The Gwydir Wetlands and Macquarie Marshes

Introduction

The Gwydir Wetlands and Macquarie Marshes occur on flat open floodplains containing highly mobile water channels. Each of these wetland systems is often defined as a specific region, but within each system flood inundation patterns are highly variable. This means that not all areas within these regions are inundated with the same duration, frequency, extent or predictability.

In this publication, the broad areas that are used when describing the Gwydir Wetlands and the Macquarie Marshes are those that were mapped by Kingsford *et al.* (2003) according to the presence of water between 1987 and 1994.

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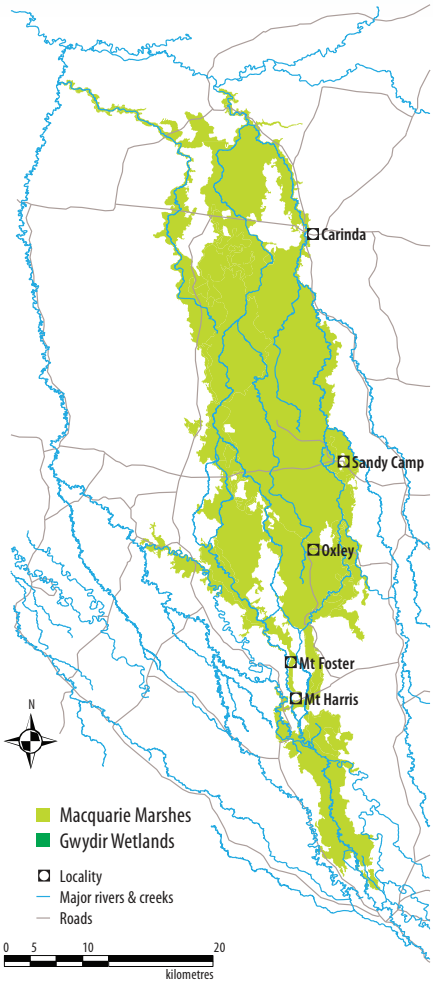
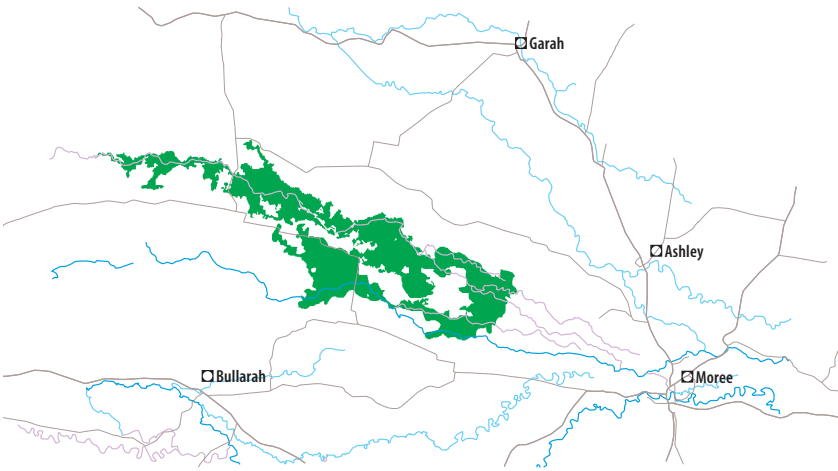




In the Gwydir Wetlands, the area containing core healthy 'semi-permanent' wetland vegetation has decreased from an estimated 14,000 ha in 1996 to only 3,500 ha in 2005 (DECC 2009a).

In the Macquarie Marshes, the area of semi-permanent wetland vegetation has declined from around 72,000 ha in the early 1990s to an area of less than half this size that could be described as being of fair condition or better in 2008 (DECC 2009b).

Soils

The cracks in Vertosols (Isbell 1996) swell closed during wetting and open as they dry because of the soil clay content and clay type. This means that these soils are able to develop structure over a number of wetting and drying events. So when these soils become compacted or pugged, they can re-develop structure. Soil structure is important in all soils and structure can help to provide oxygen to plant roots even when soils are flooded.

Sodic soils have more than 6% exchangeable sodium and are dispersive. These soils can be easily eroded and compacted, and are difficult to manage.

Different soil groups in these wetlands

In these guidelines the soils of the Gwydir Wetlands and Macquarie Marshes are mapped as seven groups based on differences in flooding frequency and behaviour.

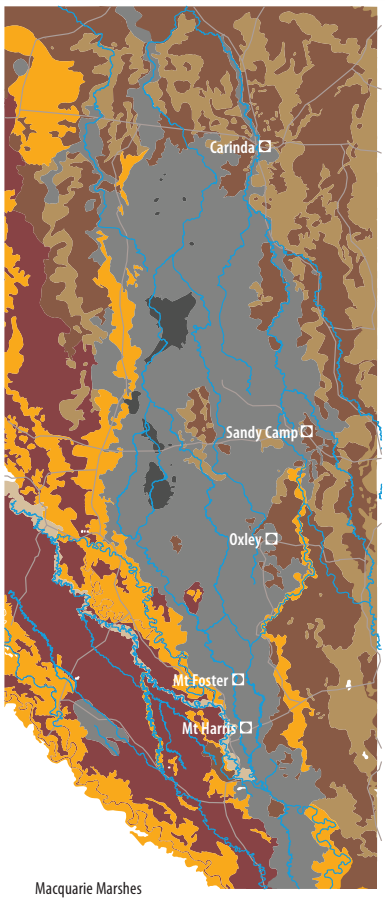
Black Vertosols (Isbell 1996) tend to occur in both wetland areas where flooding is more permanent. These soils are strongly structured heavy clays that crack extensively as they dry, can form gilgais or 'crab holes' but are easily eroded. These soils are very fertile.

Grey and Black Vertosols (Isbell 1996) is the most common soil group in these wetlands and broadly represent the more semi-permanent wetland areas. These soils have properties that are very similar to the Black Vertosol group. These soils are very fertile.

Brown and Grey Vertosols (Isbell 1996) are much older than the other Vertosols in these wetland areas. These soils are strongly structured heavy clays that crack as they dry. They can form gilgais or 'crab holes' but are easily eroded and subsoil sodicity is common.

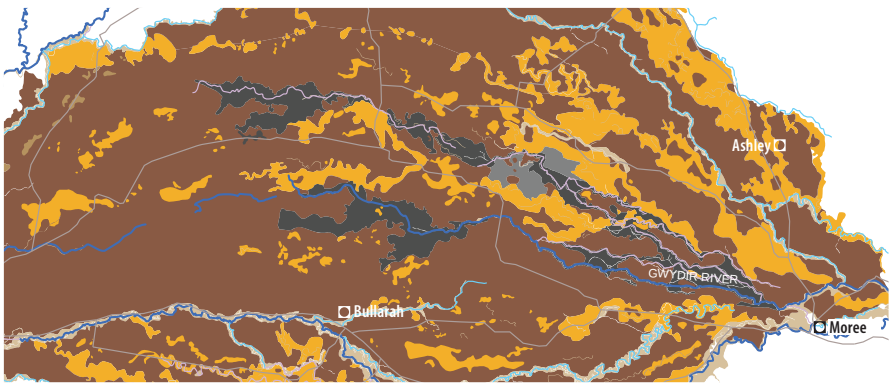
Grey, Brown and Black Vertosols (Isbell 1996) are similar soils to the Grey and Black Vertosols but are flooded infrequently. These soils are very fertile.

Brown and Grey Dermosols and Chromosols (Isbell 1996) occur along the edges of some creek systems. These soils contain less clay than any of the Vertosols and do not tend to develop large cracks as they dry. Subsoil sodicity is localised.



Macquarie Marshes

- Black Vertosols
- Red and Brown Kandosols and Chromosols
- Grey and Brown Dermosols
- Brown, Grey and Black Vertosols
- Grey and Black Vertosols
- Grey and Brown Vertosols
- Red and Brown Chromosols



Gwydir Wetlands

- Black Vertosols
- Brown and Grey Chromosols
- Brown and Grey Chromosols and Dermosols
- Brown, Grey and Black Vertosols
- Grey and Black Vertosols
- Grey and Brown Vertosols
- Red and Brown Chromosols

Locality
Major rivers, creeks, intermittent
Roads

0 10 kilometres

N

The Nyngan Soil Landscape Map and Draft Walgett Soil Landscape Map were used with permission of the Central West Catchment Authority and the Department of Environment and Climate Change NSW, 2009. Draft Border Rivers-Gwydir Soil Reconnaissance mapping was used with permission of the Department of Environmental and Climate Change NSW, 2009. Cadastre information is used with the permission of the NSW Department of Lands, 2009.

Red and Brown Chromosols (Isbell 1996) occupy higher parts of the landscape and tend to form clay pans. Surface sodicity is common and subsoil sodicity is widespread. Subsoil salinity is common. These soils are extremely fragile and should be managed differently to other soils.

Red and Brown Kandosols and Chromosols (Isbell 1996) occur as red sandy ridges throughout both wetlands. These soils are easily degraded and are hard-setting.

Soil constraints in the Gwydir Wetlands and Macquarie Marshes

Three potential soil problems in the Gwydir Wetlands and Macquarie Marshes are erosion, compaction and pugging, and salinity.

Erosion is a potential issue in most areas of the Gwydir Wetlands and Macquarie Marshes. It leads to decreased water quality for aquatic plants and animals by increasing the turbidity of water.

Erosion causes incisions through wetlands and floodplains that affect flooding during different flows through diversion of water. Incised channels can cause water to drain from flooded areas of wetlands and influence water movement across entire wetland areas.

There are four factors that influence erosion in the Gwydir Wetlands and Macquarie Marshes:

- reduced extent of semi-permanent wetlands that means there is less vegetation to slow flood waters;
- clay soil types dominating these wetland areas are easily disturbed and eroded;
- animals moving through wetlands create pathways, and disturb channel banks and wetland margins; and
- water flow regime.

Compaction is caused by animals or machinery continually moving across damp or wet soils. It is often observed on the banks of waterways and dams or around trees where domestic animals congregate.

Pugging is compaction on a small scale. It occurs where animals move in saturated soils and these soils become bogged. Pugging occurs around the margins and shallows of wet areas.

Compaction and pugging:

- cause increased soil density and a reduction in air-filled porosity which can lead to increased water-logging (lack of oxygen in wet soils); and
- can be detrimental to plant growth or support weed invasion.

The type of soils that occur in and around wetlands determines the long-term effects of compaction and pugging. Vertosols can overcome compaction or pugging problems if animals or machinery are removed from an area and the soil has the opportunity to go through a number of wetting and drying cycles.

The Chromosols, Kandosols and Dermosols are generally unable to re-develop structure without assistance from soil flora and fauna (e.g. termites and worms). Compaction and pugging can potentially have long lasting effects on plant growth in these areas, even if animals are excluded.

Turbidity is a measure of the suspended solids or 'muddiness' of a solution.

Sodic clay-pans (NSW DPI)

Turbid water (NSW DPI)

Cattle pugging around the edge of a wetland (NSW DPI)

Salinity has been identified in some parts of both wetland areas and can have serious consequences for land management.

Scattered salinity sites have been identified in the Gwydir Wetlands. More information can be obtained from the Border Rivers-Gwydir Catchment Management Authority.

The Australian Bureau of Rural Sciences has identified some level of salinity risk in the Macquarie Marshes (BRS 2009). More information can be obtained from the Bureau of Rural Sciences or from the Department of Environment and Climate Change NSW.

Climate

The Gwydir Wetlands and Macquarie Marshes are complex episodic wetlands in the semi-arid climatic zone of NSW. Climatic conditions can vary significantly both within and around each of these wetlands. Significant flooding and extreme drying has been recorded since explorers and squatters began frequenting the Gwydir Wetlands and Macquarie Marshes from the1830s.

In almost all cases, local rainfall is insufficient to maintain semi-permanent wetland vegetation in either the Gwydir Wetlands or Macquarie Marshes. The main driver of these wetlands is flood waters from rain on the tablelands and slopes of each river system. In the Gwydir Wetlands, flooding has generally occurred during late spring and summer, while in the Macquarie Marshes most flooding has tended to occur during late winter and spring. In both areas, flooding:

- is semifrequent and unpredictable; and
- volumes are highly variable.

	Town	Summer °C	Winter °C	Rainfall mm	Annual Pan Evaporation mm	Frost* days
Gwydir Wetlands	Moree	20–34	4–18	580	>1750	25
	Collarenebri	21–36	4–18	510		
Macquarie Marshes**	Quambone	20–35	4–16	440	>1900	20–30

Summarised climate information (from Bureau of Meteorology 2009)

* Frost limits the growth of most wetland plant species.

** There are no official records for the western edge of the Macquarie Marshes. Unofficially the average rainfall 50 km west of Quambone is approximately 415 mm per year.

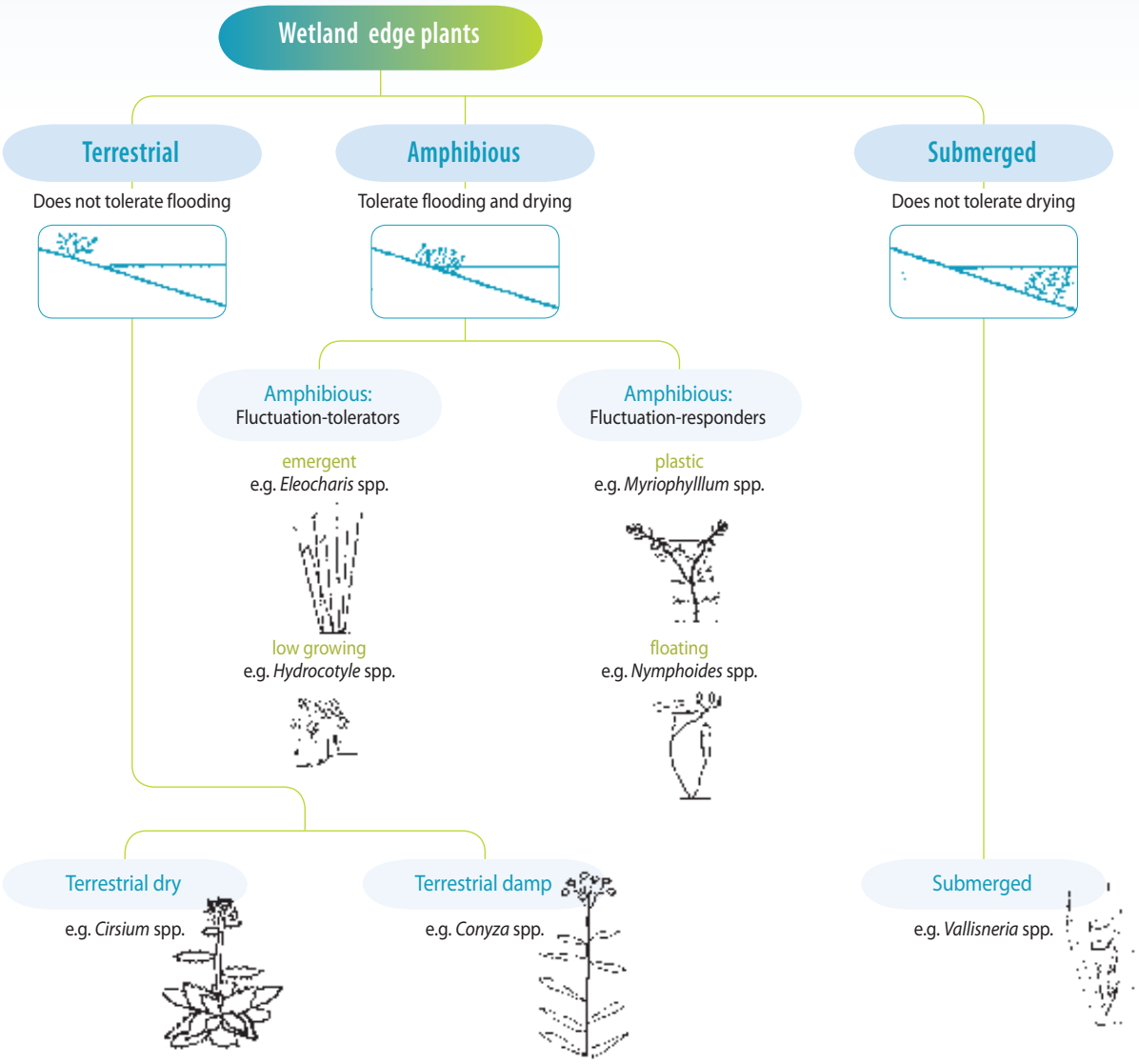
Gwydir Wetlands in flood (Liz Savage, BRG CMA)

Different plant communities

The types of plant communities occurring in different areas of the Gwydir Wetlands and Macquarie Marshes grow in response to changes in the moisture regime along gradients. Changes in moisture levels along a gradient from the wettest parts of a wetland to the margins create conditions that are favourable for the germination and growth of some species but that are unfavourable for other species. Conditions or cues that stimulate seed germination and plant growth are:

- flooding;
- rainfall;
- temperature;
- day length; and/or
- water depth.

For example, plant species that do not tolerate flooding germinate and grow in drier more elevated areas in and around, wetlands in response to rainfall, temperature or day length. These are **terrestrial plants** such as Bladder Saltbush, Curly Mitchell Grass and Ruby Saltbush. Plants that require flooding grow in the lower areas of a wetland where water depth may be the growth cue. **Submerged plants**, such as Ribbon Weed, cannot tolerate drying. Other plants that can tolerate both flooding and drier conditions are found in between these other communities and may grow in response to one or all of the conditions. These are the **amphibious plants** such as Marsh Club-rush and Common Reed.



Terrestrial plants in wetlands

Terrestrial plants are unable to tolerate flooding because of the anaerobic soil conditions that develop. These plants grow predominantly in regions that are never flooded or that are only flooded for very short periods.

Seeds of terrestrial plants are carried by wind or water into wetland areas and form part of the seed bank. Seeds remain in the soil and germinate when conditions are suitable. Examples of terrestrial plants in the Gwydir Wetlands and Macquarie Marshes are:

- Spear (or Black) Thistle;
- Boggabri;
- Climbing Saltbush; and
- Noogoora Burr.

The seed bank includes all un-germinated seed in soil and it plays a vital role in the ability of wetland ecosystems to recover from disturbances such as droughts, floods, fires and grazing.

Plant growth stages

There are three recognised stages of plant growth. The first is called the germination and establishment stage, which refers to the development of the root system, stems and leaves. At this stage, plants begin to photosynthesise. The energy for initial growth comes from stored reserves in the seed or rhizome.

The second stage is called the vegetative growth stage, when the stem and root systems increase their size dramatically. Any excess energy is stored in leaf and root matter. The energy for this growth is derived through photosynthesis. Plants at this growth stage are most easily digested.

The third stage refers to dormancy (perennial plants) or senescence (annual plants):

- Dormancy means that only very limited plant growth occurs. Perennial plants store energy in the root system (rhizomes) and structural carbohydrates in the stems and/or leaves. Structural carbohydrates cause the plant to become 'woody' and both digestibility and palatability decrease.
- Senescence means annual plants must seed. Seeds are energy rich, but any remaining plant material often has low digestibility and palatability.

Spear (or Black) Thistle (NSW DPI)

Noogoora Burr (NSW DPI)

Bladder Saltbush (NSW DPI)

Cup (or Spring) Grass (NSW DPI)

Amphibious plants in wetlands

Amphibious plants occur from the edge of flooded areas in all water depths. The two main categories of amphibious plants are:

Flood responders: plants that may change the form of growth. These plants grow laterally over the soil surface as wetlands dry, but respond rapidly to flooding and grow vertically as the water depth increases. The leaves of these plants float on the surface and roots occur at plant nodes. Examples of amphibious flood responding plants include:

- Water Milfoil; and
- Water Primrose.

Flood tolerators: plants whose growth is characterised by increasing height, thereby keeping their leaves above the water at all times. The roots of these plants are adapted to tolerate flooded conditions for time periods that range from only brief or temporary inundation through to almost permanent inundation. Examples of amphibious flood tolerating plants include:

- Cumbungi;
- Knotweeds;
- Floating Pondweed;
- Spike Sedges; and
- Swamp Buttercup.

Submerged plants in wetlands

Submerged plants are likely to occur only at sites that are flooded for extended periods of at least weeks to months. These species can flower and seed underwater in some conditions, or they can flower and produce seed on soil exposed as the floodwater levels recede. Plant species in this functional group do not tolerate drying. Examples of submerged wetland plants include:

- Ribbonweed; and
- Waterwort.

It is recognised that increases in the turbidity of wetland water is associated with reduced diversity among submerged wetland plant communities. Turbidity can decrease the amount of light available for photosynthesis and smother submerged communities growing on the soil surface below flooded wetlands. Turbid wetlands favour those plant species that have leaves closer to the water surface.

Response of plants to flooding

Summer flooding

Many of the native plant species that dominate the Gwydir Wetlands and Macquarie Marshes are summer growing. Flooding in late winter, spring and/or summer results in rapid and vigorous growth of key perennial wetland species such as:

- Common Reed;
- Cumbungi;
- Marsh Club-rush;
- Ribbed Spike-sedge; and
- Water Couch.

Water Milfoil (NSW DPI)

Cumbungi (NSW DPI)

Swamp Buttercup (NSW DPI)

As the timing of flooding becomes later during summer, the growth response of these plant species becomes less vigorous and the amount of seed set is usually less (McCosker 1996, 1999a, 1999b).

In some cases, common species will be absent or sparse (e.g. Water Couch or Spike Sedge). In these parts of a wetland, summer flooding favours the germination and growth of a range of annual or semi-annual amphibious plants. Common examples of these species are:

- Brown Beetle Grass;
- Dirty Dora;
- Jerry-jerry;
- Nardoo;
- Sesbania Pea;
- Starfruit;
- Common Water Milfoil; and
- Willow Primrose.

Brown Beetle Grass (NSW DPI)

In wetland areas that are flooded for only short periods, summer flooding favours vigorous growth of native grass species such as (McCosker 1996, 1999a, 1999b):

- Native Millet; and
- Warrego Summer Grass.

Winter flooding

Flooding of the Gwydir Wetlands and Macquarie Marshes is generally less common during autumn and early winter than during late winter, spring and/or summer.

Temperatures are lower during winter and flooding tends to favour frost tolerant species. Examples of these species are:

- Marsh Club-rush;
- Ribbed Spike-rush; and
- Swamp Buttercup.

During winter flooding events, the growth of summer species is very limited and the growth response can be significantly delayed. Examples of species affected by lower temperatures are:

- Sesbania Pea;
- Water Couch; and
- Water Primrose.

Flood frequency

Frequency of flooding can alter the balance between amphibious and terrestrial plant species in a wetland. McCosker (1996, 1999b) studied the impact of flooding events on plant communities in the Gwydir wetlands and found:

- Regular flooding favours amphibious wetland species helping to maintain their dominance over the terrestrial species.

Sesbania Pea (NSW DPI)

Starfruit (NSW DPI)

Water Primrose (NSW DPI)

- Flooding appears to be the agent most responsible for producing major changes in wetland plant communities over short time scales of weeks to months.
- When flooding occurs, wetland vegetation condition dramatically changes from a system dominated by a combination of native terrestrial species such as Black Roly-poly and introduced weed species such as thistles (e.g. Spear Thistle) to one dominated by native perennial amphibious species such as Water Couch and Flat Spike-sedge when flooding occurs. The response of these amphibious species was observed to be much slower at sites that had not been flooded in earlier years or where amphibious plant species only made up a small component of the total plant biomass.

Plant species on the margins of inundated areas and on the surrounding flood plains show variable responses to flooding. Generally:

- Native grasses are not adversely affected as they are able to withstand more prolonged flooding (McCosker 1996). Examples of these species are:
  - Weeping Lovegrass;
  - Native Millet; and
  - Warrego Summer Grass.
- Native shrubs rapidly colonise and become dominant after summer rainfall or short-duration flooding events. Examples of these species are:
  - Black Roly-poly; and
  - Soft Roly-poly.

  These species grow rapidly in response to summer rainfall but are extremely sensitive to flooding and, where saturated soil conditions occur, these plants are rapidly killed.
- Observed responses of some introduced weed species to grazing exclusion in the Gwydir Wetlands indicates that these plants are killed by flooding (e.g. Bathurst Burr, Spear or Black Thistle, Noogoora Burr and Variegated Thistle).

Flood depth

Water depth influences the response of plant communities to flooding in a wetland, for example:

- Common Reed and Tall Spike-sedge are the main species that grow in deeper waters (greater than 1 m) for long periods. These plant species can also withstand periods of drought.
- Lignum is tolerant of drought periods but requires flooding for vigorous growth. Lignum is the most important shrub for waterbird nesting.
- Lippia is an undesirable introduced plant species that competes effectively with native plants. It grows in direct competition with plants like Water Couch and Flat Spike-sedge across wetland meadows. The depth of water appears to influence the competitive ability of Lippia and observations have indicated that at water depths of less than 10 cm, Lippia shows vigorous growth. However, as water depth increases, Lippia becomes submerged and is less competitive.

Species observed in locations where water depth is shallow and the duration of flooding brief include:

- Dirty Dora; and
- Water Couch.

Variagated Thistle (NSW DPI)

Tall Spike-sedge (NSW DPI)

Warrego Summer Grass (NSW DPI)

Response of plants to rainfall

Summer rainfall and wetland communities

Local spring and summer rainfall rarely result in significant floods in either the Gwydir Wetlands or the Macquarie Marshes. Rather, rainfall generally coincides with the time when the most rapid growth of many wetland species is expected in response to flooding. In cases where wetland soil moisture is derived from rainfall alone, plants respond differently.

Some amphibious tolerator species can respond to rainfall, but their growth and vigour is usually slow and often these species survive rather than thrive. These tolerator plants, together with terrestrial species, will tend to be favoured over flood responding species when good summer rainfall is not accompanied by flooding (McCosker 1994). Examples of tolerator species are:

- Common Couch; and
- Sesbania pea.

Common Nardoo and Dirty Dora become more prevalent around shallow pools that may form following summer rainfall. Perennial grass species (e.g. Water Couch) will break winter dormancy and commence growing in response to spring and summer rainfall. The growth of these plants is less vigorous than when growth occurs in response to flooding.

Terrestrial plant communities that respond to summer rainfall are often dominated by grass species:

- Box Grass;
- Curly Windmill Grass;
- Queensland Bluegrass; and
- Windmill Grass.

Other terrestrial plants that may become prevalent following rainfall in the spring and summer months include:

- Black Roly-poly;
- Soft Roly-poly;
- Climbing Saltbush.

Summer rainfall and introduced plants

Many introduced weed species respond quickly to summer rainfall and compete strongly with native plants. For example, Lippia has the ability to extract water from depth due to a deep tap root system and can expand and flower when many competitor species exhibit reduced growth. Other introduced species can complete their lifecycle and disperse their seeds when moisture in a wetland results from rainfall. Examples of these species include:

- Bathurst Burr;
- Spear Thistle;
- Noogoora Burr; and
- Variegated Thistle.

Response of plants to winter rainfall

Germination of many wetland plant species is associated with periods of sustained soil moisture (Capon 2003). Therefore, the composition of the plant community following winter rainfall is a reflection of the germination requirements of species present and the tolerance of these plants to environmental conditions.

Windmill Grass (NSW DPI)

Box Grass (NSW DPI)

Common Couch (NSW DPI)

Many of the wetland plant species that grow vigorously in the warmer months of the year tend to show only a limited response to autumn and winter rainfall. Species such as Water Couch are frost sensitive and tend to be dormant during winter. Some grass species respond strongly to one or more years of good winter rainfall. These species seed prolifically and become more common (e.g. Blown Grass).

Introduced species (e.g. Medics) grow prolifically following autumn or winter rainfall.

A different blown grass species (*Lachnagrostis aemula*) has been associated with a condition called floodplain staggers. Nematodes carry bacteria into flowering seed heads. These bacteria produce a toxin which is potentially fatal to livestock.

Animals

Wetlands provide habitat, food and breeding areas for insects, crustaceans, amphibians, reptiles, fish, birds, and mammals. Ecosystem populations vary depending on the:

- duration and frequency of wetting and drying periods;
- wetland size;
- plant species;
- threats;
- food availability; and
- water quality.

Reducing populations of any animals or plants can influence the viability of other species. For example, in the Macquarie Marshes, Red-bellied Black Snakes (*Pseudechis porphyriacus*) eat frogs. Frogs are an indicator of healthy systems because of their sensitivity to changes in water availability. Landholders throughout the Macquarie Marshes report a significant reduction in the number of Red-bellied Black Snake sightings during extended dry periods and associate this reduction with reduced levels of wetland flooding and fewer frogs.

Insects and crustaceans

Insects and crustaceans occur toward the bottom of food chains. Flood events increase the populations of these species. These populations are an important food source for breeding water birds. Species that feed on insects, crustaceans and small fish include:

- turtle species: feed on water beetles and small fish; and
- heron and egret species: feed on fish, insects and spiders.

Dragon fly, Gwdir Wetlands (NSW DPI)

Queensland Bluegrass (NSW DPI)

Healthy wetlands (NSW DPI)

Golden orb weaver, *Nephila plumipes* (NSW DPI)

Reptiles

The Macquarie Marshes and the Gwydir Wetlands support many reptiles, including turtles, geckos, dragons and snakes.

Reptiles are an important indicator species. For example the Eastern Snaked-necked Turtle (*Chelodina longicollis*) is common in the Gwydir Wetlands. This turtle is carnivorous with a diet consisting of insects, worms, tadpoles, frogs and small fish that it swallows whole or shreds with its clawed front feet. The presence of turtles in the Gwydir wetlands depends on the existence of at least some prey species.

Examples of other reptiles in these wetlands include:

- Common Goanna (*Varanus varius*);
- Eastern Brown Snake (*Pseudonaja textilis*);
- Eastern Water Dragon (*Physignathus lesueurii*);
- Murray-Darling Carpet Snake (*Morelia spilota metcalfei*); and
- Sand Goanna (*Varanus gouldii*).

Frogs

Frogs are an important food source for water birds and for snakes. The Gwydir Wetlands and Macquarie Marshes are characterised by diverse and abundant frog populations. Each contains at least fourteen different species. The most common frog species are:

- Barking Marsh Frog (*Limnodynastes fletcheri*);
- Broad Palmed Frog (*Litoria latopalmata*);
- Crucifix Frog (*Notaden bennettii*);
- Green Tree Frog (*Litoria caerulea*);
- Salmon Striped Frog (*Limnodynastes salmini*);
- Spotted Marsh Frog (*Limnodynastes tasmaniensis*); and
- Water-holding Frog (*Cyclorana platycephala*).

Landholders in the Macquarie Marshes believe that frog populations have greatly reduced during the last ten years. This has impacted on the populations of predators, and there has reportedly been a large fall in the population of Red-bellied Black Snakes.

Fish

Freshwater wetlands and floodplains can contribute thousands of wild, healthy native fish to river systems. Fish productivity is likely to underpin the breeding of fish-eating waterbirds such as Cormorants and Egrets.

However, the interaction between fish and wetland habitats is still relatively poorly understood. Freshwater wetlands and floodplains provide feeding, spawning and nursery areas for many species of freshwater fish. One key source of food for juvenile fish is the micro-invertebrates that are supported in very large densities across inundated floodplain habitats of the Macquarie Marshes (UNSW 2009).

Green Tree Frog, *Litoria caerulea* (NSW DPI)

Crucifix Frog, *Notaden bennettii* (Darren Shelly, DECC)

Water-holding Frog, *Cyclorana platycephala* (Darren Shelly, DECC)

Barking Marsh Frog, *Limnodynastes fletcheri* (Darren Shelly, DECC)

Native fish

Common native fish species that occur in the Gwydir Wetlands (Spencer and Heagney 2009, Wilson *et al.* 2009a, Wilson *et al.* 2009b) are:

- Australian Smelt (*Retropinna semoni*);
- Bony Bream (*Nematolosa erebi*);
- Eel-tailed Catfish (*Tandanus tandanus*);
- Murray River Rainbowfish (*Melanotaenia fluviatilis*);
- Unspecked Hardyhead (*Craterocephalus stercusmuscarum fulvus*);
- Spangled Perch (*Leiopotherapon unicolor*); and
- Western Carp Gudgeon (*Hypseleotris* spp.).

Silver perch (*Bidyanus bidyanus*) had previously been recorded in the wetlands, but were not observed during a 2006–2009 study (Wilson *et al.* 2009a).

Native species recorded in the Macquarie Marshes include:

- Murray Cod (*Maccullochella peeli*);
- Golden Perch (*Macquaria ambigua*);
- Silver Perch (*Bidyanus bidyanus*); and
- Eel-tailed Catfish (*Tandanus tandanus*).

Introduced fish

In 1997, the Macquarie Marshes Land and Water Management Plan indicated that introduced fish species dominated the ecosystem. A more recent survey found that native fish were outnumbered by exotic species 3:1 (Rayner *et al.* 2008).

The Gwydir wetlands have much smaller proportions of introduced fish (Spencer 2007, Spencer 2008) than the Macquarie Marshes. Spencer found that introduced fish accounted for less than 30% of the total fish number at most sites she investigated. However, Wilson *et al.* (2009a) noted that introduced fish (most commonly carp) accounted for around 54% of fish biomass in the channels of the Gwydir Wetlands.

Research indicates that Common Carp breed in wetlands and NSW DPI (2007) has identified ten carp-breeding hot-spots in NSW. Four of these are internationally recognised wetlands: the Barmah-Millewa forest, Gwydir wetlands, Macquarie Marshes and Namoi wetlands. There is an extremely large concentration of carp in these hot-spots, and at one site the study estimated that there were 30,000 carp larvae per megalitre of water.

Common Carp, *Cyprinus carpio* (NSW DPI)

Silver Perch, *Bidyanus bidyanus* (NSW DPI)

Bony Bream, *Nematolosa erebi* (NSW DPI)

Murray Cod, *Maccullochella peelii peelii* (NSW DPI)

Murray Darling Rainbowfish, *Melanotaenia fluviatilis* (NSW DPI)

Introduced fish present in the Gwydir Wetlands and Macquarie Marshes include:

- **Common Carp** (*Cyprinus carpio*): widely believed to have detrimental effects on aquatic plants and animals, particularly through their destructive feeding habits. Carp are found in degraded areas.
- **Mosquito Fish** (*Gambusi holbrooki*): have a high reproductive rate, are considered habitat generalists and compete with other aquatic animals for food. They are highly successful breeders and give birth to live young. Mosquito Fish are aggressive and interfere with the activities of other aquatic animals. Mosquito Fish are known to prey upon the eggs and juveniles of other fish species and have been linked to the decline of frog species through the predation of tadpoles and adult frogs.
- **Goldfish** (*Carassius auratus*): thought to exhibit similar behaviour to Common Carp in freshwater ecosystems.

Birds

Highly productive wetland ecosystems support extensive bird populations numbering in the many tens of thousands. Birds are probably the most iconic fauna of both the Macquarie Marshes and Gwydir Wetlands.

Different species require different habitats. Some species rely on reed beds (e.g. Magpie Geese – *Anseranas semipalmata*) and others rely on trees like Black Wattle and shrubs such as Lignum (e.g. Ibis and Egrets). Birds quickly colonise healthy habitat and respond rapidly to a decline in water and food supply.

In the Gwydir Wetlands at least (DWE 2008):

- 235 different species of birds have been recorded;
- 134 species have been observed breeding;
- 75 species of water birds occur;
- 5 endangered species have been identified; and
- 9 species of migratory birds have been listed under CAMBA, JAMBA and/or ROKAMBA.

Goldfish, *Carassius auratus* (NSW DPI)

Birds in wetlands (NSW DPI)

Egrets and Glossy Ibis (Melissa Dell, BRG CMA)

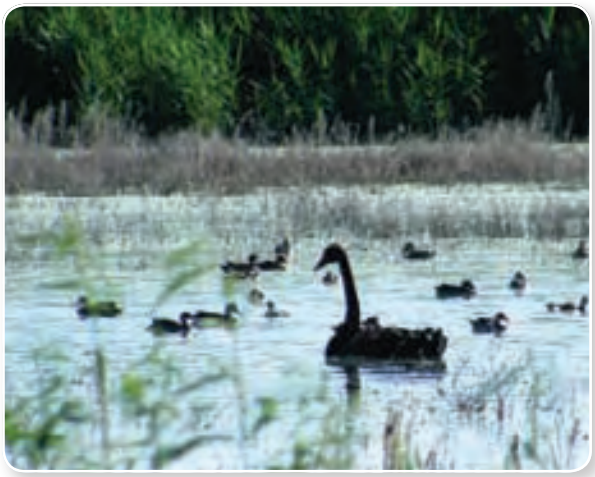
Jabiru (Tara Schalk, DIPNR)

White Necked Heron (NSW DPI)

The Chinese-Australian Migratory Bird Agreement (CAMBA), Japanese-Australian Migratory Bird Agreement (JAMBA), and the Republic of Korea-Australian Migratory Bird Agreement (ROKAMBA) require the participants to protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

The Macquarie Marshes have historically been the largest Australian site for colonial nesting waterbirds such as Egrets, Ibis and Heron. The wetland has had the greatest diversity of wetland bird species and highest nest density rates in Australia (NPA 2009). The Macquarie Marshes is an important wetland for the conservation of these species (NPA 2009).



Water birds (NSW DPI)

In the Macquarie Marshes, at least (Shelly 2005; Kingsford and Thomas 1995):

- 230 species of birds have been recorded;
- 74 species of water birds have been reported;
- 42 species of nesting waterbird including ibis, egret and heron species have been observed; and
- 9 migratory species including sandpipers, godwits and Japanese snipe have been identified.

Mammals

The Gwydir Wetlands and Macquarie Marshes support a range of both introduced and native mammal species (DECC 2009a, DECC 2009b, Wetlands International 2009):

- Common Brushtail Possum (*Trichosurus vulpecula*);
- Common Wallaroo (*Macropus robustus*);
- Eastern Grey Kangaroo (*Macropus giganteus*);
- Feral Pig (*Sus scrofa*);
- Koala (*Phascolarctos cinereus*, vulnerable in the *Threatened Species Conservation Act 1995*);
- Little Pied Bat (*Chalinolobus picatus*, vulnerable in the *Threatened Species Conservation Act 1995*);
- Narrow-nosed Planigale (*Planigale tenuirostris*);
- Red Kangaroo (*Macropus rufus*);
- Short-beaked Echidna (*Tachyglossus aculeatus*);
- Sugar Glider (*Petaurus brevicepsl*);
- Swamp Wallaby (*Wallabia bicolor*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*, vulnerable in the *Threatened Species Conservation Act 1995*);
- Western Grey Kangaroo (*Macropus fuliginosus*); and
- Water Rat (*Hydromys chrysogaster*).

Emu (NSW DPI)

Little Pied Bat, *Chalinolobus picatus* (Darren Shelley, DECC)

Red Kangaroo, *Macropus rufus* (NSW DPI)

Historical landuse

Gwydir Wetlands

Indigenous peoples inhabiting the region were of the Kamilaroi Nation (Northern Regional Library 2009) and they have used the wetlands for thousands of years:

- Reeds, plants and trees were used for food and fibre for weaving, and wood/bark was used for carrying, canoes and clothing.
- Birds and their eggs, Kangaroos, Emus, Snakes, Fish and other animals provided a constant food source.
- Resources for ceremonial purposes.

Physical evidence indicates that midden sites, camp fires and tools tended to be located on red soil ridges (Red and Brown Kandosols and Chromosols). This suggests that areas subject to flooding were utilised for hunting and harvesting.

Copeton Dam has a capacity of 1,364,000 ML and drains a catchment area of 5,360 km^2. It provides irrigation water and stock and domestic supplies to the Gwydir and Mehi Rivers, and to the Carole and Moomin Creeks. A series of weirs are used to manage flow along the river system (ANRA 2009).

The first recorded European to have visited the Gwydir Wetlands was surveyor Thomas Mitchell in 1832. The wetlands were settled soon after and pastoralists produced beef and wool. Cropping was introduced in the 1860s and irrigated crop production began in the 1960s. River regulation started after completion of Copeton Dam in 1976.

The reported impacts of river regulation are summarised by Casanova (2007). These are:

- increased rate of expansion of Water Hyacinth through the Gingham Watercourse;
- decreases in the size of reed beds (Marsh Club-rush and Cumbungi);
- declining populations and diversity of wetland birds and native fish;
- declining water quality; and
- reduced flood frequency of almost 70%.

Macquarie Marshes

Indigenous peoples, belonging to the Wailwan tribal group, have used the Macquarie Marshes for thousands of years. Masman and Johnston (2000) describe the use of the Marshes by the Wailwan people:

- Communities used wetlands as a source of materials (e.g. skins, boomerangs, spears and shelters).
- Summer grasses formed part of the diet e.g. Native Millet and Woollybutt.
- Pigweed was an important source of nutrition with higher levels of protein than Wheat or Rice.
- Other plant species (e.g. Nardoo, Ruby Saltbush, Quinine Bush) were used for food and medicine.
- Kangaroos, Fish, Echidnas, Possums, Mussels and Crayfish formed part of the diet.

Native Millet (Tara Schalk, DIPNR)

Common Nardoo (NSW DPI)

Remains of wetland crustaceans and insects (NSW DPI)

European settlement of the Macquarie Marshes began in the late 1830s when cattle production started in these wetlands. The surrounding floodplains were used for grazing sheep. River regulation began in 1967 with the completion of the 1,188,000 ML Burrendong Dam.

River regulation has decreased the frequency of large flows and changed the water supply regime to the Macquarie Marshes. Regulation has placed competing needs on finite supplies of river water and is reported to have resulted in (Casanova 2007):

- declines in health and abundance of tree species dependent on groundwater;
- decline in the area of key wetland plants (e.g. Water Couch);
- declining population and diversity of waterbirds including endangered and protected species; and
- declining population diversity and abundance of native fish species.

Current landuse

Gwydir Wetlands

The Gwydir catchment is a rich agricultural area, producing both extensive dryland and irrigated crops, and beef cattle. Cropping regimes are often continuous dryland (e.g. Wheat) or irrigated (e.g. Cotton) systems.

Agricultural systems in the Gwydir Wetlands are diverse. Agri-businesses are either:

- grazing only;
- grazing with a cropping (irrigated and/or dryland) component;
- cropping (irrigated and/or dryland) with a grazing component; or
- cropping (irrigated and/or dryland).

Often 'grazing only' businesses use tillage practices as a means of improving pastures in areas that are no longer subject to frequent flooding. This is done to:

- improve carrying capacity; and
- manage Lippia infestations.

Despite the range of agricultural enterprises, landholders in the Gwydir Wetlands report a strong personal interest in their grazing activities.

Water Hyacinth infestation in the Gwydir Wetlands (NSW DPI)

Horses in the Macquarie Marshes (NSW DPI)

Lippia (NSW DPI)

Macquarie Marshes

The agricultural practices in the Macquarie Marshes are commonly focused on the grazing of breeding cattle or trade cattle. Some of the trends in land management in the Macquarie Marshes are as follows:

- Currently most landholders include some form of crop production in their businesses. Cropping can be aimed at improving grazing value of areas that were formerly inundated and had livestock capacities that have been greatly reduced.
- Grain and Cotton production is utilised by some graziers as an alternative income source.
- Pasture improvement is uncommon in the Macquarie Marshes.

Floodplain grasses (NSW DPI)

Summary

Landholders and the community place significant ecological and agricultural values on the Gwydir Wetlands and Macquarie Marshes.

The Gwydir Wetlands and Macquarie Marshes are:

- reliant on river water for flooding because local rainfall is generally insufficient to ensure wetland flooding;
- recognised as 'hot spots' for water bird breeding when conditions are right;
- highly dynamic systems making them difficult to define; and
- diverse ecosystems that are becoming more fragile because of the current wetting regime and management practices.

The interaction between wetting regimes, climate and soil types drive these wetlands by influencing plant communities and animal populations.

Cotton crop (NSW DPI)

Gwydir Wetlands (NSW DPI)

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