of a statewide monitoring program.

7 Personnel Requirements and Training

7.1 Roles and responsibilities

The IAI RCM project involved seven staff members with the following responsibilities:

- Project team leader (1.0 FTE):
  - liaises with land managers and other stakeholders;
  - organises field visits (accommodation, equipment etc);
  - team logistics (delegation); and

- finalises protocols.

- Botanist/Ecologist (1.0 FTE):

- assesses vegetation condition;
- identifies plant specimens;
- enters data into the relevant database; and
- analyses and interprets findings in liaison with a DEC statistician.

- Aquatic ecologist x3 (2x0.75 FTE and 1x0.5 FTE)

- collect, sort and identify aquatic invertebrates;
- record species presence and abundance; and
- enter data into the relevant database.

- Project/Field officer x2 (1.0 FTE and 0.2 FTE):

- assist in collection and recording of data;
- write methodology for the project;
- write site reports in liaison with Botanist/Ecologist and Statistician; and
- write Standards of Operation (SOPs) for all sampling components of the project.

Advice and involvement is also sought from other DEC staff when required.

7.2 Qualifications

The EPA's 'Guidance for the Assessment of Environmental Factors Western Australia (in accordance with the Environmental Protection Act 1986) No. 51: Terrestrial flora and vegetation surveys for Environmental Impact Assessment in Western Australia (June 2004)' recommends the following:

"Flora and vegetation surveys should be coordinated and led by botanists who have had training, mentoring and experience in flora and vegetation survey. It is expected that they will have specific training and/or experience in ecology and taxonomy of the Australian flora and would normally have had a wide exposure to WA's flora and vegetation, preferably with knowledge and experience in the region being surveyed.

It is recognised that some surveys may be done by survey teams that include members with less experience. These members should be supervised and mentored by the specialists mentioned above. This is seen as useful in training new practitioners."

Similarly, it is recommended that water quality and aquatic invertebrate data collection be conducted by personnel with relevant experience. If field staff do not possess previous experience in the collection of water quality and aquatic invertebrate samples, they should be appropriately instructed and supervised by experienced staff.

Identification of aquatic invertebrates should be conducted by ecologists with training and experience in invertebrate identification. It is preferred that they have knowledge of and experience in the taxonomy of Australian aquatic invertebrates.

7.3 Training procedures

Prior to sampling, field staff had been trained in invertebrate and plant sample collection, species identification, GPS navigation, and foliar cover measurements, first aid and four-wheel driving. Training is required for field staff to undertake all aspects of the methodology employed.

Training in the use of this methodology and WetlandBase will be provided at a series of workshops in the Perth metropolitan area and key regional centres. The workshops will be aimed at increasing the capacity of NRM groups and DEC regional staff to apply standard methods in monitoring wetlands within their region. They will also improve understanding of the use of existing datasets and awareness of available information to assist in making informed management decisions and highlight key knowledge gaps the need to be filled.

8 Operational Requirements

8.1 Annual workload and field schedule

The initial survey required one team of approximately four people for each of site visit. The duration and timing of the 2008 initial survey is provided below. The time required for any future sampling may vary depending on logistics, weather and the experience of team members.

Pilbara: 8 May to 14 May (7 days)

Kimberley: 15 May to 25 May (11 days)

Goldfields: 17 August to 27 August (11 days)

Midwest: 6 October to 14 October (9 days)

South West and Couth Coast: 10 November to 16 November (7 days)

8.2 Start-up costs and budget considerations

The IAI RCM project is part of a broader wetland resource condition monitoring project being undertaken by the Department of Water (DoW). Funding for the project was provided by the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality. DoW subcontracted DEC to complete elements of the project that relate to non-channel, inland wetlands. Funding to continue wetland sampling is currently being sought.

Should sampling be continued by a group or organisation external to DEC, feasibility and cost should first be assessed specific to the scope of the monitoring program. It must be determined whether monitoring can be done regularly, effectively and continually.

The following costs need to be considered in the budget for monitoring according to this protocol:

- staff;
- purchase and/or hire of field equipment;
- accommodation and meals during field trips;
- vehicle hire and running costs;
- outsourcing of analysing water quality samples or identification of plants / invertebrates; and
- statistical analyses and data acquisition.

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10 Appendix

1. List of all wetlands sampled and their GPS locations.
2. Field data forms for recording (a) site description, (b) vegetation data, and (c) water quality sampling. These forms should be printed out and taken into the field. Also, (d) instructions in the use of the vegetation forms.

10.1 Appendix 1 – Location of wetlands

Table 2 Location of wetlands sampled as part of the Inland Aquatic Integrity resource Condition Monitoring project.

NRM Region	DEC Region	Site Code	Site Name	Lat°	Long°
Rangelands	Pilbara	RCM001	Dales Gorge	-22.47742	118.55131
Rangelands	Pilbara	RCM002	Fortescue Marsh West	-22.31619	119.31097
Rangelands	Pilbara	RCM003	Mooroobinia	-22.51333	119.77094
Rangelands	Pilbara	RCM004	Lower Fortescue Pool	-21.33275	116.15486
Rangelands	Pilbara	RCM005	Palm Pool	-21.56997	117.05489
Rangelands	Pilbara	RCM006	Fortescue Marsh East	-22.50928	119.77675
Rangelands	Pilbara	RCM008	Desert Queen Baths	-22.46733	122.25825
Rangelands	Kimberley	RCM008	Saunders Spring	-19.78255	121.33779
Rangelands	Kimberley	RCM009	Lake Eda	-17.88719	122.63690
Rangelands	Kimberley	RCM010	Ngallagunda Swamp	-16.43065	126.42497
Rangelands	Kimberley	RCM011	Airfield Swamp	-14.77724	125.82231
Rangelands	Kimberley	RCM012	Parry Lagoons	-15.54928	128.25993
Rangelands	Kimberley	RCM013	Lake Gregory	-20.13680	127.53263
Rangelands	Kimberley	RCM014	Le Lievre Swamp	-17.95768	124.42311
Rangelands	Goldfields	RCM015	Rowles Lagoon	-30.43748	120.89534
Rangelands	Goldfields	RCM016	Lake Ballard	-29.44796	120.60280
Rangelands	Goldfields	RCM017	Yeo Lake	-28.06329	124.39117
Rangelands	Goldfields	RCM018	Mungilli Claypan	-25.37212	124.25906
Rangelands	Goldfields	RCM019	Lindsay Gordon Lagoon	-26.24603	121.46858
Rangelands	Midwest	RCM020	Muggon Lake	-26.68703	115.48000
Rangelands	Midwest	RCM020b	Muggon Claypan	-26.64105	115.52120
Rangelands	Midwest	RCM021	Lake Wooleen	-27.13355	116.20322
Northern Agricultural	Wheatbelt	RCM022	Lake Goorly	-30.14835	117.03635
Northern Agricultural	Midwest	RCM023	Lake Guraga	-30.86642	115.56600
Northern Agricultural	Midwest	RCM024	Lake Logue	-29.85177	115.13949
Northern Agricultural	Midwest	RCM025	Leeman Lagoon	-29.94707	115.00786
Northern Agricultural	Midwest	RCM026	Arro Lake	-29.74253	115.17144
Northern Agricultural	Midwest	RCM027	Nebroo Mound Spring	-29.46176	115.49111
Northern Agricultural	Midwest	RCM028	Hutt Lagoon	-28.14873	114.25034
Rangelands	Midwest	RCM029	Lake MacLeod	-23.93273	113.63576
Avon	Wheatbelt	RCM030	Lake Campion	-31.12756	118.36181
Avon	Wheatbelt	RCM031	Paperbark Swamp	-32.67361	118.41489
Avon	Wheatbelt	RCM032	Lake Bryde	-33.35026	118.82626
Avon	Wheatbelt	RCM033	East Lake Bryde	-33.36253	118.90310
Avon	Wheatbelt	RCM034	Lake Grace system	-33.11459	118.37682
Avon	Wheatbelt	RCM035	White Water Lake	-32.53925	117.63292
Southwest	Wheatbelt	RCM036	Coyrecup Lake	-33.71194	117.83242
South Coast	South Coast	RCM037	Balicup Lake	-34.26434	117.78547
South Coast	South Coast	RCM038	Howick Swamp	-33.76157	122.76243
South Coast	South Coast	RCM039	Lake Gore	-33.77531	121.52155
South Coast	South Coast	RCM040	Ewans Lake	-33.80302	121.96416
South Coast	South Coast	RCM041	Dunns Swamp	-33.92459	120.15471
South Coast	South Coast	RCM042	Lake Pleasant View	-34.82581	118.17991
Southwest	Southwest	RCM043	Vasse Estuary	-33.63490	115.41549
Southwest	Southwest	RCM044	Spearwood Creek	-34.09747	115.18013
Southwest	Warren	RCM045	Lake Marringup	-34.83353	116.20022
Southwest	Warren	RCM046	Lake Jasper	-34.41012	115.68258
Southwest	Swan	RCM047	Barraghup Swamp	-32.55993	115.78400

10.2 Appendix 2 - Inland Aquatic Integrity Resource Condition Monitoring Field Sheets

Inland Aquatic Integrity RCM Site Description

Site Name _____ *Site Code*_____

Recorders _____ *Time*_____ *Date*___ /___ /____

Location and Access Description

Wetland Type and Description (hydrology, size, habitats sampled)

Site scale notes on photos, vegetation, fauna, condition, land use and threats

Map of Transect Locations

Inland Aquatic Integrity RCM Transect Description

Site Name _____

*Site Code*_____ *Transect ID*_____

Notes

Diagram of Transect Vegetation (if required)

Site Name _____ *Site Code*_____

Dominant Stratum: _____ *Emergents*_____

Strata (U1,M1 etc)		Form		form			form	
Crown Cover (%)								
Height								
Species Name (in order of dominance)	GF	Voucher number	Species Name (in order of dominance)	GF	Voucher number	Species Name (in order of dominance)	GF	Voucher number
1								
2								
3								
4								
5								
6								

Strata (U1,M1 etc)		form		form			form	
Crown Cover (%)								
Height								
Species Name (in order of dominance)	GF	Voucher number	Species Name (in order of dominance)	GF	Voucher number	Species Name (in order of dominance)	GF	Voucher number
1								
2								
3								
4								
5								
6								

Stratum																								
Crown Gap or tape intercept																								
Crown Width or tape intercept																								

Site and Transect Identification

Project				Date	Recorder	
Site Name					Transect Location	
Site Code				Datum	Easting	Length
Transect ID				Zone	Northing	Bearing
Wetland state at time of visit	Filling	Drying	Recent Rainfall		Soil State at Time of Visit (%)	
	Full	Dry		Dry	Waterlogged	Inundated
Reason for Transect Location			Benchmark Used	Photographs (number, location, facing)		

Substrate

	Bare %	Rock %	Cryptogam %	Litter %	Trash %	Logs %	Time since last fire (describe evidence)
Observed							
Expected							
Soil Type							

Vegetation Composition and Structure

	% Cover		Dominant Species (list in order)	% Showing Stress	Recruitment		Expected Species Absent from Site (provide reason if known)
	Observed	Expected			Observed	Expected	
Stratum 1							
GF							
Ht							
Stratum 2							
GF							
Ht							
Stratum 3							
GF							
Ht							
Stratum 4							
GF							
Ht							

Impacts of Threatening Processes on Vegetation Community

Threat Category	Threat	% area affected	Severity of impact*	Notes
Altered biogeochemical processes	waterlogging and salinisation			
	eutrophication (aquatic only)			
	erosion			
	drainage into site			
	groundwater abstraction			
Introduced plants and animals	weeds			
	feral animals			
	stock grazing			
Problem native species (list)				
Disease (list)				
Detrimental regimes of physical disturbance	fire			
	drought			
	flood			
	storm damage			
Impacts of pollution	spray use			
	spills			
	runoff			
Competing land uses	recreation			
	agriculture (other than above)			
	consumptive, productive use			
	mines and quarries			
	illegal activities			

*Impact Severity:
Nil - no evidence of any stress to vegetation

Neg - negligible to slight, vegetation showing signs of stress

Mod - moderate, vegetation has been lost or altered but is likely to recover with removal of threat

Sev - severe vegetation has undergone permanent change and is likely to continue degrading without urgent remedial action

Overall Community Condition Rating (circle appropriate class)

Table based on Thackway, R. and Lesslie, R. (2005). Vegetation Assets, States, and Transitions (VAST): accounting for vegetation condition in the Australian landscape. Technical Report. Bureau of Rural Sciences,Canberra.

	0	1	2	3	4
Community Condition Class	RESIDUAL BARE	NATURAL	IMPACTED	DEGRADED	REMOVED / REPLACED
	Areas where native vegetation does not naturally persist.	Native vegetation community structure, composition and regenerative capacity intact no significant perturbation from land management practices.	Native vegetation community structure, composition and regenerative capacity intact but perturbed by land management practices.	Native vegetation community structure, composition and regenerative capacity significantly altered by land management practices.	Species present are alien to the locality and either spontaneous in occurrence or cultivated. Alternatively, vegetation may have been removed entirely.
Regenerative Capacity	Natural regenerative capacity unmodified - ephemerals and lower plants.	Regenerative capacity intact. All species expected to show regeneration are doing so.	Natural regenerative capacity somewhat reduced, but endures under current / past land management practices.	Natural regenerative capacity limited and at risk due to land management practices. Rehabilitation and restoration possible through removal of threats.	Regenerative potential of native vegetation has been suppressed by ongoing disturbances. There is little potential for restoration.
Vegetation Structure	Nil or minimal.	Structural integrity of native vegetation is very high. All expected strata, growth forms and age classes are present.	Structure is altered but persists i.e. a some elements of a stratum are missing.	Structure of native vegetation is significantly altered i.e. one or more strata are missing entirely.	All structural elements of native vegetation are missing or highly degraded.
Vegetation Composition	Nil or minimal.	Compositional integrity of native vegetation is very high. All species expected at the site are present.	Composition of native vegetation is altered. All major species are present, although propotions may have changed. Some minor species may be missing.	Significant species are missng from the site and may have been replaced by oppournist species. Loss of species affects structure of vegetation.	Native vegetation removed entirely +/- replaced with introduced species.

Water Sampling Information

CHECKLIST Photo numbers: Camera:

125ml filtered water ☐ Chlorophyll ☐ vol for chl (ml) ☐

125ml unfiltered water ☐ 250ml unfiltered water ☐ 500ml unfiltered water ☐

area surveyed for waterbirds ☐

sediments ☐☐☐ **macrophyte biomass** ☐☐☐

Habitats sampled for invertebrates (give number of 15m samples and description)

macrophytes	☐	☐
littoral/edge	☐	☐
riffle	☐	☐

Meter measurements

Conductivity below surface			
Conductivity above sediment			
Salinity below surface			
Salinity above sediment			
pH below surface			
pH above sediment			
Turbidity above sediment			
Turbidity below sediment			
Temperature below surface			
Temperature above sediment			
Maximum flow (30s duration)			
Minimum flow (30s duration			

Units	
Units	

fan used	
meter number	

Site code

Depth profiles at deepest point and 2 other transects

Details:

Details:

Details:

Site code

Habitat descriptions for invertebrate samples

Habitat: _____ Maximum depth sampled: _____

Large roots in water	none	few (<10% of area)	moderate (10-50% of area)	abundant (>50% of area)
Fine roots in water	none	few (<10% of area)	moderate (10-50% of area)	abundant (>50% of area)
Small woody debris (<5cm diameter)	none	sparse (only a few scattered sticks)	moderate (few accumulations and/or numerous sticks but distributed)	abundant (numerous accumulations or distributed and common)
Logs (>5cm diameter)	none	sparse (1 or 2 in sampling area)	numerous (3-10 in sampling area)	abundant (>10 in sampling area)
Leaf litter	none	sparse or only very small patches (<0.5m)	moderate (several packs, most >0.5m or with more even or scattered distribution	abundant (numerous packs >0.5m or over continuous large areas of bed)
Submerged macrophytes	none	sparse and/or only small patches	moderate density and/or cover	high density and/or cover over
Emergent macrophytes	none	sparse and/or only small patches	moderate density and/or cover	high density and/or cover over

Fish	none seen	few	many

Sediments

% bedrock ____ % pebble/cobble ____

% boulders ____ % finer sediments ____

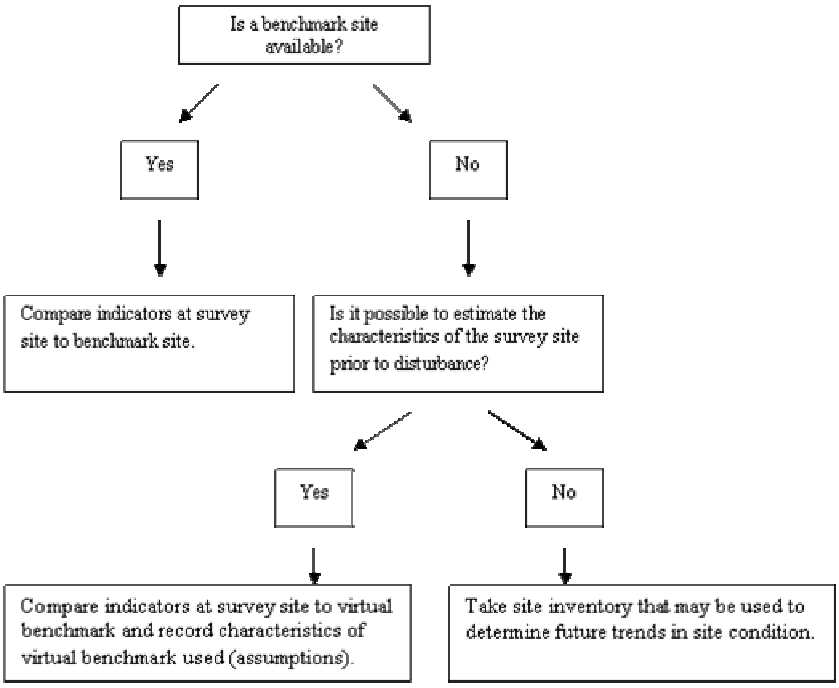
Map of area sampled: show dimensions and boundaries, tracks, location of depth and macrophyte transects, submerged macrophyte quadrats, invertebrate sampling areas, distinguishing features etc.

10.3 Appendix 3 (d) - Instructions - Wetland Vegetation Condition Field Assessment Sheet V4

General Notes

Wetland condition – The relative integrity of the wetland ecosystem compared to a reference state. It includes being able to maintain key ecological and physical processes, ecosystem services, and communities of organisms.[2]

Determination of *condition* requires comparison of the site being assessed to a reference site. A reference state may be an actual example of a 'desirable' area of the type of vegetation being considered (benchmark site) or it may be an idealized state 'constructed' with the opinion of the site assessor or some expert (virtual benchmark).



Where the term *expected* is used on the Wetland Vegetation Condition Field Assessment Sheet, it refers to the characteristics of the benchmark site. Where historical data exists for the site, the expected values may be those recorded at the last survey. In other instances, the expected values may be a construct of the surveyor or some other expert.

As the Field Assessment Sheet is expected to be used in condition monitoring projects, it is also useful to be explicit about the definition of monitoring:

Survey is an exercise in which a set of qualitative observations are made but without any preconception of what the findings ought to be.

Surveillance is a time series of surveys to ascertain the extent of variability and/or range of values for particular parameters.

Monitoring is based on surveillance and is the systematic collection of data or information over time to

2 National Land and Water Resources Audit. 'Wetlands - Status of information for reporting against indicators under the National Natural Resource Management Monitoring and Evaluation Framework'.

ascertain the extent of compliance with a predetermined standard or position.[3]

Site and Transect Identification

Project – the identity of the project collecting these data, including the organisation responsible.

Site Name – the name by which the site is most commonly known (may also provide alternative names)

Site Code – the code assigned to the site in the current project.

Transect ID – an identifier to distinguish between transects at the same site.

Date – the date on which the survey was undertaken.

Recorder – the name of the person(s) undertaking the survey.

Datum – the datum to which the GPS used to record the transect location is set. This will usually be WGS84 or equivalent.

Zone – the UTM zone in which the survey site is found (between 49 and 52 in W.A.).

Easting / Northing – the GPS location of the transect beginning.

Length – the length of the transect that was established.

Bearing – the direction the transect runs from the start point.

Wetland state at time of visit – tick the box that describes the status of the hydroperiod at the time of the survey.

Recent Rainfall – If recent rainfall records are available, record the amount of rain received and the period it was received over. If not, state if there are any signs of recent rainfall in the area.

Soil state at time of visit – record the percentage of the transect with dry, waterlogged and inundated soil.

Reason for transect location – Record the factors that led to the decision to locate the transect at this particular location within the site. i.e. was it related to management actions, considered to be representative etc.

Photographs – record all the relevant information pertaining to any photos taken at the transect. In particular, the shot#, where it was taken, the direction facing and what it shows.

Substrate

Record the mean percentage of *bare ground* and *exposed rock* along the length of the transect. This will probably be an estimate and should give a general impression of the survey area.

Also record the percentage of the ground that is covered by:

Cryptogams – algae, lichens, mosses etc.

Litter – dead organic material with a diameter of less than 2 cm

Trash – dead organic material with a diameter of between 2 and 20 cm

Logs – dead organic material with a diameter of greater than 20 cm.

Record the *soil* texture according to the methods described in R. J. Hnatiuk, R. Thackway & J. Walker (2008). Field Survey For Vegetation Classification.

Time Since Last Fire

The time since the last fire may be known or may be inferred from evidence at the site. Record the

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[3] *C.M. Finlayson & D.S. Mitchel Australian wetlands: the monitoring challenge Wetlands Ecology and Management 7: 105–112, 1999.*

time since the last fire and how this was determined.

Vegetation Composition and Structure

Stratum # - Identify the stratum as U (upper) M (mid) or G (ground). If multiple strata occur within these categories, add a numerical identifier (1 is the tallest). For example U1 is the tallest layer of overstorey vegetation, U2 is a second layer of overstorey vegetation etc.

GF – Describe the dominant growth form of plants in the stratum (tree, shrub etc.).

Ht – estimate the minimum and maximum heights of plants in the stratum.

% Cover – this is the canopy cover of the stratum. It can be measured or estimated using many different techniques and the project methodology should stipulate which technique was used.

Dominant Species – list the species in the stratum in order of their apparent dominance. If no dominance is apparent, make a note of co-dominance.

% Showing Stress – estimate the percentage of individuals of each species that are showing any symptoms of ill health.

Recruitment – estimate the number of plants of each species that are showing evidence of ongoing successful recruitment. It may be sufficient to make a note such as 10's or 100's etc. or none / some / most / all.

Expected Species Absent From Site – If any species are expected to occur at the survey site, but are not observed, list them here. It may be useful to provide a very brief explanation for their absence (such as grazing, fire etc.).

Impacts of Threatening Processes

For each of the listed categories, record the percentage of the site that is affected and the severity of the impact. If multiple recordings are present (for instance 10% of site heavily grazed, 90% lightly grazed) add this information to the 'notes' section. The suggested scale for impact severity is:

0 - no evidence of any stress to vegetation

1 - negligible to slight, vegetation showing signs of stress

2 - moderate, vegetation has been lost but is likely to recover with removal of threat

3 - severe vegetation has undergone permanent change and is likely to continue degrading without urgent remedial action.

Overall Community Condition Rating

Based on the information collected, circle the appropriate class.