Coastal Freshwater Wetlands of North Queensland – Imperatives for their Conservation

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Abstract

The freshwater wetlands of the north Queensland coast are an important part of the landscape mosaic. Their function and intrinsic worth are valuable community assets. In the past, poor management of these ecosystems has resulted in many becoming degraded or disappearing altogether. There is concern that some current planning and management practices still threaten their viability and, occasionally, their very existence. An overview of coastal freshwater wetlands in north Queensland is provided, together with a discussion of wetland functions, biological values and threatening processes. Recommendations for improved conservation and management through a catchment management approach is suggested. The need for greater understanding and awareness of wetlands through education and research is highlighted.

Introduction

On the north Queensland east coast (nominally Rockhampton to Bamaga), the mean annual rainfall ranges from in excess of 4000 mm (e.g. Tully/Babinda) to less than 1000 mm (e.g. Bowen). This variability in rainfall produces a disparate pattern of surface discharge, with the relatively small wet tropical catchments between Rollingstone and Daintree accounting for more than 16% of Queensland's mean annual river discharge, but the almost 140 000 km^2 Burdekin River catchment discharging less than 7% of the total (QDPI 1993). However, the mean annual discharge of the Burdekin River is an order of magnitude greater than any individual stream in the wet tropics (QDPI 1995).

These variable rainfall and discharge patterns produce a variety of coastal wetlands. Some freshwater wetlands simply require seasonal rainfall, others may require overbank flow, groundwater recharge or even tidal inundation. Stanton (1975) was the first to assess the complexity of Queensland's wetlands, identifying 142 different wetland aggregations across 24 classes, at the 1:1 000 000 map scale. Importantly, this wetland diversity (including the intertidal) occupies only 4.3% of the total land area of the state (E. Ross pers. comm.).

Stretching from the remnant coolibah (*Eucalyptus microtheca*) stands on the Fitzroy River floodplain near Rockhampton, to the Jardine River swamps at the tip of Cape York Peninsula, there are wetlands of national and international significance. For example, Bowling Green Bay National Park, located to the south of Townsville, is one of only two sites in the state listed under the Ramsar Convention. Although predominantly listed for the habitat values of its mangrove and intertidal zone for waterfowl, significant freshwater wetlands exist within, and immediately adjacent to (e.g. Cromarty wetlands), the declared area.

The need to manage this variety of wetlands has been recognised by both the State government, through its (proposed) Strategy for the Conservation and Management of Queensland's Wetlands (QDoE 1996), and by the Commonwealth government, through its Wetlands Policy (EA 1997). These documents promote a position of joint responsibility between governments and landholders for sustainable use and protection of the values and functions of wetlands. Nevertheless, threats to the integrity and viability of Queensland's wetlands remain, with several regions under considerable pressure (Arthington and Hegerl 1988; Lukacs and Pearson, in press).

In this paper, the functions and values of wetlands are briefly reiterated and specific threats to north Queensland's coastal wetlands are examined. Central to this workshop was the role that

wetlands may play in the management of catchment water quality (with respect to Great Barrier Reef waters), and a framework for their prospective use is suggested.

Functions and Values of Wetlands

Wetlands possess a range of functions and values in the landscape. The Wetland Evaluation Technique (WET) is used throughout the world as a generic method to define the functional value of wetlands in a region (Adamus et al. 1987; Marble 1992). Essentially, these functions are as follows:

Nutrient Removal and Transformation	In the short term, wetland vegetation can take up and store nutrients, but these are returned into the system once the plants die or defoliate. On a long-term basis, vegetation may remove nutrients through sedimentation of plant material, the provision of substrata for bacterial uptake (and subsequent sedimentation), and by providing the conditions for biochemical transformation/removal (e.g. denitrification, nitrogen fixation, ammonium volatilisation, phosphorus adsorption and precipitation).
Sediment/Toxicant Retention	Through the deposition of sediment (and associated toxicants), contaminants can be removed temporarily or permanently by burial, chemical breakdown, and/or assimilation into plant and animal tissues.
Shoreline Stabilisation	The binding of soil at the shoreline or water's edge by wetland plants increases the physical dissipation of erosive energy caused by waves, currents and tides in a basin or channel. Stabilisation protects adjacent lands from erosion and protects navigable channels from eroded sediments.
Floodflow Alteration	Peak flows from run-off, surface flow and precipitation can be stored or delayed in wetlands, thereby decreasing flood-related damage. Wetlands located in the upper portion of catchments are most effective but even on floodplains, wetlands may desynchronise flow by soil capillary storage and the frictional roughness of vegetation.
Groundwater Recharge	Wetlands can hold surface water long enough to allow the water to percolate into the underlying sediments and/or bedrock aquifers. This water can then augment regional surface water streams and lakes. Accession to deeper groundwaters may contribute to water supply systems.
Groundwater Discharge	Groundwater discharge areas often reflect the interaction between the water table and surface waters. These wetlands are a resource for many communities as they can provide water for domestic supply, irrigation, and grazing.
Production Export	The production of organic material in a wetland and its downstream transport is an important element in food chains, particularly for primary consumers (e.g. fish and aquatic invertebrates).

Wildlife Diversity/Abundance Wetlands support a wide diversity of unique aquatic, semi-aquatic and terrestrial species. From phytoplankton communities to crocodiles, the biota of wetlands are intrinsically linked to the processes within the wetland. The vegetation, in particular, contributes substantially to habitat complexity and the diversity of the dependent fauna.

Wildlife Diversity/Abundance for Migration and Wintering Wetlands are key sites for migratory and nomadic waterfowl species, as is recognised by the Ramsar Convention and international treaties (e.g. JAMBA, CAMBA). Many other species seasonally utilise wetlands as part of their lifecycle, for example, macropod species use the seasonal 'greening up' of wetlands as feed targets in the landscape.

Recreation Increasingly, wetlands are the focus for tourism and leisure activities, such as fishing. In north Queensland, guided tours of wetland habitats are becoming more common (e.g. Hull River boat tours, the proposed Jacana Foundation at Cromarty wetlands), producing economic as well as educational benefits to the community.

Uniqueness/Heritage The value of wetlands also relates to their inherent worth to the community. For example, Kakadu is readily identified by most Australians as a place of significant cultural value and is to be afforded appropriate protection. Similarly, some wetlands in local communities are regarded as cultural icons (e.g. Townsville Town Common, Trinity Inlet, Hinchinbrook Channel).

Threats to Wetlands

In the past, the draining, clearing and filling of north Queensland's coastal lowlands and wetlands, often for agriculture, has resulted in their significant loss in some regions (see Johnson, this volume). More recently, the proposed implementation of elements within the Sugar Industry Infrastructure Packages (SIIP) also threatens the integrity of coastal wetlands in north Queensland. For example, different sections of the Herbert Existing Cane Area Water Management Project (HECAWMP) propose mangrove clearing, deep drainage, and the truncation of watercourse meanders, as part of infrastructure development in the area (Queensland Department of Natural Resources 1997). The likely impacts on coastal wetlands and fish habitat of such proposals are overt and crude. More subtle threats to the region's wetlands, but which are also prevalent throughout Australia (Bunn et al. 1997), include:

Pollution Past changes in catchment land-use, together with the utilisation of synthetic agricultural chemicals and fertilisers, have been responsible for significant increases in nutrient and other contaminant loadings into the coastal waterways and wetlands of north Queensland (Moss et al. 1993; Bramley and Johnson 1996). The effects on wetland trophic states and processes largely remain unknown.

Exotic Species The introduction of aggressive pasture grasses (e.g. para grass, *Hymenachne*), escaped biological control agents (e.g. cane toads) and aquarium species (e.g. tilapia, water hyacinth), feral pigs, goats, cats, and the spread of noxious weeds (e.g. rubbervine, salvinia) have all contributed to the degradation of many north Queensland coastal wetlands.

Altered Hydrology	Land-use changes, flow regulation and extraction, streambank stabilisation practices, groundwater abstraction, and drainage schemes each affect the natural water regimes upon which wetlands are dependent. For example, floodplain wetlands require a seasonal flooding regime commensurate with their biotic needs and to maintain their geomorphologies. Insufficient, ill-timed or oversupplied water will degrade these wetlands.
Grazing	For decades many coastal wetlands have been used as 'fattening country' for western Queensland cattle prior to shipment for slaughter. Overgrazing and inappropriate clearing has resulted in the severe degradation of wetlands on some properties, whilst on others, sensitive (and sensible) grazing regimes have sustained wetlands of significant value (e.g. 'Cromarty').

Other issues which require management include recreation/tourism, inappropriate fire regimes, insect control and associated chemical use, mining and cropping (see Bunn et al. 1997)

The Use of Wetlands to Manage Catchment Water Quality

It has been proposed by several researchers (e.g. Whigham et al. 1988; Mitsch 1993; Hammer 1993) that a landscape approach to controlling non-point source pollution, utilising constructed and natural wetlands, may be feasible. It is seen by many as a viable method to augment land-based pollution control methods; however, in Australia there is little information on which to either design or model such a system. The vast majority of data which exists on the role of wetlands in improving water quality is based on constructed wetlands in temperate climates to polish sewerage treatment plant effluent or other point sources of effluent. In such situations, hydrological and biological control can be relatively easily achieved. In comparison, developing a system of wetlands to better manage catchment pollution in tropical and subtropical Australia, requires an approach which is more aware of regional opportunities and limitations.

Raisin and Mitchell (1996) have recently reviewed the role of natural wetlands in treating non-point sources of pollution in Australia and concluded there are insufficient data on wetland function to confidently promote their use in catchment management. Their own extensive research of a wetland which received non-point source agricultural run-off demonstrated that, depending on seasonal conditions and biotic responses, a net release of contaminants can occur from the site (Raisin and Mitchell 1995). However, Raisin and Mitchell concur with several overseas researchers, that given optimal conditions (for biota, hydrology and management), a landscape approach to using wetlands (constructed and natural) for improved water quality is likely to be worthwhile (G. Raisin pers. comm.).

There are also several issues associated with the legal framework for the use of wetlands in controlling non-point source pollution. The Queensland *Environmental Protection Act 1994*, through its Environmental Protection (Water) Policy (1997) fails to address non-point source pollution (other than urban stormwater) and the possible role of wetlands in catchment management. It does discuss proposed construction of artificial wetlands within natural wetlands, and incongruously allows for such construction, provided a series of issues are considered (e.g. preventing construction if the natural wetland is of local, regional or national importance – but using the inappropriate ANCA (1991) guidelines as criteria). Similarly, the (proposed) Strategy for the Conservation and Management of Queensland's Wetlands (QDoE 1996) emphasises the need to protect natural wetlands from the 'release of substances or non-indigenous species'; however, it does not prohibit the development of constructed wetlands within natural wetlands.

In contrast, the New South Wales government, through a comprehensive wetland management policy, openly discourages the siting of constructed wetlands in natural wetlands, and promotes a range of management principles which aim to minimise any further loss or degradation of wetlands and, where possible, restore degraded wetlands (NSWDLWC 1996). Perhaps the most useful integrated model is that of the United States Environmental Protection Agency (USEPA 1997) which explicitly prevents the use of natural wetlands for treating wastewaters (*Clean Water Act 1970*), and provides for non-point source pollution control through i) the protection and restoration of wetlands and riparian areas and ii) the promotion of the use of vegetated treatment systems (*Coastal Zone Act Reauthorization Amendments 1990*).

This comprehensive approach to catchment management benefits not just downstream environments, but also the 'en route' wetlands. The Queensland Government similarly needs to develop a catchment management framework that expressly protects and restores natural wetlands, and uses vegetation strips and constructed wetlands for non-point source pollution mitigation.

A Possible Approach

Essentially, wetlands cannot be expected to compensate for poor land management or insufficient use of best practice management in industry. This view has been reiterated by several other researchers (Olson 1993). However, independent of improvements to on-farm land management practices, wetlands can play an important part in a management strategy for catchment water quality.

A system of wetlands to manage non-point source pollution should be based on a clear delineation of the different roles and functions wetlands can possess. Hammer (1993) has proposed a hierarchical model of four wetland types, with each having a specific purpose in the catchment.

Natural — are those areas wherein, at least periodically, the land supports predominantly hydrophytes and the substrate is predominantly untrained hydric soil or the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. Natural wetlands have and continue to support wetlands flora and fauna.

Restored — are areas that previously supported a natural wetland ecosystem but were modified or changed, eliminating typical flora and fauna, and used for other purposes. These areas have subsequently been altered to return to poorly drained soils and wetlands flora and fauna to enhance life support, flood control, recreational, educational, or other functional values.

Created — formerly had well-drained soils supporting terrestrial flora and fauna but have been deliberately modified to establish the requisite hydrological conditions producing poorly drained soils and wetland flora and fauna to enhance life support, flood control, recreational, educational, or other functional values.

Constructed — consist of former terrestrial environments that have been modified to create poorly drained soils and wetlands flora and fauna for the primary purpose of contaminant or pollutant removal from wastewater. Constructed wetlands are essentially wastewater treatment systems and are designed and operated as such, though many systems do support other functional values.

If the differences between these wetlands are recognised, a framework for their use in catchment management can be compiled. The following (table 1) is a suggested hierarchical wetland management strategy for the control of catchment non-point source pollution (after Hammer 1993). Four levels of pollution control are suggested, which relate to the type of wetland (e.g. natural, constructed, etc.), its place in a catchment, its role in water quality management, and its management requirements (e.g. maintenance).

Table 1. A hierarchical wetland management approach for non-point source pollution

	First Order Control	Second Order Control	Third Order Control	Fourth Order Control
Definition	Constructed wetlands designed and operated specifically for treating wastewater emanating from concentrated livestock areas, processing facilities, and in many cases, septic tanks serving the farm household.	Consists of nutrient/sediment treatment systems strategically located downstream from the first-order wetlands, at the lower end of grassed waterways and within intermittent stream courses throughout the individual farm.	Deploys nutrient/ sediment treatment systems, constructed wetlands/pond complexes, and restored or created wetlands at specific sites within a watershed that may include many individual farms.	Consist of larger wetlands in the lower reaches of an individual watershed that function primarily for hydrological buffering and life-support values in addition to limited water purification.
Catchment Location	Wastewater at the source. Often located within boundaries of an individual farm.	Less concentrated, aggregate wastewater from a variety of sources. Often located within a regional drainage scheme.	Buffer strips of riparian wetlands along permanent streams, small restored or created wetlands specific points in the upper reaches of the watershed.	Larger areas of restored or created wetlands at tributary stream intersections in the lower sections of the watershed.
Purpose	Principally designed for and operated for wastewater treatment.	Treatment but some ancillary benefits.	Function same as regional natural wetlands accomplishing water purification. Polishes run-off from a number of farms.	Hydrologic (flood) buffering, life support, and related beneficial values. Controls NPS from an entire watershed.
Requirements	Requires deliberate management and/or manipulation to maintain optimal treatment performance.	Requires deliberate management and/or manipulation to maintain optimal treatment performance.	Active management not needed and supports additional wetland functions.	Active management not needed and supports additional wetland functions.

This approach has already been adopted by the USEPA as part of their 'Nonpoint Source Pollution Control Program' (USEPA 1997). Within this program, 'Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters' are provided for:

- agricultural sources,
- forestry,
- urban areas,
- marinas and recreational boating,
- hydromodification (channelisation and channel modification, dams, and streambank and shoreline erosion),

- wetlands, riparian areas and vegetated treatment systems,
- monitoring and tracking techniques.

Specifically in relation to wetlands, the guidance measure formally recognises wetlands (both natural and constructed) as integral to the control of non-point source pollution. This extends to providing a legislative basis for the protection and restoration of natural wetlands and the construction of detention basins, wetlands and vegetated filter strips.

In Australia, the concern over non-point source pollution affecting Great Barrier Reef waters (see Mitchell et al. 1996) can only be met through the development of such a comprehensive strategy, with wetlands being a key component. Through the Federal Government's Coasts and Clean Seas program (developed from the Commonwealth Coastal Policy 1995), together with the provisions contained within the Queensland *Coastal Protection and Management Act 1995*, the development of such an integrated approach is possible (e.g. through the Regional Coastal Management Plans and Control Districts). The challenge which remains for Australia (and particularly Queensland) is to develop such a strategy.

Suggested Research

There is a need to better evaluate the effectiveness of using wetlands for non-point source pollution control, prior to implementing any collaborative program. For example, the proposed construction of detention basins and wetlands as part of the Murray–Riversdale SIIP (Tait 1995) is intended to provide for a variety of functions (e.g. water quality improvement, waterfowl and fish habitat, floodflow desynchronisation); however, there is little evidence to suggest that the outlined approach can achieve any or all of these goals. A comprehensive planning document which provides guidelines for wetland use at the catchment level, and is supported by research data, is urgently required.

The Land and Water Resources Research and Development Corporation (LWRRDC) has initiated a 'focus catchments' approach to catchment-scale adoption of research. That is, in catchments where there is a large volume of existing information, management processes, such as Adaptive Environmental Assessment and Management, are being trialed to enable catchment groups to implement and evaluate on-ground management strategies (LWRRDC 1996). The Herbert and Johnstone River catchments are two such focus catchments in Queensland.

It is suggested that a 'focus catchment' be utilised in the development of a pilot program for using wetlands in non-point source pollution control. Using such a catchment would provide a firm basis to evaluate different design criteria, catchment responses and management requirements, given the ready availability of data on landuses, fertiliser and contaminant loads, hydrology, etc. Intrinsic to the pilot program would be improved protection for natural wetlands, restoration of degraded wetlands, and the strategic construction of wetlands.

There are a number of possibilities for supporting such an initiative. For example, it could be a collaborative approach involving the Coastal and Marine Planning Program (e.g. design, strategic planning), the Coasts and Clean Seas program, Coastcare and Landcare (community implementation), the Queensland Government (legislation, infrastructure and implementation), the LWRRDC (evaluation), and the Great Barrier Reef Marine Park Authority (education and awareness). The existing Memorandum of Understanding (November 1995) between the three tiers of government on implementation of the Coastal Action Program, also allows for the development of Local Water Quality Management Planning (Schedule 6). Specific to this schedule is section 5.4: 'One project demonstrating the preparation and implementation of a local water quality management plan promoting optimal use will be undertaken in the areas adjacent to the

Great Barrier Reef Marine Park'. Such a demonstration project could be an integral part of a research program.

It is clear there are existing opportunities to trial a catchment approach to non-point source pollution control using wetlands. A carefully planned project which can demonstrate the effectiveness of different wetland types to provide a variety of functions within the catchment should be encouraged and supported.

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