Increasing Wetlands IQ – Conceptual Models for Managers

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Through statewide mapping currently being conducted the EPA has identified approximately 700 000 wetlands in Queensland. The diversity within these mapped wetlands is huge – there are an astonishing array of lakes, swamps, river and stream systems, estuaries and coastal marine wetlands. This makes the management of wetlands incredibly complex. There is therefore a need to simplify the diversity of wetland into types of wetland habitats that are likely to have similar characteristics and processes and capture the current scientific understanding of the key processes and components of these different wetland habitat types. Synthesising and integrating current understanding and knowledge of wetlands is a crucial first step in the adaptive management framework. As part of the Queensland Wetlands Programme, we have developed a Typology that categorises Queensland's floodplain (and non-floodplain) lakes and swamps into major wetland habitat types based on the EPA Wetland Mapping. We have developed a series of conceptual models that synthesis the best available understanding of the key components and processes of these major wetland habitat types and identify knowledge gaps for future research. Though the models have been developed for a regional, as opposed to local, scale, we have attempted to capture as much of the diversity within these major type groupings as possible. These models are useful for identifying knowledge gaps, and presenting complex and vital information to managers and legislators in an accessible and engaging form, and also form the basis for developing a monitoring program. This allows the monitoring program and its suite of indicators to be; based on the best scientific understanding of each wetland habitat type; and applied and interpreted appropriately for each wetland habitat type. These models also demonstrate our understanding of wetlands within a landscape context, which is crucial for successful floodplain river management. This paper will outline the context of and process for the creation of the Queensland Wetlands Habitat Typology and Wetlands Science Synthesis Conceptual models.

Wetlands Management

The Adaptive Management Framework is an iterative, non-linear process for undertaking natural resource planning and management activities. It provides a conceptual vehicle for integrating knowledge and science into planning and management to achieve sustainable outcomes (Queensland Government, 2004). A crucial part of developing the 'Current Understanding' component of the Adaptive Management Framework is collating and understanding the current knowledge of the systems you are managing. The Wetland Habitat Typology provides a framework for the knowledge, while the Science Synthesis conceptual models attempts to collate and present the knowledge in a form accessible to a wide and varied audience.

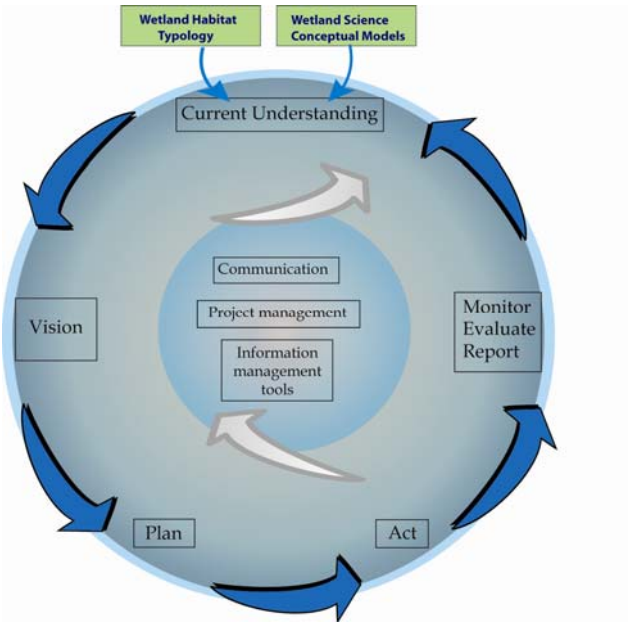

Figure 1. How the Wetland Habitat Typology and Wetland Science Conceptual Models fit into the Adaptive Management Framework.

Wetland Habitat Typology

Wetlands are dynamic systems, influenced by and influencing a complex range of environmental variables and wetlands can be highly influenced by hydrology and climate variables and undergo cycles of wetting and drying over temporal and spatial scales. Like most natural systems no two wetlands are the same, which makes distinguishing wetlands into meaningful, discrete types very challenging. Nonetheless, the characterisation (whether through a general 'typology' or more detailed and specific 'classification') of wetlands into ecologically relevant groups that are more like each other than others and share similar ecological and physical drivers can still be very useful and has been an important component of the Queensland Wetlands Programme, providing a framework for mapping, mangagement and scientific information to be understood and collated within.

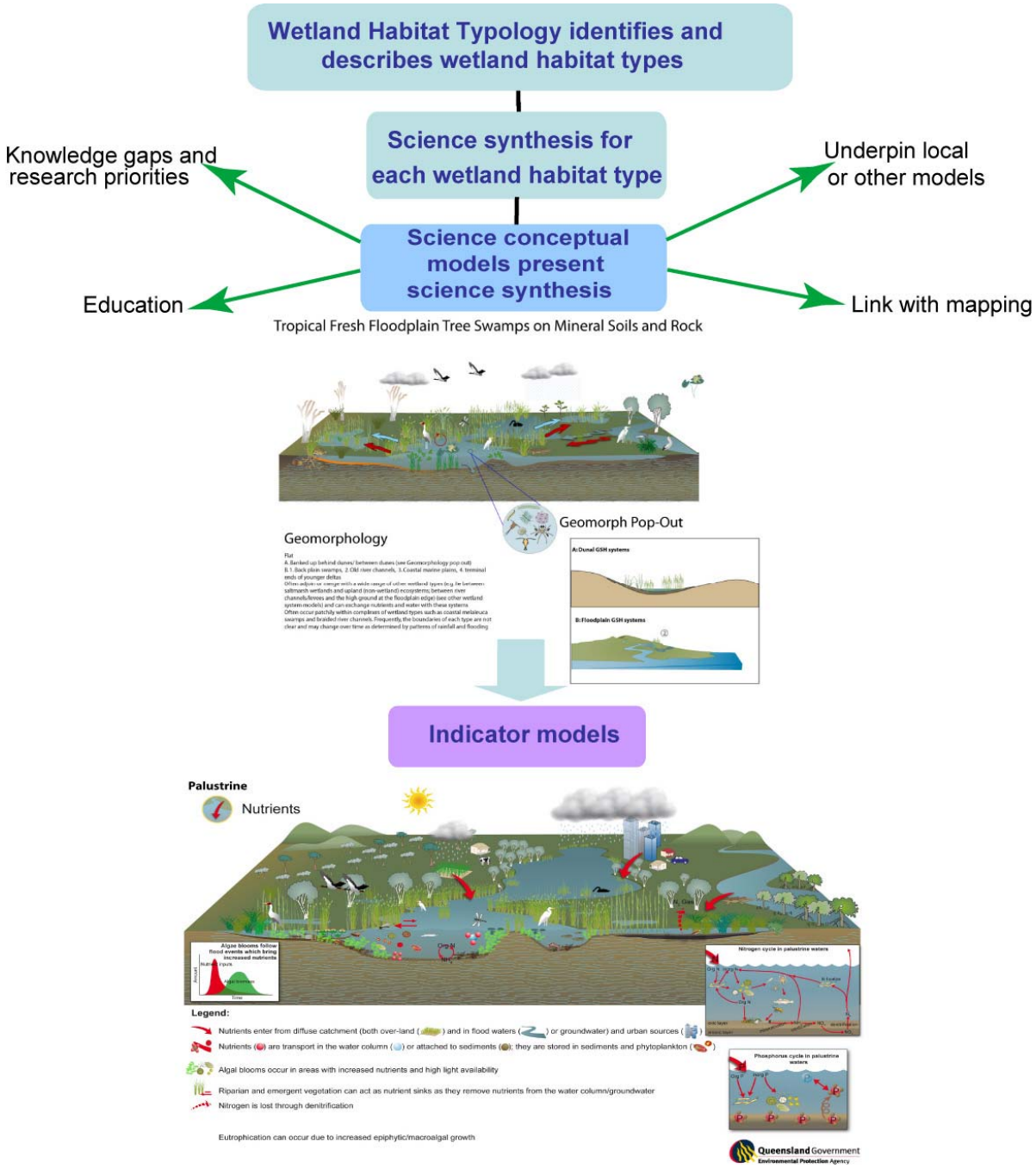

Figure 2. The Queensland Wetland Habitat Typology provides a framework for the Science Synthesis which has a range of uses, including feeding into the development of indicators for monitoring

Wetland Classification in Australia

Many wetland classification systems and typologies have been developed over the past few decades, signifying both the difficulty in creating a definitive system and the potential for different frameworks for different purposes and scales. Reasons for the identification of wetland types can vary, from representativeness or uniqueness assessments within an area, to the identification of different monitoring needs, and for a range of other management purposes. Regardless of their specific purpose most wetland characterisations are based on describing attributes that can be measured and which, when combined, help to define the nature of a specific wetland and distinguish it from others.

Recently there has been agreement at an Australian national level to accept a wetland characterisation based on broad wetland ecosystems (Cowardin et al. (1979) as follows:

- marine (coastal wetlands including rocky shore);
- estuarine (including deltas, tidal marshes and mangrove swamps);
- riverine (wetlands along rivers and streams);
- lacustrine (lakes);
- palustrine (marshes, swamps and bogs);
- reservoirs (including water storage areas, excavations, wastewater ponds, irrigation channels, rice fields, canals) and
- subterranean (inland subterranean wetlands) are also identified as wetland types.

Based on this national agreement the Queensland EPA development a wetland typology that could be applied at a state wide scale, utilising the information collated in the Wetland Mapping Project, to distinguish wetland habitat types that would be both ecologically relevant and useful for management.

Queensland Wetland Habitat Typology

Under the Queensland Wetlands Programme and as part of the National Project on National Wetland Indicators Final Report (Conrick et al. 2007), attributes have been identified addressing characteristics of wetlands at increasingly specific scales (continental, ecosystem, landscape, and local) which can be used for classification purposes. This has been termed the Wetland Description Tool. Each category has specific layers to identify different features of wetlands that can be used in classification systems.

The Queensland Wetlands Programme has developed a typology that uses attributes collated in the Queensland Wetlands Mapping and the framework of the Wetlands Description Tool to provide further resolution for wetlands, beyond this system level. The attributes include:

- Wetland System – Lacustrine (Lake) / Palustrine (Swamp)
- Climate regions - Coastal and Sub-Coastal/ Arid and Semi-Arid
- Water Type – Fresh/ Saline
- Water Regime – Commonly wet/ Periodically inundated
- Substrate – Peat/ Soil/ Rock/ Sand
- Geomorphology/Topography – Floodplain/ Non-floodplain
- Vegetation – Tree/ Heath/ Grass, sedge, herb

Through expert consultation and an iterative process of ‘reality checking’ with the outputs of the Queensland Wetlands Mapping Project a series of Wetland Habitat Types have been developed that are both broad enough to cover the state of Queensland but also allow for identification and grouping of key ecological and physical processes within wetlands of each broad climatic zone.

Wetlands can be temporally and spatially diverse on fairly small scales, so this typology looks at 'Wetland Habitat Types' which can be found adjacent to each other to form wetland complexes (eg. A lacustrine water body may have a palustrine fringe) or even change into each other over time (eg. a wetland may have a lacustrine water body during the wet component of its cycle and may dry to form a palustrine system).

For more detailed classification of wetlands at a local scale the Blackman system (based on the Cowardin et al 1979), developed by Blackman (1992) and further explored in Blackman et al (1995). It is this detailed classification system that is recommended for use when a more localised is needed, which is beyond the scope of the typology described here.

Advantages of the Queensland Wetland Habitat Typology include:

- Through using the National Wetlands Description Tool, the Wetlands Habitat Typology has been workshopped nationally and debated extensively
- The Typology is not designed to replace existing classification systems, and can be easily 'translated' to other systems as it includes a descriptive list of attributes and this allows for consistency in reporting across jurisdictions
- The attributes and components that form the basis of this system can be applied efficiently at a state wide scale using wetlands mapping and inventory in a GIS system
- The Typology is based on key attributes, drivers and components of Australian wetlands and therefore lends itself to depicting wetland function in conceptual models and choosing indicators for wetland monitoring
- If additional attributes are considered important at a state or regional level more refined wetland typologies can be developed, however, for the purposes of reporting nationally they can be combined up and robustly compared.
- The naming convention for the typology is intuitive and descriptive and relates directly to the key components driving the system
- The Typology is exhaustive – all wetlands are covered
- The Typology can underpin subsequent management guidelines, indicators, science synthesis, conceptual models, literature review etc. These can be developed up based on the typology and can therefore be used appropriately according to relevant wetland habitat type.

Development of Science Synthesis Conceptual Models

Conceptual Models – In General

Conceptual models are simplified representations of the real world. In this case we have developed pictorial representations of the lacustrine (lake) and palustrine (swamp) wetland habitat types of Queensland derived from the Wetland Habitat Typology. Our conceptual models provide both text and diagrams as large amounts of complex information and processes can be more effectively communicated by this means than text alone (Thomas et al, 2006). The diagrams in conceptual models use symbols to represent, describe and convey information about components and processes of the system. Discussions with stakeholders have identified conceptual models as a key technique for scientific information to be communicated and shared.

Conceptual models are useful tools as they:

- Provide diagrammatic representations of ecosystems in which key features and major impacts can be illustrated
- Show what is known and what is not known about a system in an engaging format, therefore providing a summary of the current understanding and an identification of knowledge gaps and points of contention

- Provide synthesis, visualisation and context.

The **process** of creating conceptual models also highlights elements of consensus in understanding, as well as, discovering knowledge gaps and areas of contention – allowing priorities for research to be targeted. Creating conceptual diagrams facilitates communication between scientists, resource managers and non-scientists by assisting in both one way (eg. idea presentation) and two way (idea development) communication (Thomas et al, 2006).

Conceptual Modelling for the Queensland Wetlands Programme

The Queensland Wetlands Programme is reassessing existing models, and developing more detailed models of the complete suite of lacustrine (lake) and palustrine (swamp) Wetland Habitat Types in Queensland, which were identified by the Wetland Habitat Typology.

Wetland Science conceptual models will form an important component of the Wetland*Info* (the Queensland Wetland Programme website) Science and Research Hub –

- They provide a synthesis of science for those working with, managing and making decisions about wetlands in Queensland of each of the major lacustrine and palustrine wetland habitat types
- They provide the scientific understanding to underpin the Wetland Monitoring Project
- Link with mapping and management
- Highlight knowledge gaps
- Useful wetlands education tools

Process for Creating Science Conceptual Models

1. Literature reviews are conducted to identify key features, processes, drivers for each of the Wetland Habitat Types.
2. Wetland experts from a range of climatic areas, disciplines and areas of expertise are identified and engaged
3. Workshops are held where experts are asked about their ideas on major drivers and components of the wetland types of that climatic region and to identify relevant papers and projects
4. Draft model based on expert feedback and literature review
5. Disseminate draft model to experts for review
6. Assimilate feedback
7. Continue the iterative process until consensus is reached
8. Publish models on the Wetland*Info* website
9. Regularly review and update models as new knowledge becomes available.

The final step - reviewing and updating the science conceptual models, is a very important part of maintaining an Adaptive Management approach, as knowledge is continually generated and as new understandings are developed they need to be incorporated into the models so they can maintain their currency and usefulness.

Scope

The conceptual models developed in this project are at a broad, climate regional scale and may require further refinement for use on a local scale. Though this is outside the scope of the project a resource kit is being compiled throughout this project and will be available with the models on Wetland*Info* website to assist interested parties with local scale model development.

Conceptual Modelling and Monitoring Programs

Well-constructed conceptual models have been identified as a key element of environmental monitoring programs. This is because they integrate current understanding of system dynamics, identify important processes, facilitate communication of complex interactions and illustrate connections between indicators and ecological states or processes, all of which provide a vital foundation and scientific framework for a monitoring program and justification for the choice of indicators and context for understanding the results (Gross, 2003).

Conceptual Modelling Collaboration

In order to share resources and develop conceptual models and monitoring programs that can span borders and jurisdictions the Queensland Wetlands Programme has formed collaborations with the Monitoring, Evaluation and Reporting Programme of the Department of Environment and Climate Change, New South Wales, the South Australian Wetlands Condition Indicator project of the Department of Water, Land and Biodiversity Conservation in South Australia and the Murray-Darling Freshwater Research Centre in Victoria. This collaboration are underpinned by a shared understanding of the Wetlands Habitat Typology and a shared set of wetland conceptual modelling guidelines as well as a joint review process and joint workshops.

Model Release

The science synthesis conceptual models are currently available in draft form for review and will be published on www.epa.qld.gov.au/wetlandinfo in October 2008.

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