Project Plan SP 2020-007

Tracking the condition of Ramsar wetlands in Western Australia

Ecosystem Science

Project Core Team

Supervising Scientist	Michael Venarsky
Data Custodian	Michael Venarsky
Site Custodian	

Project status as of June 9, 2021, 4:04 p.m.

Approved and active

Document endorsements and approvals as of June 9, 2021, 4:04 p.m.

Project Team	granted
Program Leader	granted
Directorate	granted
Biometrician	granted
Herbarium Curator	not required
Animal Ethics Committee	granted

Tracking the condition of Ramsar wetlands in Western Australia

Biodiversity and Conservation Science Program

Ecosystem Science

Departmental Service

Service 6: Conserving Habitats, Species and Communities

Project Staff

Role	Person	Time allocation (FTE)
Supervising Scientist	Michael Venarsky	0.7
Research Scientist	Bart Huntley	0.25
Research Scientist	Gavan McGrath	0.1
Research Scientist	Michael Coote	0.05
Technical Officer	Adrian Barrett	0.2

Related Science Projects

Proposed period of the project

April 10, 2020 – April 10, 2035

Relevance and Outcomes

Background

Wetlands across Western Australia reflect the broad climatic gradients and geomorphological variability found the state, and range from naturally saline intermittent playas to heavily vegetated freshwater swamps and permanent open water lakes (ANCA 1996). The large variability in wetland hydroperiod and water chemistry has resulted in high floral and faunal diversity and endemism, with approximately a half of threatened and priority ecological communities being associated with wetlands (Halse et al., 1993a; Halse et al., 1993b; Halse et al., 2004). Furthermore, these wetlands are critical feeding and reproductive habitats for various species of migratory and non-migratory waterbirds, including the endangered Australasian bittern (Halse et al., 1993b; Halse et al., 2004) and threatened fish. These ecological characteristics have resulted in twelve wetland systems in Western Australia being listed under the international Ramsar Convention on Wetlands of International Importance (AGR 2006) and another 120 being recognized as nationally important through listing on the Directory of Important Wetlands of Australia (ANCA 1996). Many more high conservation value wetlands are distributed across the state and many reserves were specifically created to protect wetland assets.

Most wetlands across Western Australia are either threatened or currently being affected by a range of factors, including water resource development, agriculture and urban development, invasive species, mining, plant diseases, salinisation, and climate change (ANCA 1996; Lane et al., 2004; Lane et al., 2009). The Department of Biodiversity, Conservation and Attractions (DBCA) is responsible for managing wetlands within the Western Australian conservation estate, with management activities supported by monitoring and focused research. Monitoring of wetland condition and undertaking research are components of adaptive management programs, but resource constraints mean that such activities need to be targeted towards high priority wetlands, be collaborative, and use efficient monitoring technologies. This project focusses on filling monitoring and knowledge gaps for the State's Ramsar wetlands on the basis that internationally listed wetlands are the highest priority and that DBCA is largely responsible for their management, reporting on their condition and coordinating and updating management and information documents (Australian Government 2012).

Monitoring is a key component of managing and reporting on Ramsar wetlands (Storey 1997; Finlayson and Mitchell 1999) and each of the Ecological Character Descriptions have recommendations for monitoring,

associated with limits of acceptable change (LACs) and conceptual models (Davis and Brock, 2008). These documents also list knowledge gaps, including those that prevent LACs from being adequately defined, which can also guide monitoring and research. Some monitoring has been undertaken at all Ramsar wetlands in Western Australia but this has usually been associated with short-term opportunistic projects or initiatives within regions or by other agencies or non-government organisations, and has lacked a coordinated approach (Auditor General of WA 2006). This project has been designed to fill priority monitoring gaps at Ramsar wetlands, and to provide consistency of monitoring and data delivery for key attributes. The focus will be on monitoring against, or informing, limits of acceptable change and/or to inform adaptive management programs, and will take a collaborative approach, within and external to DBCA, where possible.

Aims

The overarching aim of this project is to monitor spatial and temporal changes in flora and faunal communities of Ramsar wetlands and the underlying processes that drive these patterns. In particular, this project will;

1) Collate previously published studies and data sets on Ramsar sites to prioritize research and monitoring activities.

Most Ramsar sites in Western Australia are either the focus of ongoing monitoring programs or have been the focus of short-term studies. The results of these studies reside in various formats, including peer-reviewed journal publications, grey-literature (conference proceedings, reports, dissertations), databases and individual files. Thus, we aim to create a shared bibliography for publications focusing on Ramsar sites in Western Australia, which will allow DBCA to: i) report on the status of Ramsar wetlands, ii) identify priority monitoring and research needs, and iii) avoid duplicating previously conducted studies. We also aim to combine new and existing data into a single data repository that is accessible to DBCA personnel.

2) Monitor spatial and temporal patterns in wetland hydrology, water quality and vegetation structure as primary drivers of wetland biodiversity.

Ecological Character Descriptions (ECDs) for Ramsar sites recognise that hydrology, water quality, and vegetation structure are the major drivers of wetland biodiversity and 98 out of 156 Limits of Acceptable Change (LACs) relate to these variables. These gross habitat descriptors will therefore be used to track wetland condition, as changes in these key variables will potentially cause changes in wetland biodiversity. We will use a combination of remote sensing data, images collected using unmanned aerial vehicles, environmental sensors, and on-site work to track spatial and temporal patterns in these core drivers of wetland biodiversity.

3) Continue existing waterbird monitoring efforts and expand these efforts at select sites.

Most WA Ramsar wetlands were selected for their high value to waterbirds. While the criteria for Ramsar listing have broadened, waterbirds remain a focus at most Ramsar wetlands and 29 LACs relate to waterbirds. Waterbirds are also a major consideration for other high priority wetlands that have the potential acquire Ramsar listing in the future such as Lake Gregory, Fortescue Marsh, Lake McLeod, and Lake Carnegie. We aim to continue waterbird monitoring at a subset of Ramsar sites where monitoring is ongoing and expand regular monitoring to other sites.

4) Fill other gaps in monitoring data collected at Ramsar sites and other priority wetlands.

While aims 1 to 3 will constitute the core activities for this project across Ramsar wetlands, there will remain monitoring and knowledge gaps specific to each Ramsar site. As resources allow, we will work with relevant stakeholders and managers to fill these gaps. Initial examples include understanding the condition and drivers of thrombolite TEC in Lake Clifton and surveying for threatened endemic fish in the Muir-Byenup wetlands following recent changes in hydrology and water quality. This project will also analyse the long-term data set generated by the South West Wetlands Monitoring Program (1977 to 2016), using a variety of remote sensing methods to better describe hydrological regimes of south west wetlands and examine long-term trends in wetland depth.

Expected outcome

Aim 1 – Reduced time invested in collating data for reporting. Clear map of where to focus efforts that address the “knowledge gaps” outlined in the ecological character descriptions.

Aim 2 – Improved ability to report on limits of acceptable change in the ECDs through direct measurements of habitat quality and quantity as surrogate indicators of broader wetland health and biodiversity values.

Aim 3 – Consistent data on which to base assessments of limits of acceptable change and listing criteria associated with waterbird populations.

Aim 4 – Site specific monitoring and research will provide local managers with information to assist with adaptive management of Ramsar wetlands and for Species and Communities Branch to report on Ramsar wetland condition and criteria.

Knowledge transfer

General outputs - reports, peer-reviewed journal articles, conference and workshop presentations, contributions to working groups, provision of advice on condition and values for DBCA reporting, outreach materials, contributions to updates to the ecological character descriptions and Ramsar Information Sheets for each site.

Research results will also be communicated in ways that allow their inclusion in DBCA processes such as species and area planning and the work of recovery teams. Raw and processed data and associated interpretations will be securely stored in appropriate corporate and external databases and repositories. These outputs, together with research agreements will also allow knowledge transfer to external researchers such as those within government agencies and universities.

Tasks and Milestones

The project will operate across all Ramsar sites on a rolling basis, with each site visited at least five-yearly and some more frequently. More frequent monitoring of some attributes may be made where remote sensing allows data collection without visiting sites or where collaborations with regional staff and/or collaborations and funding from external organisations allow more regular sampling. Sites closer to Perth are likely to be visited more regularly for logistical/resourcing reasons. For some sites, such as Lake Toolibin, monitoring will be implemented opportunistically if the lake fills and is not mentioned here as a regional project routinely monitors hydrology and vegetation when the lake is dry. Tasks are listed below for the first three years.

2021

- Develop bibliography of publications and datasets for Ramsar sites and commence collation of data, possibly via a Sharepoint site and/or Data Catalogue.
- Reinstall and maintain depth gauges as needed to allow water level monitoring to continue at Ramsar sites. This will be an ongoing task. Top priority is the Muir-Byenup site.
- Assist Species and Communities Program with an analysis of the condition of select Ramsar sites for the Forest Management Plan-End of Term report (2014-2023) and updating of Ramsar Information Sheets.
- Commence development of methods to use remotely piloted aircraft to monitor vegetation structure and extents.
- Use the long-term data set generated by the South West Wetlands Monitoring Program (1977 to 2016) to understand past, present, and future changes in wetland hydrology.
- **Forrestdale and Thompsons Lakes**: Waterbird surveys; species level invertebrate diversity to complement family level sampling contracted by Water Corporation and to compare to 1990s data; water quality sampling; use lakes as test sites for developing RPA/remote sensing methods for vegetation structure monitoring.
- **Muir-Byenup**: Fish survey (to determine diversity compared to previous sampling by Storey (1998) in relation to water quality changes) including collection of eDNA samples; water quality sampling; invertebrate survey targeted towards short-range endemics listed in Ecological Character Condition; progress publication of multi-decadal invertebrate survey dataset from SPP2015-017 and Natural Diversity Recovery Catchment program.
- **Peel-Yalgorup System**: Collaborate with Peel-Harvey Catchment Council to develop research projects related to the thrombolite communities at Lake Clifton; conduct invertebrate diversity sampling at at least Lake McLarty; collaborate with Birdlife Australia to regularly survey for waterbirds should their application for a Community Stewardship grant be successful.

2022

- Continue to populate the bibliography and data sharing site for Ramsar sites.
- Finalise, implement and publish protocols for the use of unmanned aerial vehicles to monitor wetland hydrology and vegetation structure.
- Use the long-term data set generated by the South West Wetlands Monitoring Program (1977 to 2016) to understand past, present, and future changes in wetland hydrology and publish results.
- Assist Species and Communities Program with updating of Ramsar Information Sheets.

- Assist a University of Adelaide Ph.D. student with a study exploring how environmental DNA (eDNA) sampling can supplement traditional biological survey methods by collecting sediment samples at Ramsar sites across Western Australia.
- **Forrestdale and Thompsons Lakes:** Waterbird surveys; water quality; vegetation extent monitoring.
- **Muir-Byenup System:** Complete seasonal round of fish survey and prepare manuscript on changes in fish communities; invertebrate sampling targeted towards short-range endemics listed in the ECD; water quality sampling; fringing and aquatic vegetation structure monitoring; seasonal waterbird surveys if Warren region no longer undertaking; publish paper on multi-decadal changes in invertebrate communities; assist district staff to analyse and publish waterbird data.
- **Lake Warden System:** Waterbird surveys in spring with SCNRM funding; baseline fish survey at selected wetlands; aquatic invertebrate surveys in selected wetlands; water quality sampling.
- **Lake Gore System:** Waterbird surveys in spring with SCNRM funding; baseline fish and invertebrate survey at selected wetlands; water quality sampling.
- **Lake Toolibin**. Collect sediment samples for the PhD project mentioned above and for hatching of aquatic invertebrate propagules to test the idea that persistent dry conditions have reduced the propagule bank in the sediment.
- **Peel-Yalgorup System**: Aquatic invertebrate survey in the Yalgorup lakes, Lake McLarty, Lake Mealup, Geogrup Lake, and Black Lake to provide baseline, understand spatial patterning, and inform development of limits of acceptable change in relation to invertebrate biodiversity.
- **Northern sites**: Liaise with Kimberley staff and traditional owners in relation to collection of water quality and sediment samples from inland waters of the northern Ramsar sites and plan monitoring and research for other attributes from 2023.

2023

- **Forrestdale and Thompsons Lakes:** Waterbird surveys; water quality sampling.
- **Lake Warden System**: Late summer waterbird surveys timed to coincide with Birdlife Shorebird Monitoring Project community survey; water quality sampling. Funded by South Coast NRM.
- **Lake Gore System**: Late summer waterbird surveys timed to coincide with Birdlife Shorebird Monitoring Project community survey; water quality sampling.
- **Focus on monitoring at northern Ramsar wetlands in collaboration with Kimberley District staff.**

References

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Study design

Methodology

Aim 1: The bibliography search for each Ramsar site will be conducted on two platforms: the DBCA library and Google Scholar. We have chosen Google Scholar because the search engine produces results of literature from both peer-reviewed sources as well as grey-literature sources. Given that each Ramsar site is often a collection of multiple waterbodies, we will conduct the searches using both the name of the Ramsar site as well as using each named waterbody at the Ramsar site. For example, the Peel-Yalgorup Ramsar site includes more than five named water bodies. Thus, we will conduct our literature search using "Peel-Yalgorup" as well as each named water body, including "Goegrup Lake", "Black Lake", "Lake Mealup", etc.

Aim 2: The methods used to monitor the key drivers of wetland biota (vegetation structure, water chemistry and hydrology) will vary depending on the element being monitored. However, a priority task will be to developing protocols to use unmanned aerial vehicles to track changes in vegetation structure. Members of the DBCAs Remote Sensing and Spatial Analysis group are developing photogrammetry techniques using unmanned aerial vehicles to monitor changes in vegetation cover at various sites across Western Australia. We will collaborate with RSSA to assemble a protocol for the mapping of major vegetation structural units. In general, we intend to use 2-dimensional photos to map the spatial extend of broad vegetation groups (e.g., grasses, bare ground, shrubs, trees). We also intend to use methods to develop 3-dimensional maps of vegetation to also map aspects of vegetation structure (e.g. height). Once the protocols are developed, plots or transects will be established at wetlands of interests and vegetation mapping will be conducted on regular intervals to track temporal changes in vegetation structure. The interval at which mapping occurs will be site specific, but could be multiple times per year to once every several years depending on the needs of the site.

Water quality variables will vary somewhat depending on the LACs and threats at each site but will generally include turbidity, pH, oxygen, redox, conductivity and macronutrients (N and P). Samples will also be collected to obtain current baseline data for dissolved metals. Hand held meters will be used or samples will be submitted to NATA accredited commercial laboratories.

Hydrological monitoring will be largely in the form of depth and extent of surface water, including through measurements on surveyed depth gauges (manually or through deployment of sensors and cameras), and through remote sensing products being developed for this project. The latter is a collaboration between Ecosystem Science Program and Remote Sensing and Spatial Analysis Program Landsat images to model depth data from the former South West Wetland Monitoring Program (SWWMP, SPP2015-002) to develop a spectral index that correlates water depth with water presence/absence across a wetland. This approach is a "gap-filling" procedure that can transform intermittent measures of water depth into a more continuous record (e.g., biannual to monthly measures of water depth). To accomplish this we will compare an index developed by DBCA to traditional indices of water presence/absence, such as the Normalized Difference Water Index . Thus, we will derive several indices that relate water depth to remotely sensed measures of wetland inundation and then assess how well each index performs at identifying the spatial extent, depth, and volume of water at SWWMP wetlands. Furthermore, we will assess how sensitive these indices are to environmental factors, such as wetland geomorphology, fringing vegetation, and sun angle. These methods will be applied to analysis of the long-term trends in hydrology of wetlands in south west Western Australia.

Monitoring of groundwater will be undertaken as appropriate and where there is an established network of monitoring bores.

Aim 3: All waterbirds on a wetland are counted and identified using binoculars and spotting scopes from the ground, unless the wetland is very large and then the portion of the wetland surveyed is documented. Boats will be used for deeper lakes where on-ground access is limited or not feasible. Aerial surveys will occasionally be conducted, sometimes via external contractors, on particularly large wetlands such as those in northern Australia. At sites in close geographic proximity to Perth (e.g., Peel-Yalgorup and Forrestdale and Thomsons Lakes) we will conduct multiple surveys per year to better understand intra-annual variability of waterbird numbers. At more remote sites (e.g., Ord River floodplain) we will aim to conduct surveys every five years depending on funding. Note that regular water bird surveys are already being conducted at multiple Ramsar sites, including Vasse-Wonnerup, Muir-Byenup, Eighty-mile beach, and Roebuck Bay and we will not replicate these programs while they are running.

An Animal Ethics project for ground surveys of waterbirds has been a approved.

Aim 4: The short-term activities that will occur under Aim 4 cover multiple disciplines and thus the methods will vary depending on the activity. Below we provide methods for current and likely work.

Fish surveys will be conducted using a combination of fyke nets, seines, dip nets. In some situations underwater cameras, drones and/or eDNA will be used in addition to traditional methods. Fish identifications will occur in the field and fish will be released unless voucher specimens are retained and lodged with the Western Australian Museum. An animal ethics project for fish sampling has already been approved. Fish data will be provided to Department of Primary Industries and Regional Development.

Aquatic invertebrate sampling for biodiversity (presence/absence) usually involves sweep netting using techniques, mesh sizes and sample sizes that are compatible with all other DBCA aquatic invertebrate sampling (and which have become a standard outside of DBCA for some other research groups). Invertebrate abundance studies will be less common and conducted using standard methods such as water column/sediment cores or passive plankton samplers. Invertebrate will be identified to species/morphospecies level using a reference specimen collection held at Kensington and external taxonomic assistance is sought where needed.

Generally a combination of multivariate analyses including modelling and ordination/classification methods using data from the project in question and comparable pre-existing datasets. Species distributions and conservation assessments are made by comparison with previous records and ecological knowledge.

Collaborative projects – A number of sub-projects in which DBCA is a collaborator are still under development and methodological details cannot be provided at this time. However, DBCA will attempt to ensure that the methods used will follow best practices and that the results will assist in the management of wetland assets across Western Australia. Three projects are currently under development:

1. The Lake Clifton thrombolite TEC is a significant asset within the Peel-Yalgorup Ramsar site, but several knowledge gaps are hindering DBCAs ability to design and implement a cost-effective monitoring program. In 2018 the Peel-Harvey Catchment Council (PHCC) commenced a five-year Ramsar project funded by the National Landcare Program. A key component of PHCC's project is to understand the environmental factors that influence the activity and condition of the Lake Clifton thrombolites. DBCA and PHCC are collaborating to develop projects whose results will form the foundation of a future monitoring program.
2. BirdLife Australia have applied for a Community Stewardship grant through the State NRM office to collect and analyse data on wetland birds through the extension of an established citizen science program. Management actions implemented by DBCA directly affect the health of wetlands throughout Western Australia. However, the current bi-annual monitoring program for shorebirds and wetland birds leaves a gap in our knowledge of how the timing and scale of management actions are impacting birds throughout the Peel-Yalgorup Ramsar site. Thus, we will assist in collection and management of environmental and waterbird data as well as assist in the analysis of these data sets in required.
3. A University of Adelaide Ph.D. student has commenced a study, co-supervised by DBCA's Josephine Hyde, exploring how environmental DNA (eDNA) sampling can supplement traditional biological survey methods in wetlands. Traditional survey methods have produced results that have significantly improved conservation management. However, survey methods are continually evolving, and eDNA is an emerging technology that shows promise as a monitoring tool. We will assist the Ph.D. student by collecting sediment samples from Ramsar sites across Western Australia as they are visited for this project.

Biometrician's Endorsement

granted

Data management

No. specimens

Herbarium Curator's Endorsement

not required

Animal Ethics Committee's Endorsement

granted

Data management

All data will be stored in appropriate corporate databases such as Data Catalogue, corporate GIS databases and, in the future, BioSys. Raw data will be published with reports and papers.

Budget

Consolidated Funds

Source	Year 1	Year 2	Year 3
FTE Scientist	1	0.7	0.7
FTE Technical	0.2	0.2	0.2
Equipment	15000	5000	5000
Vehicle	5000	5000	5000
Travel	5000	20000	20000
Other	15000	10000	10000
Total	40000	40000	40000

External Funds

Source	Year 1	Year 2	Year 3
Salaries, Wages, Overtime			
Overheads			
Equipment			
Vehicle	1000		1000
Travel	6300		6300
Other			
Total	7300		7300