WETLAND MANAGEMENT TECHNICAL MANUAL:

Wetland Classification

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Introduction

This paper presents a classification for wetlands in New South Wales (NSW). The purpose of the classification is to provide a basic framework for the presentation of wetland management guidelines for specific wetland types and wetland issues. The guidelines are the subject of separate chapters within this manual.

Three main criteria were considered during development of the classification:

1. The classification must result in wetland types that can be easily recognised by people without a scientific background

2. The classification must be broad, reflecting the broad level of guidelines to be included in the manual.

3. The classification must reflect wetland management issues so that wetlands with similar management problems are included in the same wetland type.

Management Issues

Wetlands have many different values and uses including commercial, recreational, hydrological, ecological and aesthetic. Brady and Riding (1996) provides a detailed discussion of wetland values. The wide range of uses means that there are many, sometimes conflicting, values of wetlands to achieve a sustainable habitat for all these uses.

Table 1 provides a list of wetland management issues that may need to be considered by wetland managers.

TABLE 1. WETLAND MANAGEMENT ISSUES

Water Management

- Water extraction (pumping impacts).
- River regulation (impacts of dams and weirs).
- Floodplain structures (impact of levees and blockbanks).
- Determining wetland water requirements.
- Design / construction of structures.

Land Management

- Sedimentation.
- Erosion.
- Sand and gravel extraction.
- Peat mining.
- Grazing.
- Lakebed cropping.
- Pesticide and fertilizer use
- Forestry.
- Commercial fishing.
- Urban development (clearing, draining and nutrient impacts).
- Fire.
- Rising groundwater tables.
- Acid sulphate soils.

Water Quality

- Nutrient cycling.
- Turbidity.
- Salinity.
- Nutrients.
- Irrigation tailwater.

Flora and Fauna Protection

- Fish habitat.
- Waterbird habitat.
- Other fauna habitat.
- Mammal pests.
- Exotic fish.
- Terrestrial weeds.
- Aquatic weeds.
- Rare/endangered species.
- Research and monitoring.

Management Planning

- Planning controls (SEPP 14, REP 2, REP 20).

- Vegetation rehabilitation.
- Attracting fauna.

Recreation

- Hunting.
- Fishing.
- Boating.
- Camping.
- Picnics.
- Birdwatching.

Cultural Values

- Aboriginal heritage and significance.
- European heritage.

Wetland Classification

Wetland classification is an important first step in wetland management. Different wetland types respond differently to management tools, and wetlands need to be managed for a variety of reasons.

There are many existing classifications that have been used for describing wetlands within Australia. A brief search revealed 12 classifications that use a variety of criteria for defining wetland types. It was outside the scope of this study to undertake a thorough review of wetland classifications, however a very brief review was completed to determine the main criteria used in the existing classifications, and the usefulness of these classifications from a management perspective. A summary of the review appears in Appendix A.

Developing a Classification Scheme

The classification scheme developed in this report focuses on wetland management. In order to determine what characteristics of a wetland needed to be considered within the classification, a three stage process was used.

The first phase involved identification and investigation of the criteria used in the existing wetland classification schemes (Appendix A). Secondly, the relative importance of each of these criteria in determining how a wetland is managed was investigated (Table 2). Thirdly, consideration was given to each of the management issues with respect to their applicability to certain wetland types and the degree of information known (Table 3).

From the review of classifications, the main criteria used in classifying wetlands are hydrology, geomorphology, vegetation and geographic location. To determine the relative importance of each of these criteria in relation to wetland management, a matrix was compiled using the list of management issues in Table 1. This matrix is shown in Table 2

and identifies the dominant factor, or factors, that are likely to affect each of the management issues. When compiling Table 2, the question was asked "Would wetland management need to vary for different hydrologic regimes, wetland morphologies, vegetation communities and geographic locations?"

For example, Table 2 indicates that extraction of water from wetlands is dependent on wetland hydrology and wetland morphology. This means that guidelines for water extraction from wetlands would vary for different water regimes (such as permanent versus intermittent flooding), and would also vary for different wetland morphologies (shallow wetlands being less suitable than deep wetlands). For similar wetlands located in different parts of the state, management of water extraction would be the same, and therefore geographic location is not an important factor in determining how this issue is managed.

To give another example, fire is a very specific land management issue that is affected more by the vegetation present at the wetland, than by any other factor. For different vegetation types, guidelines for fire management are therefore likely to vary.

Table 2 shows that hydrology, whether it be frequency of inundation or water source is the most important factor affecting each management issue. The remaining criteria appear to be of equal importance as secondary factors. These results however assume equal importance to each of the management issues, which is not necessarily the case. Also some issues are very general, while others are quite specific. These points are discussed further in the following section.

TABLE 2. FACTORS AFFECTING WETLAND MANAGEMENT ISSUES

- Will the guidelines need to vary for different wetland hydrology/ morphology/ vegetation/ geographic location?
- What is the controlling factor / factors that affect each issue?

MANAGEMENT ISSUES	Hydrology	Morphology	Vegetation	Geographical. Location
Water Management				
water extraction	Y	Y		
river regulation	Y			
floodplain structures	Y			
wetland water requirements	Y		Y	Y
design/construction of structures				
Land Management				
sedimentation	Y	Y	Y	
erosion	Y	Y	Y	
sand and gravel extraction		Y		Y
peat mining			Y	
grazing	Y		Y	
lakebed cropping	Y	Y		
pesticide and fertiliser use				
forestry			Y	
commercial fishing	Y	Y		
urban development				Y
fire			Y	

rising groundwater acid sulphate soils	Y			Y
Water Quality				
nutrient cycling	Y		Y	Y (temp)
turbidity				Y
salinity	Y			Y
nutrients				
irrigation tailwater	Y	Y		Y
Flora and Fauna Protection				
fish habitat	Y	Y		
waterbird habitat	Y	Y	Y	
other fauna habitat	Y	Y	Y	
mammal pests			Y	Y (species)
exotic fish	Y	Y		Y (species)
terrestrial weeds				
aquatic weeds	Y			
rare/endangered species				
research and monitoring				
Management Planning				
planning controls				Y
vegetation rehabilitation	Y		Y	
attracting fauna	Y		Y	
Recreation				
hunting	Y	Y	Y	
fishing	Y	Y		
boating	Y	Y		
camping/picnics/birdwatching				
Cultural Values				
aboriginal heritage and significance				
European heritage				

Level of Detail in the Classification Scheme

As noted, the level of detail to which the classification extends is dependent on the detail of the management information available that could be included in the manual. There is no point in finely subdividing wetland types, when it is only possible to give the same very broad management guidelines for each type.

It is expected that some management guidelines will be necessarily broad, either because there is little information on a particular management issue, or because it occurs across the

state affecting a wide range of wetland types. On the other hand, there will be some issues that affect only one type of wetland, or where research and available information allow more detailed guidelines for a particular issue or wetland type. The wetland types should, to some extent, take into account these differences, so that the maximum level of detail can be included in the manual where this is possible. Table 3 provides comments on the amount of information available for each management issue, whether the issue applies generally to all wetlands or to specific wetland types only. It also shows the relative importance of each management issue.

Many issues, particularly water quality and some land management issues, are fairly general and apply to all wetland types. While they may be important, these issues are not, therefore, particularly useful for grouping wetland types by management.

Many issues were identified as being specific to coastal wetlands or inland/riverine wetlands, or encompassed variations (e.g. species) between coastal and inland wetlands. For this reason a broad geographic division which reflects these differences is appropriate as the first step in defining wetland types for the manual.

Management issues, such as peat mining, sand and gravel extraction, forestry and lakebed cropping apply to fairly specific types of wetlands are therefore important in determining wetland groups. Greater consideration also needs to be given to those issues considered important, rather than those considered of "moderate importance".

TABLE 3. COMMENTS ON MANAGEMENT ISSUES

- Is the issue specific to particular wetland types?
- How much do we know about each management issue?
- How important is each issue (i.e. level of threat)?

MANAGEMENT ISSUES	COMMENTS
Water Management	
Effect of water extraction.	Only open water wetlands, good information, important.
Effect of weirs and dams.	Mostly riverine wetlands (but can apply to local catchments), good information, important.
Effect of levees / block banks	Mostly riverine wetlands, good information, important.
Est. wetland water req'ments	All wetlands but requirements vary according to wetland type, variable information, important.
Design/construction of structures.	Applies mostly to riverine and local catchment wetlands but site specific.
Land Management	
Sedimentation	General issue relating to all wetlands; little information; moderate importance.
Erosion	Mostly riverine wetlands and coastal wetlands; good information; moderate

	importance.
Sand and gravel extraction	Mostly coastal wetlands; good information; important.
Peat mining	Peat swamps only; moderate information; important.
Grazing.	General issue relating to most wetland types; poor information; moderate importance.
Lakebed cropping.	Ephemeral lakebeds / lagoons (mostly inland but also tablelands), moderate information; important.
Pesticide and fertilizer use.	General issue relating to all wetlands; poor information; moderate importance.
Forestry.	Riverine forest/woodland; good information; moderate importance.
Commercial fishing.	Mostly coastal estuarine but also some inland lakes; poor information; moderate importance.
Urban development.	Most relevant to coastal wetlands; good information; important.
Fire.	General issue but relates more to tablelands and some inland wetlands; poor information; moderate importance.
Rising groundwater.	General issue but most relevant inland ; poor information; important.
Acid sulphate soils.	Coastal wetlands only; poor information; important.
Water Quality	
Nutrient cycling	General issue relating to all wetlands; moderate information; moderate importance.
Turbidity	General issue relating to most wetlands; poor information; moderate importance.
Salinity	Mostly inland wetlands; moderate level of information; important.
Nutrients	General issue relating to all wetlands; moderate information; important.
Irrigation tailwater	General issue but relates mostly to riverine wetlands; poor information; important.
Flora and Fauna Protection	
Fish habitat	Estuarine and riverine wetlands; good information; important.
Waterbird habitat	Most wetland types but habitat varies between types; good information; important.
Others fauna habitat	Most wetland types but habitat varies between types; moderate information; moderate importance.
Mammal pests	Applies generally to all wetland types but species vary between coast/ tablelands/ inland; poor information; important.

Exotic fish	Estuarine and riverine habitats but species vary between coast and inland wetlands; moderate information; important.
Aquatic weeds	Generally permanent lakes and lagoons; moderate information; important.
Terrestrial weeds	General issue relating to all wetlands; little information; moderate importance.
Rare/endangered species	All wetlands but depends on occurrence of specific species; poor information; important.
Research and monitoring	General issue relating to all wetlands but specific topics for specific wetland types.
Management Planning	
Planning controls	Applies to specific locations (SEPP 14 - coastal; REP2 - Murray wetlands) ; good information; moderate importance.
Vegetation re-establishment	Specific to each wetland type and species type; moderate information; moderate importance.
Attracting fauna	Specific to each wetland type and species type; moderate information; moderate importance.
Recreation	
Hunting	Applies to most wetland types but varies according to species hunted (ducks v pigs); poor information; moderate importance.
Fishing	Mostly open water, usually permanent wetlands; poor information; moderate importance.
Boating	Open water, usually permanent wetlands; poor information; moderate importance.
Camping/picnics/birdwatching	General issue but is influenced by land tenure; poor information; moderate importance.
Cultural Values	Aboriginal heritage varies according to wetland type; poor information; moderate importance.

Proposed Wetland Types

The wetland types are based on three geographic locations (coastal, tableland and inland). Within these groups, wetlands are divided by broad hydrologic, geomorphic and vegetation characteristics.

The following wetland types are proposed:

COASTAL

- Mangrove and saltmarsh swamps
- Estuarine lakes and lagoons
- Dune swamps and lagoons
- Coastal floodplain swamps and lagoons
- Coastal floodplain forest

TABLELAND

- Upland lakes and lagoons
- Upland swamps

INLAND

- Permanent inland wetlands
- Inland floodplain lakes and lagoons
- Inland floodplain meadows
- Reed swamps
- Lignum swamps
- Inland floodplain forests and woodlands
- Arid wetlands

A key for identifying the wetland types appears below. The key begins with the broad geographic location.

The wetland types are generally unique to each geographic region, with the exception of upland lakes and lagoons, and upland swamps. These two wetland types may occur in any of the three geographic regions, although are most common on the tablelands. This is reflected in the key, with these wetland types being included in all of the geographical regions.

The wetland types are described in detail in the following pages. Each description consists of a simple definition of the wetland type followed by basic information on location (within the landscape and within New South Wales), hydrology, vegetation, significance and management issues. Specific names for all vegetation species are listed in Appendix B.

Key to Wetland Types

1. Identify your Geographic Region: COASTAL, TABLELAND or INLAND.

2. What is the main source of water for your wetland?

COASTAL WETLANDS

Water Source	Description	Wetland Type
Estuarine:	Saline waterbodies	***Estuarine lakes and lagoons***
	Tidal flats dominated by vegetation	***Mangrove and saltmarsh swamps***
Groundwater, Rainfall or Runoff:	Located on sand dunes or plains	***Dune swamps and lagoons***
	Not located on sand dunes or plains:	
	- mostly open water	***Upland lakes and lagoons***
	- mostly vegetation	***Upland swamp***
River	Mostly open water or aquatic vegetation	***Coastal floodplain swamps and lagoons***
	Mostly Trees	***Coastal floodplain forest***

TABLELAND WETLANDS

Water Source	Description	Wetland Type
Groundwater, Rainfall or Runoff:	Mostly open water	***Upland lakes and lagoons***
	Mostly vegetation	***Upland swamps***

INLAND WETLANDS

Water Source	Description	Wetland Type

River	Permanently flooded (filled by low river flows or impounded)	
	- *Mostly open water*	***Permanent inland wetlands***
	- *Mostly reeds*	***Reed swamps***
	Not permanently flooded (filled by seasonal or intermittent flooding)	
	- *Mostly open water*	***Inland floodplain lakes & lagoons***
	- *Mostly lignum*	***Lignum swamps***
	- *Mostly trees*	***Inland floodplain forest & woodlands***
	- *Mostly reeds*	***Reed swamp***
	- *Mostly grasses, herbs, rushes or sedges.*	***Inland floodplain meadows***
Groundwater, Rainfall or Runoff:	Located in far western New South Wales	***Arid wetlands***
	Not located in far-western New South Wales	
	- mostly open water	***Upland lakes and lagoons***
	- mostly vegetation	***Upland swamp***

Mangrove and Saltmarsh Swamps

Definition

Estuarine areas subject to tidal flooding which support mangrove and saltmarsh vegetation. Also included here are non-tidal basins which occur on estuarine sediments adjacent to mangrove and saltmarsh areas, as well as any mudflats and small creeks which occur within or adjacent to the community.

Location

Mangrove and saltmarsh communities are found along tidal shorelines which are exposed to seawater. They often extend up coastal rivers as far as the tidal limit. They often occur in association with one another, with saltmarsh communities occurring on the landward side of mangroves.

Hydrology

Mangroves and saltmarshes are dependent on periodic tidal inundation. In New South Wales, mangroves dominate those areas inundated daily, whereas saltmarsh vegetation occurs in areas less frequently flooded.

Vegetation

Grey mangrove (*Avicenia marina*) is the dominant species within New South Wales and is present along the entire coastline. The river mangrove (*Aegiceras corniculatum*), a smaller shrub-like species, occurs sporadically with the grey mangrove but reaches its southern most limit at Batemans Bay on the south coast (Goodrick 1983).

Within saltmarsh communities there is often a distinct zonation of vegetation across the wetland according to frequency of inundation from the sea. A typical zonation comprises samphire, salt couch and salt rush in a progression from the sea to the land (Goodrick 1983). Swamp sheoak may be found growing in or on the landward margins of the marsh (Jacobs and Brock 1993).

Significance

Mangroves form a part of the food chain for estuarine animals via the breakdown of leaf and other plant material. One square kilometre of mangrove forest contributes about 600 tonnes of leaf litter each year to the detrital food chain (West 1985).

Mangroves and saltmarsh communities provide habitat and shelter for other plants and animals. At Towra Point in Botany Bay, 176 birds species have been recorded, of which 30 are migratory species protected in international agreements between Japan and Australia (West 1985). The mangrove forest floor also supports large numbers of benthic fauna such as molluscs and crabs.

Waterways associated with mangrove forests are important nursery areas for commercial fish species such as bream, flathead, luderick, silver biddy and mullet, as well as for many non-commercial species (West 1985).

Mangrove and saltmarsh communities act as visual screens along the shoreline, and act as a buffer by reducing silt and nutrient loads in runoff from surrounding areas.

Management Issues

- Sedimentation (produced by clearing and erosion) alters and degrades wetland habitat.
- Commercial fishing activities are heavily reliant on mangrove areas.
- Urban development results in clearing of habitat and increased nutrients and stormwater pollution.
- Conservation of habitat for waterbirds, waders and fish. Australia had obligations under the JAMBA and CAMBA Agreements to conserve waterbird habitat.
- Many mangrove and saltmarsh wetlands are subject to controls on development activities (SEPP 14).
- Mangroves and saltmarsh often occur in areas that are popular for recreation (fishing and boating).

Estuarine Lakes and Lagoons

Definition

A large open body of saline or brackish water which has a relatively narrow permanent or intermittent connection to the sea. The difference between a lake and lagoon is arbitrary, lakes usually being the largest, however it depends more on the name by which each waterbody is commonly known.

Location

Saline lakes and lagoons occur all along the New South Wales coast but are most extensive on the south coast. They are separated from the estuary or ocean by a barrier sand dune, and have a connection (usually intermittent) with the open water.

Hydrology

The water of coastal lakes and lagoons can vary from brackish to as saline as sea water. Many coastal waterbodies are only open to the sea during floods or at very high tides. In some cases, lagoons may be artificially opened (by dredging) in response to pollution problems. Due to the irregular connections with the sea they are usually characterised by changes in water levels.

Vegetation

Lakes and lagoons that are more frequently open to the sea usually have submerged seagrass beds such as *Zostera capricorni* in the north or *Zostera muelleri* in the south.

Less saline lagoons usually support species of sea tassel that often grows in association with stonewort. Species of algae are also common (Jacobs 1983).

Shallow edges are usually dominated by emergent plants such as common reeds or sedges (*Bulboschoenus, Schoenoplectus or Baumea spp*.) (Jacobs, 1983).

Significance

Shallow saline lakes have high value as waterbird habitat (Goodrick 1970).

Estuarine lakes are important areas for fish habitat and production (Green and King 1996, Bady and Riding 1996).

Coastal lakes and lagoons form an important recreational resource for fishing, boating, swimming and camping activities.

Management Issues

- Sedimentation (produced by clearing and erosion) alters and degrades wetland habitat.
- Extractive industries and dredging can degrade or destroy seagrasses.
- Seagrasses are difficult to re-establish once destroyed.
- Commercial fishing industries are heavily reliant on estuarine lakes and lagoons.
- Urban development results in clearing of habitat and increased nutrients and stormwater pollution.
- Conservation of habitat for waterbirds, waders and fish. Australia had obligations under the JAMBA and CAMBA Agreements to conserve waterbird habitat.
- Floodplain management (opening of lakes) to prevent flooding of adjacent urban and rural areas.
- Many areas fringing estuarine lakes and lagoons are subject to controls on development activities (SEPP 14).
- Recreational boating can disturb sensitive habitats and damage shorelines through wave actions.

Dune Swamps and Lagoons

Definition

Any freshwater wetland occurring on coastal sand dunes or plains. Dunal wetlands include lakes, lagoons, shallow vegetated basins, heaths and forests.

Location

Dunal wetlands are found on prior dune systems which occur behind the present beach and foredune. Dunal wetlands occur along the entire New south Wales coastline, but are most numerous on the north coast between Myall Lakes and the Queensland border.

Hydrology

Dunal wetlands are dependant on groundwater and runoff from local catchments. The waters of dunal lake and swamps are often tea-coloured and acidic as a result of dissolved organic matter from peaty soils.

They can be found in a variety of situations and consequently can possess different hydrologic characteristics (from Timms 1988 and Winning 1992):

1. Perched wetlands occur on top of dunes on an indurated sand layer that lies above the regional groundwater table. They are formed by accumulation of organic matter in dune depressions which makes them almost impermeable. They are therefore reliant on rainfall and runoff as their source of water.
2. Watertable-window wetlands occur in the dune swales which lie below the regional groundwater table, thus forming a ”window ” to the watertable.
3. Upland contact wetlands occur between a sand dune and adjacent bedrock and rely on both runoff and groundwater.
4. Frontal dune ponds occur in small wind-created hollows in frontal dunes and would rely mostly on rainfall.

Vegetation

The vegetation of dunal wetlands is distinctive although some species also occur on coastal floodplains.

Seasonally flooded areas with a high watertable support a woodland or forest of broad-leaved paperbark. Paperbarks may also be found in swamps behind the foredune and sporadically around the perched swamps and lakes.

Other vegetation typical of dune wetlands include sedges, rushes and wet heathland. The sedge species *Lepironia articulata* is common around the margins of perched lakes and may grow in water up to 6m deep (Goodrick 1983).

Significance

Open water dunal wetlands, have significant value for recreation (Pressey and Harris 1988) as they provide opportunities for boating, swimming and camping.

Open water dunal wetlands are considered of high value as waterbird habitat (Goodrick 1970).

Paperbark swamps are particularly important as a seasonal food source by migratory birds during the winter period (species such as insect and nectar feeders). They also provide a major food source for some bat species when in flower (Pressey and Harris 1988).

Management Issues

- Sedimentation (produced by clearing and erosion) alters and degrades wetland habitat.
- Extractive industries like sand mining can degrade or destroy wetland habitat.
- Urban development results in clearing of habitat and increased nutrients and stormwater pollution.
- Extraction of groundwater near dunal wetlands may affect wetland hydrology. Maintaining the quality of groundwater is also important.
- Conservation of high value waterbird habitat.
- Fire is a natural occurrence, particularly in dunal heath swamps, but its role and impacts are not well understood.
- Many dune swamps and lagoons are subject to controls on development activities (SEPP 14).
- Some dune swamps and lagoons are popular sites for recreation.

Coastal Floodplain Swamps and Lagoons

Definition

Any wetland located on the floodplain of a coastal river. This wetland type includes shallow marshes and meadows vegetated by sedges and aquatic herbs, as well as deeper ponds and billabongs which have large areas of open water.

Location

Coastal floodplain swamps and lagoons are associated with all the major rivers along the New South Wales coast. They may occur in several different situations on the floodplain (Pressey 1986, Winning 1992):

1. Where the floodplain gradually slopes away from the river and abuts an adjacent terrace or hill on the edge of the floodplain (a “backswamp”).
2. As a ponded tributary where the river levee has dammed the junction of a smaller tributary.
3. As a billabong resulting from the cut-off and occlusion of a river bend.
4. As a floodway or some other form of flood channel which is not connected to the river during normal flows.

Hydrology

Coastal floodplain swamps and lagoons rely on seasonal or intermittent flooding from a river as their main source of water. Many of the rivers on the north coast of New South Wales flood annually, with floods most likely in summer and autumn as a result of cyclonic depressions.

Local runoff contributes to the maintenance of some lagoons between floods while small ponds may fill after heavy rainfall.

Vegetation

The vegetation in coastal swamps and lagoons is very dynamic and can change in response to seasonal fluctuations in water depth (Winning and King 1995).

Marginal species of coastal floodplain lagoons include jointed twig-rush, *Lepidosperma* spp., spikerushes, cumbungi, water ribbon and frogsmouth (Jacobs 1983). Reasonably permanent lagoons may support submerged species such as ribbonweed, bladderwort, watermilfoil, and pondweed. Floating aquatic species include water primrose, swamp lily, waterlilies, duckweed and azolla (Jacobs 1983).

Coastal floodplain meadows which are continuously flooded over summer and autumn support a complex community including knotweeds, sedges and many emergent aquatic species (Goodrick 1983). Although typically associated with dunal swamps, jointed twig-rush dominates extensive areas of floodplain wetlands on the north coast of New South Wales (Winning and King 1995).

Significance

Coastal floodplain swamps and lagoons have high value as waterbird habitat (Goodrick 1970). Freshwater lagoons provide a drought refuge function when inland wetlands are dry (Pressey 1981) while flooded meadows and aquatic herb fields are important feeding areas for waterbirds.

Coastal floodplain lagoons provide opportunities for recreation such as boating, swimming and camping.

Management Issues

- River regulation alters the natural flooding and drying cycles of coastal floodplain wetlands.
- Floodplain structures (such as levees and floodgates) also interfere with natural flooding patterns.
- Grazing is common and may have impacts on wetland flora and fauna and water quality.
- Conservation of high value waterbird habitat.
- Pressure from urban and agricultural development may result in draining and clearing of floodplain forests.
- Pesticides and nutrients from agriculture affect wetland water quality.
- Management of acid sulphate soils.
- Some coastal floodplain swamps and lagoons are subject to controls on development activities (SEPP 14).

Coastal Floodplain Forest

Definition

A wetland located on the floodplain of a coastal river which is dominated by trees. This wetland type encompasses the paperbark forest and woodlands of the coast.

Location

Floodplain forests generally occur on the sandy sediments located on the lower reaches of coastal floodplains. Extensive woodlands of paperbark previously occurred on river flats subject to shallow seasonal flooding however many of these woodlands have been cleared and the flats are now dominated by meadow grasses.

Hydrology

Coastal forests rely on brief seasonal flooding from rivers as their main source of water. Many of the larger rivers on the north coast of New South Wales flood annually, with floods most likely in summer and autumn as a result of cyclonic depressions.

Vegetation

Broad-leaved paperbark is the dominant species of coastal floodplain forests. Narrow-leaved paperbark and northern narrow-leaved paperbark may occur as marginal species or as scattered trees through the broad-leaved paperbark (Winning and King 1995).

Forests of swamp she-oak typically occur along the lower reaches of coastal rivers and estuaries.

Understorey species typically include rushes (*Juncus spp*.), *Villarsia spp*., common reed, water ribbon, *Maundia triglochinoides* and *Persicaria strigosa* (Jacobs 1983, Winning and King 1995). Typical grasses include matgrass, spiney mudgrass, swamp rice grass and watercouch (Jacobs 1983).

Significance

Paperbark swamps are particularly important as a seasonal food source by migratory birds during the winter period (species such as insect and nectar feeders) (Pressey and Harris 1988).

Paperbark swamps provide a major food source for some bat species when in flower (Pressey and Harris 1988).

Management Issues

- River regulation alters the natural flooding and drying cycles of coastal floodplain forests.
- Floodplain structures (such as levees and floodgates) also interfere with natural flooding patterns.
- Conservation of fauna habitat (especially birds and bats which feed in the forests).
- Pressure from urban and agricultural development may result in draining and clearing of floodplain forests.
- Management of acid sulphate soils.

- Some coastal floodplain forests are subject to controls on development activities (SEPP 14).

Upland Lakes and Lagoons

Definition

Large or small bodies of freshwater usually occurring in low hills or mountains. Upland lakes and lagoons consist predominantly of open water, with vegetation, if present, confined to the margins of the wetland.

Location

Upland lakes and lagoons occur predominantly on the tablelands, however they also include any waterbody on the coastal or inland plains (apart from arid wetlands) which fills though a local catchment, groundwater or rainfall (i.e. is not flooded from a river).

Upland waterbodies may have a variety of geomorphic origins. They are found in depressions formed by erosion of the underlying bedrock, in depressions associated with past fault activity, and in depressions scoured by past glacial activity (Winning 1992).

On the tablelands of New South Wales upland lakes and lagoons occur in two main areas - the New England Plateau and the southern tablelands including the Monaro region (Pressey and Harris 1988).

In the New England area open lagoons have resulted from erosion of the underlying basalt while in the Monaro region small lakes of glacial origin occur in the Snowy Mountains.

Large lakes such as Lake George and Lake Bathurst extensive local catchments and are the result of fault activity.

Hydrology

Tableland lakes rely on groundwater, rainfall and runoff from local catchments as their water source.

Most of the large lakes are perennial and subject to large reductions in area and depth during dry periods.

Glacial lakes on the other hand are permanent as a result of high inflows from snowmelt and rainfall runoff combined with low evaporation.

Vegetation

Large internally draining lakes do not support much aquatic vegetation, although at times may have submerged growths of sea tassel, ribbonweed, *Lepilaena spp.* and water milfoils.

Marginal vegetation is usually sparse and restricted to common reed, cumbungi, sedges and rushes (Jacobs and Brock 1993).

Glacial lakes are generally devoid of any aquatic vegetation (Paijmans et al 1985).

In the smaller lakes and lagoons of the New England and southern tablelands, tall spikerush is a common species in the more permanently inundated parts of the lake. A variety of species may be found growing around the less frequently inundated edges, including blown grass, knotweeds and water milfoil (Winning and King 1995).

Significance

Large upland lakes provide habitat and drought refuge for waterbirds when large inland lakes have dried. Some also provide important breeding areas.

Large upland lakes provide a water storage / flood mitigation function within the catchment.

Glacial lakes in the Kosciusko area are important as they represent wetland types which are not common within Australia.

Management Issues

- Grazing is common and may have impacts on wetland flora and fauna and water quality.
- Conservation of waterbird habitat.
- Lakebed cropping occurs on some of the large upland lakes.
- Erosion and clearing in the catchment may result in degradation of the wetland habitat.
- Extraction of surface water and groundwater may have an impact on the hydrology of upland lakes.
- Salinity and rising groundwater as a result of catchment clearing is beginning to affect some upland areas.
- Conservation of significant habitats and plant biodiversity.
- Pesticides and nutrients from agriculture affect wetland water quality.
- Draining of lake beds alters wetland hydrology and habitat values.

Upland Swamps

Definition

Vegetated freshwater wetlands occurring in shallow basins located in low hills or mountains. This wetland type includes shallow marshes, sedge swamps, “hanging” swamps, wet heaths and peat swamps.

Location

Upland swamps occur predominantly on or adjacent to the tablelands, however they also include any vegetated wetland on the coastal or inland plains (apart from arid wetlands) that fill though a local catchment, from groundwater or rainfall (that is, they are not subject to flooding from a river).

On the sandstone plateau's surrounding Sydney and the granite plateau of the New England area, “hanging swamps” of sedge and heath occur on valley sides. That is, where groundwater discharge occurs as a result of impermeable layers in the bedrock. Swamps may also occur on valley-fill deposits eroded from the surrounding ridges.

In other parts of the tablelands, such as the Monaro region, swamps are found within shallow depressions formed through erosion of the underlying bedrock.

Swamps developed on peat beds may occur at any height, but are best developed in the sub-alpine areas above 1000m (Paijmans et al 1985) where drainage is impeded. Peatbeds are formed when the rate of accumulation of organic matter is greater than the rate of decay.

Hydrology

Upland swamps rely on groundwater, rainfall and runoff from a small local catchment for their source of water. They may hold water permanently, or may fill on a seasonal or intermittent basis.

Groundwater is the most significant hydrological influence on “hanging” swamps (Pressey and Harris 1988).

Peat swamps rely on both groundwater and surface runoff, although groundwater seepage is the most important component. They occur in areas of high water table where the water is acidic and low in dissolved minerals (Goodrick 1983).

Vegetation

The hanging swamps of the sandstone and granite plateaus are dominated by a mix of sedges, grasses and shrubs, generally with sedges occurring in the wettest areas.

Sedge swamps tend to be dominated by members of the Cyperaceae family. Common species include razor sedge, button bog-rush, fringed cord-rush and slender yellow-eye. Common shrub species include teatrees, bottlebrush, hakea banksia and melaleuca (Winning and King 1995, Keith and Myerscough 1993).

Other types of swamps, such as those in the New England area, support plant species similar to those fringing the tableland lakes and lagoons. Tall spikerush is often the dominant species occurring with a mixture of other sedges and grasses.

Whilst most tableland swamps have some degree of peat development, swamps with deep peat beds are typically restricted to acid fens and bogs. Acid fens occur where the water has a relatively higher mineral content and are dominated by sedges (usually *Carex spp*.).

Where minerals are more deficient hummocks of sphagnum moss form valley bogs. On sloping or uneven land, a sloping water table occurs in the peat layer resulting in raised bogs. The bogs are characterised by an uneven surface due to alternate hollows and hummocks of moss. The hummocks are formed above the water level by sphagnum moss or in less humid environments *Blindia spp*. or *Bryum spp*. The wet hollows in between contain a carpet of other mosses such as *Polytrichum spp*. and *Breutelia. spp.*

Significance

The hanging swamps of the Sydney sandstone have some of the highest species richness values in the world for shrub/sedge dominated communities (Keith and Myerscough 1993).

Upland swamps, particularly peat swamps, are important parts of catchments because they absorb water and allow runoff for long periods after rainfall has ceased.

Peat swamps have outstanding scientific value as sites for carbon dating and pollen analysis that can provide valuable insights into climatic and ecological changes (Pressey and Harris 1988).

Management Issues

- Grazing is common and may have impacts on wetland flora and fauna and water quality.
- Erosion and clearing in the catchment may result in degradation of the wetland habitat.
- Fire is a natural part of heath ecology but its role and impacts are poorly known.
- Peat mining may destroy scientifically important wetlands. The impacts of peat mining and the ability of wetlands to recover from it are poorly understood.
- Salinity and rising groundwater as a result of catchment clearing is beginning to affect some upland areas.
- Conservation of significant habitats and plant biodiversity.
- Pesticides and nutrients from agriculture affect wetland water quality.
- Clearing and draining of swamps alters wetland hydrology and habitat values.

Permanent Inland Wetlands

Definition

Any wetland dominated by open water which is filled from a river under regulated flow conditions or which is permanently impounded by a structure. Permanent wetlands include lakes, billabongs, and impounded channels. Permanent wetlands which do not have extensive areas of open water (i.e. support reeds and cumbungi) should be considered under the wetland type “Reed swamps.

Location

Permanent floodplain wetlands occur in a variety of situations including:

- wetlands located within the weirpool created by a major structure on a river,
- lakes and basins which have water diverted or pumped to them for storage,
- wetlands used to store large amounts of drainage water from surrounding irrigation areas or other type of effluent water,
- wetlands that have naturally low connections with the river and are therefore filled under regulated flow conditions.

Hydrology

The dominant source of water for most permanent floodplain wetlands is from stream flows, however for some wetlands tailwater is the dominant source.

Permanent floodplain wetlands are an impact of river regulation - there are no naturally occurring permanent floodplain wetlands in inland New South Wales. Some large lakes in western New South Wales may retain water for up to 5 years, or longer if further floods occur in following years, but these are still considered as "non-permanent" or intermittent wetlands.

Vegetation

Most permanent floodplain wetlands are predominantly open water. Dead trees are often present in the water or around the edges of the wetland. These indicate that the wetland has been subject to a change in its natural water regime. The imposing of a permanent regime on a previously intermittent wetland will usually result in a reduction in the ecological productivity and diversity of flora and fauna species.

Common reed is common around the shoreline of permanent wetlands while cumbungi often occurs in water up to 1.5m deep around the margins.

Submerged aquatic species may be present in smaller wetlands or around the margins of larger wetlands where sheltered conditions exist. These may include ribbonweed, watermilfoil and pondweed.

Floating aquatic plants may occur in some permanent wetlands, particularly where nutrient levels are high. Common species include azolla, duckweeds and salvinia.

Significance

Permanent floodplain wetlands provide drought refuge for waterbird species when surrounding wetlands are dry.

Large permanent lakes are important recreational areas for people living in inland areas.

Management Issues

- River regulation has affected the natural hydrologic regime of permanent wetlands.
- Management of permanent inland wetlands for water supply and water storage is often inconsistent with the requirements of wetland flora and fauna.
- Provides a permanent habitat for aquatic weeds.

- Wetlands supplied by irrigation tailwater are affected by high levels of nutrients, pesticides and herbicides.
- Large permanent wetlands are often used for recreation (such as boating and water skiing).
- Large permanent wetlands may raise local water tables and exacerbate salinity.
- Rehabilitation of some permanent wetlands is currently taking place in order to re-instate a natural water regime.

Reed Swamps

Definition

A wetland located on the floodplain of a river which is subject to permanent or intermittent river flows and is dominated by reeds. This includes wetlands vegetated by common reed and cumbungi which do not have extensive areas of open water.

Location

Reed swamps occur in relatively deep channels or depressions on the floodplains of major rivers. They often occur extensively at the end of the river system, such as in the Macquarie Marshes at the end of the Macquarie River, and the Great Cumbung Swamp at the end of the Lachlan River.

In some parts of the state, extensive cumbungi swamps have developed as a response to river regulation (where channels are used to deliver regulated flows). An example of a cumbungi swamp in this situation is the Wanganella Swamp north of Deniliquin.

Hydrology

Reed swamps rely on surplus or regulated flows from a river as their main water source.

Common reed requires fairly regular inundation although it can survive up to a year or more without flooding.

Cumbungi requires almost permanent inundation, its minimum requirement being at least six months flooding over the summer period. Cumbungi is a typical species of a regulated flow regime.

Vegetation

The dominant species are common reed and cumbungi which usually occur as dense pure stands depending on the specific hydrology of the site (cumbungi if wetter or common reed if drier). Both species may occur at the one site with cumbungi occupying the wettest areas.

In smaller wetlands common reed may occur as a mix with other species such as tall spikerush, and various rushes (*Juncus spp*.) which occur on slightly higher or less frequently inundated ground.

Significance

Reed swamps provide sheltered habitat for some bird species such as crakes, rails and reed warblers which require dense vegetation.
Some reed swamps (such as those associated with the Murray River) provide important breeding habitat for waterbirds such as ibis and spoonbills (P. Lloyd pers. comm.).

Common reed is probably the most productive emergent of temperate wetlands (Hocking 1989). Reed swamps are extremely efficient at removing and re-cycling nutrients from the water.

Management Issues

- River regulation has decreased the natural flooding of some reed swamps, while others have developed as a result of increased flows from regulation.
- Reed swamps provide dense habitat for feral animals, such as pigs.
- Grazing in reed swamps is common and may have impacts on wetland flora and fauna.
- Use of fire in land management of reed swamps.
- Provide sheltered habitat for refuge and breeding of waterbirds.

Inland Floodplain Lakes and Lagoons

Definition

A wetland dominated by open water which is located on the floodplain of a river, and which is subject to a cycle of flooding and drying. This type of wetland includes lakes, lagoons and billabongs and ponds where vegetation is restricted to the margins of the wetland.

Location

Intermittent lakes and lagoons occur on the lower part of the floodplain in several situations depending on their geomorphic origins (Winning 1992, Pressey 1986):

1. Depression on the floodplain filled by overbank flooding.
2. A cut-off channel (oxbow or billabong) formed by occlusion of an old river channel.
3. Large rounded lakes (deflation basins) formed by wind erosion of alluvial sediments (typically with dunes on their eastern margins).
4. Large wetlands which occur as the terminal basin for a river or creek system.

Hydrology

Floodplain lakes and lagoons rely on seasonal or intermittent flooding from a river as their main source of water. The most important characteristic which separates the intermittent lakes and lagoons from those in the previous category is the drying and reflooding process which occurs. Wetlands may:

- flood and dry on an annual basis
- be wet most years but dry for occasional periods
- be dry most years but flood occasionally.

Between floods rainfall and local runoff may result in brief inundation of the wetlands.

Vegetation

Intermittent floodplain lakes and lagoons have large areas of open water when flooded. Vegetation is restricted to the margins of the wetland.

In large intermittent lakes, lignum is common around the edges of the wetland where the water is not too deep. Floodplain woodlands of black box or coolibah usually occur in a narrow fringe surrounding the lakes.

Oxbow lagoons are generally located within the zone of riverine woodland adjacent to the river. They support river red gums along their banks, often in association with black box or coolibah. Understorey species commonly include lignum or nitre goosefoot.

Common sedge species of intermittent lakes and lagoons (when flooded) include spikerushes, knotweeds, nardoo, water primrose, and aquatic grasses such as watercouch and spiny mudgrass.

Significance

The ephemeral nature of inland lakes and lagoons enhances nutrient cycling and makes them valuable and productive areas for waterbird breeding and feeding.
Intermittent lakes and lagoons provide sheltered nursery areas for the survival of young fish species.

Large intermittent lakes in western New South Wales play a significant role in flood mitigation.

Management Issues

- River regulation has altered the natural hydrologic regime of most inland floodplain lakes and lagoons.
- Floodplain structures may isolate wetlands, or alternatively, concentrate flows into other wetlands.
- Opportunity cropping of lakes and lagoons may impact upon natural wetland values.
- Use of lakes and lagoons for water storage alters the natural hydrologic regime of wetting and drying.

- Disposal of irrigation tailwater into wetlands alters water regimes and affects wetland water quality.
- Salinity and rising groundwater tables are affecting wetlands in some areas.
- Conservation of habitat for waterbird feeding and breeding and nursery areas for native fish.
- Grazing of floodplain wetlands is widespread and may have impacts on wetland flora and fauna.

Lignum Swamps

Definition

Extensive wetlands located on inland floodplains which are filled by surplus or flood flows and dominated by lignum vegetation. Included here are floodways and overflow systems, basins filled with lignum, and billabongs or other flooded areas supporting lignum which occur adjacent to the river channel.

Location

Lignum is a typical species of the inland floodplains of New South Wales. Wetlands dominated by lignum are typically found at the end of the river system. It is characteristically found in extensive braided floodways or overflows associated with the rivers of central and western New South Wales, but also occurs in smaller depressions and billabongs adjacent to the river channel.

Extensive areas of lignum swamp occur in the overflow of the Paroo River, at the end of the Warrego River, in the floodways of the Lachlan and Murrumbidgee Rivers and associated with the Darling River.

Hydrology

Lignum swamps rely on intermittent flooding from rivers as their main source of water.

The frequency of flooding can vary from every one or two years, up to once every ten years depending on the river system and the location of the swamp in relation to the river channel. In the Murrumbidgee valley, extensive lignum swamps occur behind floodway banks resulting in a more permanent, although fluctuating, water regime.

Vegetation

Lignum is the dominant species, often forming large rounded plants up to 2m in height and forming a dense cover where inundation is more frequent.

After flooding, the shallow water and wet soil between the lignum bushes is colonised by a variety of aquatic species including spikerushes, water primrose, nardoo, sedges (*Cyperus spp*), knotweeds and buttercup (Jacobs and Brock 1993, Green 1992).

Associated tree species include coolibah, black box, river red gum, yapunyah and river cooba. These often occur around the margins of the wetlands or scattered throughout the lignum.

Significance

Lignum wetlands provide valuable breeding sites for colonial waterbird species such as ibis and spoonbills which trample the bushes to provide nests.

Lignum swamps are also favoured breeding grounds for endangered waterbirds such as the freckled duck.

Extensive overflows and floodways have an important role in the catchment for the dissipation of floodwaters.

Management Issues

- Pressure from agricultural development results in clearing and draining of lignum wetlands for cultivation.
- River regulation has altered the natural flooding of many lignum wetlands.
- Floodplain structures alter natural water regimes by excluding or impounding floodwaters.
- Grazing in lignum swamps is widespread and may have impacts on wetland flora and fauna.
- Lignum wetlands have high value as waterbird breeding habitat.
- Provides habitat for feral animals, such as pigs and foxes, which poses problems for land management.

Inland Floodplain Forests and Woodlands

Definition

Wetlands located on the river floodplain dominated by tree species which rely on shallow flooding. This wetland type includes river red gum forests and coolibah and black box woodlands.

Location

Floodplain forests and woodlands occur along all of the major inland river systems. The Department of Land and Water Conservation has mapped some of the floodplain woodlands associated with the inland rivers of NSW.

River red gum forests are typical of the southern rivers and occur extensively along the Murray, Murrumbidgee and Lachlan rivers.

Coolibah generally occurs on the floodplains in the north and west of New South Wales (Gwydir, Darling, Warrego, Paroo, Culgoa).

Black box generally occurs on the floodplains in the south and west of the state (Namoi, Macquarie, Lachlan, Darling, Paroo, Murray, Murrumbidgee and Lachlan).

Hydrology

Floodplain forests and woodlands rely on surplus flows or overbank flooding as their main source of water.

River red gums are found in locations subject to more frequent inundation (up to once a year). Germination and growth of seedlings generally requires flooding, and the rate of growth of adult trees also tends to increase with greater frequency of flooding. Groundwater is important in maintaining the health of river red gums in between flood events.

Coolibah and black box occur on parts of the floodplain which receive only brief or infrequent flooding.

Vegetation

The understorey of river red gum forests and woodlands is usually dominated by plants which can withstand inundation, particularly sedges, rushes, spikerushes and grasses such as watercouch and spiney mudgrass.

Black box and coolibah woodlands usually support a more shrubby understorey of lignum, nitre goosefoot, saltbush, and a variety of herbs and grasses.

Following flooding a variety of aquatic herbs can be found on the floor of the forest including nardoo, buttercup and knotweeds.

Significance

River red gum forests (particularly those of the Murray and Murrumbidgee Rivers) have significant value for tourism and recreation.

River red gum forests form an economic resource for timber, grazing and honey production.

Floodplain forests and woodlands provide important habitat for fauna - tree hollows for breeding by parrots and marsupials and branches for nesting by colonial waterbirds.

Floodplain forests and woodlands have important archaeological values including scarred canoe trees, campsites, burials and middens from aboriginal occupation (Sommerville 1988).

Management Issues

- River regulation has altered the natural flooding of most floodplain forests and woodlands.

- Floodplain structures alter natural water regimes by excluding or impounding floodwaters.
- Balancing the management of forestry, recreation and habitat values.
- Use of fire in forest management, and the natural role of fire in riverine forests and woodlands.
- Grazing is common in most forest and woodland areas.

Inland Floodplain Meadows

Definition

A shallow wetland located on the floodplain of an inland river which is dominated by grasses, herbs, sedges or rushes. This wetland type includes the typical flat meadow of floodplain grasses, as well as shallow depressions which may support a variety of emergent species (rushes, sedges, spikerushes etc) and aquatic herbs.

Coastal floodplain meadows are considered within the wetland type "coastal floodplain swamps and lagoons".

Location

On inland floodplains meadow swamps occur in association with riverine forests and woodlands, and in shallow depressions on the floodplain.

Meadows dominated by emergent species (rushes, sedges, spike rushes etc) occur in shallow depressions throughout the floodplain.

Hydrology

Floodplain meadows rely on shallow seasonal or intermittent flooding from a river as their main source of water. Between floods groundwater and rainfall can help maintain the water levels in the wetlands.

The degree of reliance on groundwater and rainfall varies according to the location of the wetland on the floodplain (i.e. those furthest away from the channel may rely more on these water sources, but will have the potential to be flooded, at least occasionally, from river flooding.

Vegetation

Dominant grass species include spiney mud grass, barnyard grass, mat grass and water couch.

Clumps of rushes (*Juncus spp*.) and sedges (*Carex spp., Cyperus spp.)* often occur in association with the grass species above. Spikerushes are common in areas subject to fairly frequent or seasonal flooding, and may form the dominant species in shallow basins.

Herb species, which occur within floodplain meadows, are the same as those occurring on the margins of floodplain lagoons. These include water primrose, nardoo, knotweed, buttercup, and watermilfoil.

Significance

When flooded, freshwater meadows become important feeding habitat for a variety of waterbirds, particularly ibis, herons, egrets, spoonbills and some ducks (Pressey 1981).

Large meadow wetlands provide dissipation and distribution of floodwaters from a catchment.

Management Issues

- River Regulation has altered the natural water regimes of most floodplain meadows.
- Floodplain structures alter natural water regimes by excluding or impounding floodwaters.
- Draining of meadows for cultivation or grazing degrades wetland habitat values.
- Meadows provide important feeding grounds for waterbirds and provide nesting areas when other suitable vegetation is also present (such as lignum or reeds).
- Management of grazing in ecologically sensitive wetlands.

Arid Wetlands

Definition

A wetland located in the arid areas of the state which is not located on a river floodplain, and fills predominantly from rainfall, groundwater or a local catchment. This wetland type includes salt lakes, saltpans, playa lakes and claypans. Overflow swamps dominated by lignum should be considered under the wetland type "Lignum Swamps".

Location

Arid wetlands occur on the alluvial sandplains and dunefields of western New South Wales. They are generally located in the area north-west of the Darling River. Arid wetlands may occur in a variety of geomorphic situations (Goodrick 1984):

- Terminal playas (lakes) of major streams receiving regional runoff via major and minor streams.
- Claypans and playas of old drainage systems located in dunefields and sandplains. The drainage systems are partly or completely occluded by dunes.
- Claypans receiving local runoff in dunefields and sandplains.

Hydrology

Arid wetlands rely on local and regional runoff for inundation, although groundwater may contribute to some wetlands.

Wetlands in arid regions characteristically have very high rates of evaporation. The duration of inundation is therefore highly variable depending on inflows and seasonal evaporation rates (Goodrick 1984). Most arid wetlands experience extended dry periods.

The salinity of arid wetlands varies from fresh to saline. The salinity of many playas and salt lakes usually increases as the wetland dries.

Vegetation

In the large playas and saltlakes, vegetation is usually absent altogether. The lakebeds are commonly bare when dry and also devoid of vegetation when flooded except for algae and sea tassel which may grow in the more saline wetlands (Goodrick 1984).

The fringes of salt lakes and the beds of smaller saltpans are dominated by samphire, saltbushes, copperburs and bluebush (Green 1992).

Claypans are typically vegetated with canegrass. In the more saline wetlands canegrass grows in almost pure stands, while in other wetlands samphires and a variety of grasses, herbs and copperburrs may also be present (Goodrick 1984, Green 1992).

Some terminal playas and claypans support fringing lignum swamps. Other floodplain species such as river red gum, river cooba, black box, yapunyah and coolibah also occur around the margins of the freshwater playas and claypans.

Significance

The large salt lakes and playas of north-western New South Wales support extremely high waterbird populations when flooded, making this area of the state particularly important for the conservation of waterbirds (Maher 1991, Kingsford et al 1994).

The wetlands have natural flooding and drying regimes and current land management practices do not interfere with these regimes (Kingsford et al 1994). They therefore represent some of the most “natural” wetlands remaining in the state.

Management Issues

- Grazing is widespread in arid wetlands.
- Feral animals, particularly pigs, goats and foxes, have an impact on wetland flora and fauna.
- Extraction and management of groundwater may be an issue where surrounding wetlands rely on this resource as their main source of water.
- Conservation of habitat for waterbird breeding and feeding.

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Appendix A - Review of Wetland Classification

Goodrick (1970) used water type (saline or fresh), permanence, depth and vegetation types to classify coastal wetlands of New South Wales. Goodrick has also ranked the value of each wetland type as waterfowl habitat, therefore making it useful for wildlife management.

DWR (1990) groups wetlands firstly by geomorphic origin and secondly by morphology. The focus of the classification is on morphology rather than hydrology and hence wetlands in different systems and sub-systems have similar management potential and threats. The proposed classification derives some wetland types from this classification.

Corrick and Norman (1980) used water type, depth and permanence as primary criteria with further sub-divisions based on vegetation type. It also includes two man-made wetland types (sewage ponds and salt works). Sub-categories of vegetation used to describe freshwater wetlands are not exclusive to the main wetland categories, and hence from a management perspective there would appear to be some overlap.

Paijmans et al. (1985) groups wetlands into major geomorphic types and then sub-divides these types on the basis of frequency of inundation. Groups can be further sub-divided by vegetation type. Whilst the major geomorphic divisions form clear wetland types, the hydrologic sub-divisions are too finely divided to enable the application of the broad management guidelines which will be developed in the manual. Green et al (1992) trialed this classification using wetland data from the Gwydir Valley. The classification resulted in wetland types with different water management potentials, and hence it was concluded that it was not particularly useful from the perspective of water management.

Jacobs (1983) uses a loose geographic and geomorphic wetland classification, which was designed for the description of wetland vegetation. There is similarity between the coastal and tableland wetland types used by Jacobs and those proposed in this paper, however Jacobs' inland wetland types do not incorporate any hydrologic criteria, which is a critical issue in the management of these wetlands.

Cowling (1977) uses geographic location (inland or coastal) and water type (saline or fresh) as the major criteria for classifying wetlands. Wetland types are further divided by a variety of criteria including hydrology (frequency of flooding, depth), morphology and vegetation type. The first level of classification only results in four wetland types and is far too broad to apply management guidelines, and the next level is too finely divided. The classification was developed with the purpose of classifying waterbird habitat.

The RAMSAR classification is adopted as the official classification for the Directory of Important Wetlands in Australia. This classification includes man-made wetlands (water storages, ponds, gravel pits, irrigation channels etc) and marine wetlands (reefs, beaches etc) which are not relevant to the guidelines being prepared. Of the remaining categories, wetlands are divided according to hydrologic regime, size and geomorphology although there is no set structure to the classes.

Briggs (1981) developed a vegetation classification for freshwater wetlands. The classification is useful in a botanical sense but management principles for many of the

different wetland types would be similar (for example there would be no difference in the management of a swamp forest to a swamp woodland of the same species).

Beadle (1981) classified wetlands according to vegetation alliances. As the classification is Australia - wide many of the vegetation types are not relevant to New South Wales wetlands. In addition, the level of classification (down to dominant species) is beyond the broad management guidelines intended for the manual.

Semeniuk (1987) was developed for Western Australian wetlands and is a non-heirachical system based on the primary criteria of water permanence and the cross-sectional shape of the wetland. Descriptors may be attached to the seven main wetland types to describe salinity, shape and size of the wetland. Green et al. (1992) trialed the classification on wetland data for the Gwydir valley and concluded that in terms of water management the scheme was not particularly useful in separating wetlands according to management potential as the classification does not give any indication of a wetlands position in the landscape, only its cross-sectional shape. It also does not include estuarine wetlands.

Cowardin et al (1979) is the official wetland classification of the United States Fish and Wildlife Service. The system is hierarchical, progressing from five major systems through to subsystems, classes and subclasses. The main criteria are geomorphic origin, broad hydrology and substrate type. Green et al. (1992) trialed this classification on wetlands in the Gwydir Valley and found that the classification resulted in too many wetland groups, some of which were not significantly different from others. It was also dependent on some threshold values for wetland size and vegetation cover, which have questionable value for management purposes.

Winning (1992) uses morphology and hydrology as the primary criteria for describing wetlands. Winnings classification is based on 15 morphological classes which may then be divided into various sub-classes according to hydrology or specific morphologic characteristics. River and creek channels were deemed to be outside of the scope of the technical manual and hence Winning's four morphological classes relating to channels are not appropriate for this study. The remaining classes however are useful for broadly dividing wetland types according to their location within the landscape and broad water source, characteristics, which are useful from a water management perspective. Some of Winning's wetland types are similar to those of DWR (1990) and have been used in the proposed classification.

Appendix B - List of plant species referred to in the text

Common Name	Scientific Name
Azolla	*Azolla spp.*
banksia	*Banksia spp.*
barnyard grass	*Echinochloa colonum*
black box	*Eucalyptus largiflorens*
bladderwort	*Utricularia spp.*
blown grass	*Agrostis avenacea*
bluebush	*Maireana appressa*
bottlebrush	*Callistemon spp.*
broad-leaved paperbark	*Melaleuca quinquenervia*
buttercup	*Ranunculus spp.*
button bog-rush	*Gymnoschoenus spaerocephalus*
canegrass	*Eragrostic australis*
common reed	*Phragmites australis*
coolibah	*Eucalyptus coolabah*
copperburrs	*Sclerolaena spp.*
cumbungi	*Typha spp.*
duckweed	*Lemna spp.*
	Wolfia spp.
	Spirodella spp.
fringed cord-rush	*Restio fimbriatus*
frogsmouth	*Philydrum lanuginosum*
grey mangrove	*Avicenia marina*
grey samphire	*Halosarcia pergranulata*
hakea	*Hakea spp.*
jointed twig rush	*Baumea articulata*
knotweed	*Persicaria spp.*
lignum	*Meuhlenbeckia florulenta*
mat grass	*Hemarthria uncinata*
melaleuca	*Melaleuca spp.*
nardoo	*Marsilea spp.*
narrow-leaved paperbark	*Melaleuca linarifolia*
nitre goosefoot	*Chenopodium nitrariaceum*
northern-leaved paperbark	*Melaleuca alternifolia*
pondweed	*Potamogeton spp.*

razor sedge	*Lepidosperma limicola*
ribbon weed	*Vallisneria gigantea*
river mangrove	*Aegiceras corniculatum*
river red gum	*Eucalyptus camaldulensis*
saltbush	*Atriplex spp.*
salt couch	*Sporobolus virginicus*
salt rush	*Juncus maritimus*
salvinia	*Salvinia spp.*
samphire	*Salcornia spp.*
sea tassel	*Ruppia spp.*
slender yellow-eye	*Xyris gracilis*
sphagnum moss	*Sphagnum spp.*
spikerush	*Eleocharis spp.*
spiney mudgrass	*Pseudraphis spinescens*
stone wort	*Lamprothamnium spp.*
swamp lily	*Otellia ovalifolia*
swamp rice grass	*Leersia hexandra*
swamp sheoak	*Casuarina glauca*
tall spikerush	*Eleocharis sphacelata*
teatree	*Leptospermum spp.*
water ribbon	*Triglochin procera.*
watermilfoil	*Myriophyllum spp.*
water primrose	*Ludwigia peploides*
waterlilies	*Nymphoides spp.*
	Nymphaea spp.
watercouch	*Paspalum paspalodes*
yapunyah	*Eucalyptus ochrophloia*