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ISSN 2316-9281

New Zealand's wetlands: conservation and wise use

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Abstract. New Zealand is unique when it comes to landscapes and biodiversity, being one of the countries which has the highest numbers of endemism. With such vast diversity, wetlands play a key role maintaining many of these species and also providing essential ecosystem services for the local communities. However, New Zealand has been largely degraded on wetland areas in the last two hundred years, remaining only 10% of the original composition which brings a special attention to the country. In this case, this review provides an overview of New Zealand's wetlands highlighting aspects such as definitions, uses, values, threats and management.
Keywords: Marshes, biodiversity, endemism

Introduction

Wetlands Definitions

Wetlands are a complex and rich ecosystem which carries several definitions throughout the world. Thus, most of the countries has its own definition which complies with the ecological features and conservation management. The following five definitions are from five signatory countries from the Ramsar Convention.

In New Zealand, the definition which suits its wetlands is from the Resource Management Act (1991) that states that wetlands are wet areas which are temporary or permanent, shallow water and land water margins that shelters adapted animal and plant species.

In Zambia, wetland is described as a site which floods and the appearance of ground varies or areas that have permanent flooding, with a depth layer which do not exceed many meters (Tiner, 2000).

In Brazil, although there are certain controversy, wetlands should have an extension determined by the limit of shallow flooding or waterlogging permanent or periodical, including, if any, permanently dry areas, vital habitats for maintaining the functional integrity and biodiversity of the same (Junk et al., 2014).. The outer limits are indicated by hydromorphic soil and/or by continuous or periodic presence of hydrophytes and/or woody species adapted to periodically waterlogged soils (Junk et al., 2014).

In Netherlands, wetlands have to have hydrophytes at least periodically, undrained hydric soil, and/or a substrate which is saturated with water and covered by shallow water during the proper season (Wolff, 1993).

In China, it is used the same definition as the Ramsar Convention, however with a little broader as it includes deep lakes and large rivers as wetlands (Shuqing et al., 2007).

New Zealand became a signatory to the Ramsar Convention on Wetlands on the 13 of December in 1976 which listed six sites for inclusion in the List of Wetlands of International Importance (Department of Conservation, 2014). New Zealand has twenty wetland types gathered in this six areas, with more than one type combined in each site. The sites are listed below:

- Whangamarino: located in Waikato district and 62 km from Auckland, Whangamarino has a total area of 5690 hectares approximately and is the second largest bog and swamp wetland in the Northern Island of New Zealand (Ramsar Wetlands Information Sheet, 1992 4). It is a bird habitat of the Anatidae family, whereas sixty percent of the plant species are indigenous, of which many are threatened (Ramsar Wetlands Information Sheet, 1992 4). Under the Ramsar

Convention, Whangamarino has the following wetland types: “Permanent rivers/streams/creeks; Seasonal/intermittent saline/brackish/alkaline marshes/pools; Seasonal/intermittent freshwater marshes/pools; Non-forested peatlands; Shrub-dominated wetlands; and freshwater, tree-dominated wetlands” (Ramsar Wetlands Information Sheet, 1992 4).

- Awarua (Waituna Lagoon): on the south east of the city of Invercargill, in the Southern Island, Waituna has around 3,556 hectares of peatlands, ponds/lakes and coastline (Ramsar Wetlands Information Sheet, 1992 1). It is titled as Waituna Wetland Scientific Reserve and is home of 150 species of native plants and migratory waders during the summer (Ramsar Wetlands Information Sheet, 1992 1). Awarua has the following wetland types: “Coastal brackish/saline lagoons; Non-forested peatlands; Shrub-dominated wetlands; Permanent saline/brackish/alkaline marshes/pools; Permanent freshwater lakes; Permanent rivers/streams/creeks; Sand, shingle or pebble shores; Estuarine waters; Intertidal mud, sand or salt flats; and intertidal marshes” (Ramsar Wetlands Information Sheet. 1992 1).
- Kopuatai Peat Dome and Adjoining Swampland: situated on Hauraki Plains in the North Island with nearly 9665 hectares, Kopuatai is a peat dome and the largest bog of New Zealand, and also a very important spot for conservation, since it sustains a unique type of vegetation in the world (Ramsar Wetlands Information Sheet, 1992 2). Kopuatai wetland types are: “Permanent rivers/streams/creeks; Seasonal/intermittent/irregular rivers/streams/creeks; Permanent freshwater lakes; includes large oxbow lakes; Seasonal/intermittent freshwater lakes; Seasonal/intermittent saline/brackish/alkaline marshes/pools; Seasonal/intermittent freshwater marshes/pools; Non-forested peatlands; Shrub-
- dominated wetlands; Freshwater, tree-dominated wetlands; and freshwater springs, oases” (Ramsar Wetlands Information Sheet, 1992 2).
- Firth of Thames: 52km from Auckland in the North Island with 7800 hectares, it is an important coastal area for migratory birds, with the following wetland types: “Permanent shallow marine waters; Marine subtidal aquatic beds; Rocky marine shores; Sand, shingle or pebble shores; Estuarine waters; permanent water of estuaries and estuarine systems of deltas; Intertidal mud, sand or salt flats; Intertidal marshes; Intertidal forested wetlands; Coastal brackish/saline lagoons; and permanent saline/brackish/alkaline lakes” (Ramsar Wetlands Information Sheet, 1991).
- Farewell Spit: at the Southern Island with 11388 hectares, Farewell Spit is a giant intertidal area in Golden Bay, with a shape of a kiwi's beak, and a spot for approximately 20 thousand migratory birds (National Wetland Trust of New Zealand, 2014) “Permanent freshwater marshes/pools; Seasonal/intermittent saline/brackish/alkaline lakes and flats; Intertidal marshes; Intertidal mud, sand or salt flats; and sand, shingle or pebble shores” (Ramsar Wetlands Information Sheet, 1992 3).
- Manawatu River Mouth and Estuary: on the west coast of Northern Island and about only 250 hectares, Manawatu is a birding place of 93 species, many of which are rare, and an area of saltmarsh and sand banks (National Wetland Trust of New Zealand, 2014). Under the Ramsar Convention, it has the following wetland types: “Intertidal marshes; Intertidal mud, sand or salt flats; Estuarine waters; and sand, shingle or pebble shores” (Ramsar Wetlands Information Sheet, 2005).

Table 1. Similarities and differences between definitions:

Location	New Zealand	Zambia	Brazil	Netherlands	China
Permanent or Temporary Inundation	+	+	+	+	+
Fresh Salt or Brackish Water	-	-	-	-	+
Poorly Drained Soils	-	-	-	+	+
Hydrophytes Vegetations	+	-	+	+	+
Excludes Rivers (creeks, streams etc)	-	+	-	+	-
Includes Artificial Wetlands	+	-	+	-	+
Includes lakes	-	-	-	-	+
Includes Ground-water	-	+	-	-	-
Specific Depth of Water	-	+	+	-	-

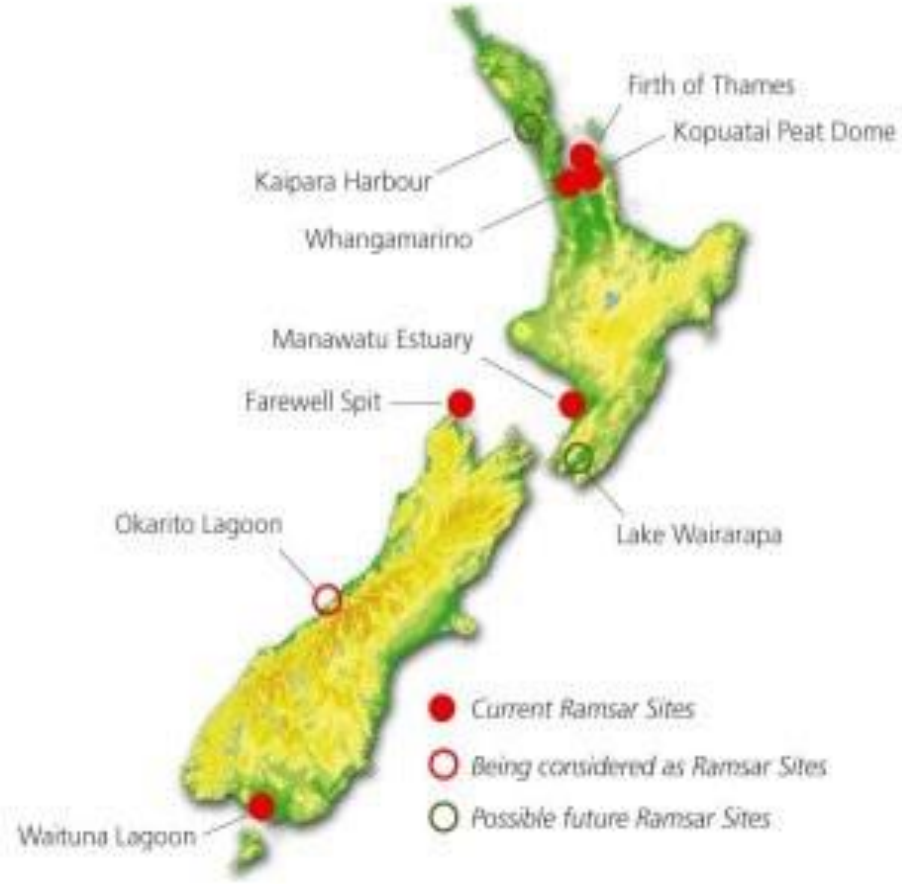

Figure 1: Map of wetlands in New Zealand. Source: National Wetland Trust of New Zealand. http://www.wetlandtrust.org.nz/Site/Ramsar_Convention.ashx

The table below summarises the information regarding New Zealand's wetlands.

Place	Designation Date	Wetland category	Flora type	Fauna type
Whangamarino	04/12/1989	Inland wetlands	"Supports rare/endangered species. Important in maintaining the geographic range of a plant species/community. Supports endemic species." [1]	"Waterbird wintering/non-breeding/dry season area; important for reptiles; supports rare/endangered species; breeding area for waterbirds; important for invertebrates; important for fishes; the wetland provides a critical link in a major food chain; supports endemic species." [1]
Awarua/Waituna	13/08/1976	Inland wetlands Marine & coastal wetlands	"Unique/last remaining example of a particular plant community. Important in maintaining the geographic range of a plant species/community. Supports endemic species." [1]	"Supports endemic invertebrate species; supports endemic bird species; supports rare/endangered bird species; supports endemic fish species; waterbird wintering/ non-breeding/dry season area; breeding area for waterbirds; moulting area for waterbirds; important for invertebrates; the wetland provides a critical link in a major food chain." [1]
Kopuatai Peat Dome	04/12/1989	Human-made wetlands Inland wetlands	"Unique/last remaining example of a particular plant community. Supports rare/endangered species. Supports endemic species" [1]	"Supports rare/ endangered species; aquatic mammals present; important for mammals; important for invertebrates; important for fishes; the wetland provides a critical link in a major food chain; supports endemic species" [1]
Firth of Thames	29/01/1990	Marine & coastal wetlands	No special values known	"Supports endemic bird species; supports rare/ endangered bird species; waterbird wintering/non-breeding/dry season area; breeding area for waterbirds; the wetland provides a critical link in a major food chain " [1]
Farewell Spit	13/08/1976	Inland wetlands Marine & coastal wetlands	"Supports rare/endangered species. Important in maintaining the geographic range of a plant species/community. Supports endemic species" [1]	"Supports rare/ endangered bird species; waterbird wintering/non-breeding/dry season area; roosting area for waterbirds; breeding area for waterbirds; moulting area for waterbirds; the wetland provides a critical link in a major food chain." [1]
Manawatu Estuary	25/07/1905	Marine & coastal wetlands	"Outstanding example of a particular plant community. Outstanding variety of species present. Important in maintaining the geographic range of a plant species/ community. The wetland provides a critical link in a major food chain. Supports rare/ endangered species." [1]	"Important for birds; staging area for migratory waterbird species; outstanding range of bird species; supports rare/ endangered bird species; outstanding range of fish species; important for fishes; supports rare/ endangered fish species; important for reproduction of fishes; outstanding zoogeographical interest for birds; waterbird wintering/ non-breeding/dry season area; breeding area for waterbirds; roosting area for waterbirds; supports endemic bird species; supports endemic fish species." [1]

[1] The Ramsar Sites Database: www.ramsar.wetlands.org/Database/SearchforRamsarsites/tabid/765/Default.aspx

Wetland Values and Uses

Wetlands in New Zealand are not only valued by its ecological and socioeconomic features, however by its cultural importance for the local Maoris. The Maori tribes are the Polynesian native people from New Zealand, who established there in early 10th century (Brown, 1991). Therefore, they are provided with food, weaving, medicines and building by the nation's wetlands (National Wetland Trust of New Zealand, 2014). Nevertheless, besides Maoris, native wildlife and flora also benefit from wetlands. The features of each wetland are vast, and described as follows:

Awarua/Waituna Lagoon:

Composed by peatlands, Awarua Plains is a habitat for several estuarine species since it consists of spit-bound lagoons and harbours (Department of Conservation, 1998). It has its vegetation controlled

by the drainage and height of the water table. Rush, sedges and bryophytes usually dominate the lower areas. The bittern (*Botaurus poiciloptilus)* and the fernbird *(Bowdleria punctata ssp*) breed in the location, although it is not diverse when it comes to wildlife (Ramsar Wetlands Information Sheet, 1992 1). Waituna Lagoon has a different environment, because it has tidal mudflats and also open to the sea, with 18 species of waders. The black swan *(Cygnus atratus)* and the grey duck *(Anas superciliosa)* are a highlight, and trouts are also present (Ramsar Wetlands Information 2 Sheet, 1992 1).

Moffat, Curran and Waituna Creeks compose the site catchment which flow into the lagoon, and the drainage network are developed on farmlands (Environment Southland, 2014). Coastal streams and rainfall feed the wetland, which maintains the quality of the water by recharging and discharging of groundwater; moreover, as social and economic values, the Maori people utilises the area for food source of brown trout on the Waituna Lagoon, which is used for fishery (Ramsar Wetlands Information Sheet, 1992 1).

Whangamarino:

It is a habitat with several and great areas of peat bog, and also swamp and mesotropic laggs (Duggan et al., 2013). It is an important spot for ten threatened species of plants and for breeding populations of the Australasian bittern (*Botaurus poiciloptilus)* (Duggan et al., 2013). Seed production of several plants and herbs, such as the water plantain *(Alisma plantago-aquatica)* and the willow weeds *(Polygonum* spp) for example, have a great importance to the black swans, grey teals, mallards, New Zealand shoveler ducks, and grey ducks (Duggan et al., 2013). Moreover, eighteen species of fish and several invertebrates also occupy the wetland, such as molluscs, the northern crayfish, Amphipods, freshwater crabs and water flea. It is also significant for endangered bird species (Ramsar Wetlands Information Sheet, 1992 4).

Furthermore, plants are adapted to live at a location unprovided with nutrients since the rainfall is the main source of water (Ramsar Wetlands Information Sheet, 1992 4). Whangamarino River behaves as a ponding area for the Waikato River and also the lake Waikare to flow until the catchment (Ramsar Wetlands Information Sheet, 1992 4). Whangamarino has an essential role controlling the flood from Waikato River, diminishing the loss from farms (Duggan et al., 2013). It was estimated at $3.8 million per year for its storage capacity (Duggan et al., 2013).

The rivers were used in the past for transport and recreation for the early Maori, whereas the wetland was a place even for battles of war due to the dense vegetation (Duggan et al., 2013). Nowadays, it is used for fishery, bird watching and recreational activities (Duggan et al., 2013).

Kopuatai Peat Dome:

Kopuatai Wetland consists of endemic and vulnerable vegetation species, such as the greater jointed rush *(Sporadanthus traversii)* and the clubmoss *(Lycopodium serpentinum),* however a kahikatea *(Dacrycarpus dacrydioides)* forest is still remaining in the area (Department of Conservation, 2014).

The only fish species in Kopuatai Peat Dome are the mudflsh *(Neochanna diversus),* the longfinned and shortfinned eels *(Anguilla dieffenbachii* and *A. australis)* (Ramsar Wetlands Information Sheet, 1992 2). These wetlands are significant as spawning area fot the inanga (*Galaxias maculatus)* and also for outside species of rodents, cats, possums and mustelids, since they have a negative effect for the native species (Ramsar Wetlands Information Sheet, 1992 2). Fifty four of bird species were registered thus far (Department of Conservation, 2014).

The wetland has two types areas, peatland and mineralised (Department of Conservation, 2014). The dome and the bog do not interact much and the hydrology is controlled by rainfall (Department of Conservation, 2014). The wetland has a mineralised part which is influenced by the river as it floods and, as a result, it contains more nutrients (Ramsar Wetlands Information Sheet, 1992 2). The mineralised wetlands and the peat dome's characteristics are essential for flood control as they store water from the Piako/Waitoa catchments (Department of Conservation, 2014).

As a social feature, the site was widely used by Maori people for food, transport and materials; it is still use for fishing and recreation nowadays (Ramsar Wetlands Information Sheet, 1992 2). However, the peat dome is also utilised for conservation, whereas the reserves are used for wildlife protection and recreation (Ramsar Wetlands Information Sheet, 1992 2).

Firth of Thames:

There are four main types of wetlands at the Firth of Thames: grass flats, shellbanks, estuarine water and mudflats, salt marsh and swamp, and mangrove forest (Ramsar Wetlands Information Sheet, 1991). Several species of birds use the shellbanks as high tide roosts, since the Firth of Thames is an essential coastal zone for shorebirds with seventy four registered species (Department of Conservation, 2014).

Rails and marine fish have a shelter provided by the mangrove and salt-marsh areas, whereas waders and waterfowls can have food on the sand flats and intertidal mud (Department of Conservation, 2014).

The wetland is nowadays flown by the Waihou, Piako and Waitakaruru rivers, which establishes the biological feature and value with the north west wave (Ramsar Wetlands Information Sheet, 1991). It prevents erosion and sediment trapping, besides supplying birds and fishes with

food and habitat (Ramsar Wetlands Information Sheet, 1991).

Firth of Thames is a home for several traditional tribes and also significant wildlife. Besides having a scientific and educational value, it has a large commercial use for fishery (Ramsar Wetlands Information Sheet, 1991).

Farewell Spit:

The Spit shelters over ninety species of birds, some of which are migratory (Department of Conservation, 2011). The waders are the most important migratory species, coming from Siberia and Alaska to the intertidal zone searching for food such as molluscs and small crustaceans (Department of Conservation, 2011). Besides waders, caspian and White-fronted terns, gannets, and black swans are present in the area.

The dry areas were transformed since the cattle was removed, and nowadays the area is recovering, with predominant species such as the marram grass *(Ammophila arenaria)* and lupin *(Lupinus arboreus),* manuka *(Leptospermum scoparium),* kanuka *(Kunzea ericoides),* flax *(Phormium tenax),* bracken *(Pteridium aquilinum var esculentum),* sedges *(Carex* spp.) and herbs (Ramsar Wetlands Information Sheet, 1992 3).

The wetland is located on the Golden Bay which creates a lagoon, and plays a key role in food chains. The sandspit's landscape is culturally valued and, in the past, it used to have sealing and whaling (Ramsar Wetlands Information Sheet, 1992 3).

Manawatu River Mouth and Estuary:

Manawaty is very diverse when it comes to birds, as it has ninety three registered species (Infomation Sheet on Ramsar Wetlands, 2005). However, there are 13 species of birds, 6 species of fish and 4 species of plants in Manawatu that are listed as threatened (Information Sheet on Ramsar Wetlands, 2005).

The wetland has the largest saltmarsh area in New Zealand, which maintains the local biodiversity (Infomation Sheet on Ramsar Wetlands, 2005). Moreover, it is the only location which enables wintering, passage and breeding waterbirds (Information Sheet on Ramsar Wetlands, 2005).

The Manawatu river drains the Tatarua and Ruahine Ranges, and has a flood control and sediment trapping role (Information Sheet on Ramsar Wetlands, 2005). Cropping, forestry, fishery and dairy farming are the main use from the towns the river goes through (Information Sheet on Ramsar Wetlands, 2005). On the other hand, it has a spiritual value for Maori people and is a essential part of the tribes' region (Information Sheet on Ramsar Wetlands, 2005).

Wetland Threats

Wetlands are continuously under threat due to economic pressures, population development and invasive species, and half of them have been destroyed around the world in the past century (WWF). It is not different for New Zealand's wetlands, and the threats listed in the Ramsar Wetlands Information Sheets are :

Whangamarino: Energy developments/proposals have been a pressure, as it is among them; coal is transported through the wetland. Another coalfield is being assessed and also an opencast mine. The reduction of the water level is a concern. Willows and exotic species are invading the mineralised area. Rare and endangered plant species demands protection from any human activity.

Firth of Thames: Past deforestation has resulted in sediment deposition and loss of habitat, and landslides are taking place in the catchment area. The mangroves are also affected by stock grazing. In the surrounding area, mining, land and house development could be possible threats, and also water pollution from farming.

Awarua/Waituna: Drainage and bushfire have been occurring in the past years. Waituna Lagoon is also under significant water fluctuations due to sea exit blocking. It can be good for breeding of black swans, however not good for waders, as the mudflats turns to be hidden. The weed species of gorse *(Ulex europaeu)* also have a negative effect on the native plants in bad tidal conditions. Weed species are also an issue, as well as ploughing, sowing grass and draining. Mining could also be a threat.

Kopuatai Peat Dome: The main threat to Kopuatai is drainage, where the mineralised area is the most affected. Low water levels is also an issue. Peat mining, bushfires and tuberculosis infecting possums area serious danger to the wetland.

Farewell Spit: The gorse *(Ulex europeus),* blackberry *(Rubus fructicosus)* and the climbing dock were introduced and are a concern. The red deer and hares were also introduced and can put native plant species in danger. Shipping also occurs in the area and oil spill and plastics dumping can be a result from it. Fires and cockle harvesting can also affect the marine food chains.

Manawaty Estuary: Invasive plant species are a threat for the benthic fauna. Domestic livestock is damaging natural areas and introducing the invasion of *Agrostis stolonifera* and *Festuca arundacea*. *Gambusia* (mosquito fish) is present in the catchment area and can potentially invade the estuary. Manawatu River travels through towns and one city, all of which releases treated waste; if not well managed, it can represent a threat to the water quality. Off road vehicles also damage the coastal dunes and impede the growth of vegetation.

Wetland Management

As wetlands are under continuous economic and social pressures, a few measures have been undertaken for conservation and protection porpuses. Under the Ramsar Wetlands Information Sheets, the following management procedures are being executed:

Awarua/Waituna Lagoon: There is limited

accommodation at the reserve to control the number of people, although it is not prohibited. Isolation is also made to assure the least disturbance. The water levels, nesting gulls and past bushfires are also monitored.

Firth of Thames: Birds were benefited by grazing the grass roost. A 30 hectare coastal reserve was included was part of the wetland, and also a 27.7 hectare farm was set under conservation nearby the sea, as an agreement to maintain the integrity of the area. The Kaiaua-Miranda coastline had its importance recognised. A proposal was either made to protect the area from the seaward to the terrestrial margin; some of the measures are creating tracks and interpretative trails and planting activities with indigenous plants.

Whangamarino: Willow and fire control, licencing for game bird shooting, licencing and leasing for grazing, and monitoring wildlife are some of the measures under execution. Bird and plant species are being monitored for bushfires. Limits are established for fish games regarding quantity and time of game. A few measures were proposed although not yet implemented, such as the water levels to be restored; to change the wetland name to "Government Purpose Reserve, Wetland Management"; to replace exotic species with native ones; and attaching wetlands to protect endangered species.

Kopuatai Peat Dome: To control the impact in the area, the entry permission must be obtained. Game-bird hunting is also permitted only with license. The huts accommodation are under regulations of the Department of Conservation. A few areas are grazed for weed control. Measures have been proposed to map and describe the hydrology of Kopuatai, as well as the bog dynamics, such as depression, peat flow direction and water retention attributes. Water level and water quality for potential development are also under study to be implemented. The cryptogams of the area also need to be described. Tuberculosis and possums control also need efforts to be established.

Farewell Spit: the traffic of people to the lighthouse is controlled. The Puponga Farm Park was joined to the wetland and is a recreational reserve. An existing propose is to investigate the entire North West South Island besides the wetland, to eventually change the protected area legislation.

Manawatu Estuary: the Crown land is inside a river channel, due to shifting channels. The aquatic weed *Spartina angelica* is being controlled with aerial spraying. The bird feeding ground is also being cared from off-road vehicles, and two of them agreed to restrict their activities. Vehicles are also being prevented to pass through a mudflat feeding ground. Is being proposed that the management takes place with three agencies, to facilitate the monitoring process; a visitor centre is also being proposed to expose the wetland's values and create awareness to its significance.

Acknowledgement

The authors are grateful to Griffith University

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