

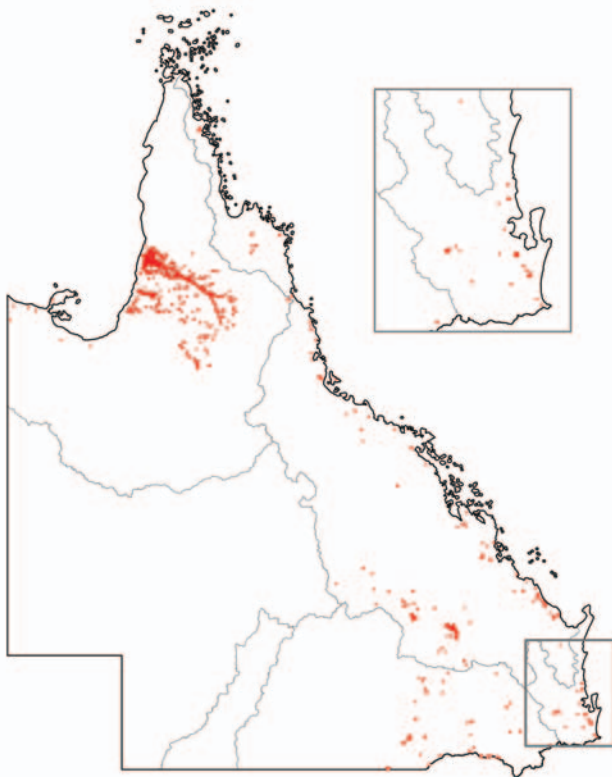
WETLAND MANAGEMENT PROFILE

COASTAL AND SUB-COASTAL FLOODPLAIN LAKES AND NON-FLOODPLAIN SOIL LAKES

Coastal and sub-coastal floodplain lakes are natural water bodies that occur predominantly on **alluvial** soils receiving water when rivers break their banks. Coastal and sub-coastal non-floodplain soil lakes also occur on alluvial soils, however these lakes depend primarily on rainwater, local run-off and groundwater for their existence. Both lakes can exhibit various characteristics—permanent, semi-permanent, temporary, deep, shallow, freshwater or **saline**. Threats to these wetlands include agriculture; land clearing; tourism and recreation; water extraction; weeds; feral animals and inappropriate fire regimes.

Coastal and sub-coastal floodplain and coastal and sub-coastal non-floodplain soil lakes provide important feeding and breeding habitats for a range of species, particularly waterbirds. This profile covers the habitat types of wetlands termed coastal and sub-coastal floodplain lakes; and coastal and sub-coastal non-floodplain soil lakes.

This typology, developed by the Queensland Wetlands Program, also forms the basis for a set of conceptual models that are linked to dynamic wetlands mapping, both of which can be accessed through the WetlandInfo website <www.derm/qld.gov.au/wetlandinfo>.



Map showing the distribution of coastal and sub-coastal floodplain lakes and non-floodplain soil lakes in Queensland. Grey lines indicate drainage divisions.

Map: From Queensland Wetlands Mapping v2.0 (September 2009)

Description

In Queensland, coastal and sub-coastal floodplain lakes occur on alluvial plains and in billabongs no longer connected to channel flow that receive a significant proportion of their water from overbank flow. Non-floodplain soil lakes occur in closed depressions on alluvial plains; they receive most of their water from local rainfall or groundwater, and not from river overbank flow. Coastal non-floodplain sand lakes and coastal and sub-coastal non-floodplain rock lakes have been treated separately, for further information on these profiles see the WetlandInfo website <www.derm.qld.gov.au/wetlandinfo>.

The origin, evolution and processes involved in the formation of these lake types are diverse so a precise definition for them is difficult. They may be broadly described as **lacustrine** or 'lake-like' meaning that they are:

- situated in a **topographic** depression;
- relatively deep (greater than 2 m in depth at their deepest point) or have a defined wave-formed or bedrock shoreline feature that makes up part of its boundary; and
- have a sparse vegetation cover—less than 30 per cent of their coverage area is made up of vegetation such as trees, shrubs or persistent emergent vegetation.

FACTORS that contribute to the variation between lakes include the age and size of the lake, how it was formed, its proximity to the sea and rivers, and surrounding vegetation and land use.

Depending on their location and climatic conditions, both coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes can be permanent, semi-permanent, temporary, deep, shallow, freshwater or saline in character. The water level of these lakes may change quite markedly between seasons. Factors that contribute to the physical variation between lakes include: the age and size of the lake, how it was formed, its proximity to the sea and rivers, and surrounding vegetation and land use. Non-floodplain soil lakes rely primarily on local rainwater and run-off for their formation, although groundwater can also contribute.

Rainfall conditions that generate water flow to these lakes can vary year to year and can influence how long they are wet or dry, fresh or saline. Although inflowing water to lakes (from rainwater) is fresh, certain lakes may become **brackish** or saline over time as they dry out, resulting in significant changes to water quality. Some lakes are also naturally saline due to the presence of salts in soil. In general, temporary lakes are dry for several months or years at a time, are often shallow (less than 0.5 m)—rising to only 1–2 m deep at their peak. Smaller temporary lakes may fill one in every three to five years, while the larger lakes may receive inflow one year in every five to 10. Semi-permanent lakes tend to be deeper (up to several metres) than temporary lakes and contain water in approximately eight out of every 10 years.



Aerial view of Lake Broadwater when full.
Photo: DERM



Lake Broadwater in dry condition. Photo: DERM

Coastal and sub-coastal floodplain lakes and non-floodplain soil lakes can occur alongside, be fringed by, or form complexes with other **wetland types** including grass, sedge, herb swamps, wet heath swamps and tree swamps. Frequently the boundaries of each type are not clear and can change over time as determined by patterns of rainfall and flooding. For further information on these surrounding wetland types and how they should be managed see the *WetlandInfo* website <www.derm.qld.gov.au/wetlandinfo>.

An overview profile, which provides general information about wetlands in Queensland and background information about key elements and definitions relevant to all wetland management profiles, is also available.

Distribution

In Queensland, coastal and sub-coastal floodplain and coastal and sub-coastal non-floodplain soil lakes occur in equatorial, tropical to sub-tropical areas characterised by predominantly summer rainfall and a winter dry season. They are found on medium textured alluvial soils associated with **land zone 3**, in the following **bioregions**:

- Gulf Plains (bioregion 2) (for example, Buffalo Lake)
- Cape York Peninsula (bioregion 3) (such as Bull Lake, Jack Lakes and Middle Lake)
- Einasleigh Uplands (bioregion 9) (such as Pelican Lakes, Walters Plain Lake, Poison Lake and Lake Wairuna)
- Brigalow Belt (bioregion 11) (including Lake Nuga Nuga, Lake Murphy, Lake Elphinstone and Lake Broadwater).

The *WetlandInfo* website provides in-depth data, detailed mapping and distribution information for this wetland habitat type.



Vegetation surrounding coastal and sub-coastal floodplain and non-floodplain soil lakes is dependent on the lake's location within the Queensland landscape. Photo: John McCabe, DERM

THE Queensland *Environmental Protection Act 1994* establishes a general environmental duty upon landowners to take all reasonable and practical measures to prevent or minimise harm to wetlands.



A nationally important wetland—Lake Nuga Nuga occurs in the Condamine–Balonne catchment in the Brigalow Belt bioregion. Photo: Bernice Sigley

Queensland status and legislation

Wetlands have many values – not just for conservation purposes – and the range of values can vary for each wetland habitat type and location. The Queensland Government maintains several processes for establishing the significance of wetlands. These processes inform legislation and regulations to protect wetlands, for example, the status assigned to wetlands under the **regional ecosystem (RE)** framework.

A comprehensive suite of wetlands assessment methods for various purposes exists, some of which have been applied in Queensland. More information on wetland significance assessment methods and their application is available from the *WetlandInfo* website <www.derm.qld.gov.au/wetlandinfo>. Queensland has also nominated wetlands to *A Directory of Important Wetlands of Australia (DIWA)*, see the appendix.

The Queensland Government has direct responsibility for the protection, conservation and management of wetlands in Queensland, a responsibility shared with local government and the Australian Government (for some wetlands of international significance). These responsibilities are found in laws passed by the Queensland parliament, laws of the Commonwealth, international obligations and in agreements between state, local and the federal governments. More information on relevant legislation is available from the *WetlandInfo* website <www.derm.qld.gov.au/wetlandinfo>.

National conservation status

There are at least five species of wildlife associated with coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes in Queensland that are listed as threatened under the *Queensland Nature Conservation Act 1992* and/or the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* and/or the IUCN Red List.

Migratory bird species that utilise coastal and sub-coastal floodplain lakes and non-floodplain soil lakes are also protected under the EPBC Act. The EPBC Act recognises all species listed under the Japan-Australia and China-Australia Migratory Bird Agreements (**JAMBA/CAMBA** respectively) and/or the **Bonn Convention**.

Listed migratory species and threatened species are considered to be matters of national environmental significance under the EPBC Act and as such, are afforded protection under the Act (see <www.environment.gov.au> for further information). Any action that will, or is likely to, have a significant impact on a listed migratory species or threatened species will be subject to an environmental assessment and approval regime under the EPBC Act.

EVIDENCE of traditional occupation and use of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes include ceremonial stone arrangements, scarred trees, hearths, middens, quarries, stone artefacts and scatters, food and fibre resources and historic contact sites.

Cultural heritage

All wetland ecosystems are of material and cultural importance to Indigenous people and many will have profound cultural significance and values. More than 60 Aboriginal cultural heritage sites have been recorded within coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes in Queensland. However, most of these lakes have not been systematically surveyed or assessed for cultural heritage significance.

Almost all plant and animal species had some form of traditional use, particularly vegetation, **crustaceans**, fish, reptiles, mammals and waterbirds (particularly their eggs), or cultural significance (for example totemic significance). There is a high likelihood of encountering cultural heritage sites within and adjacent to coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes. Evidence of traditional occupation and use recorded within these lakes include ceremonial stone arrangements, scarred trees, hearths, **middens**, quarries, stone artefacts and scatters, food and fibre resources and historic contact sites. Some coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes have particular significance as story places, landscape features and as sites for cultural activities.

The most commonly recorded sites associated with coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are stone artefact scatters associated with open camp occupation sites. Archaeological evidence of cultural sites (such as stone artefact scatters and scarred trees) is often concentrated along **ecotones** around the margins of these lakes, and in association with neighbouring regional ecosystems. The clustering of sites along ecotones reflects the concentration of traditional occupation and use within areas of greatest **biodiversity**.

Some coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes also have historic cultural heritage significance of both Indigenous and non-Indigenous origin, although most have not been surveyed or assessed for historic heritage values. The Queensland Department of Environment and Resource Management (DERM) has recorded four historic sites associated with coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes. The historic heritage values of these lakes demonstrate evidence of their past occupation and use associated with pastoral and agricultural industries.

LAKES have three physical zones—a littoral or shallow area, a limnetic or open water area, and a profundal or deep water area.

Ecology and ecological values

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes within Queensland are diverse in size, form, depth, their degree of permanency (that is, seasonally drying to permanent) and surrounding vegetation. Given this diversity and their geographical range the ecological characteristics and flora and fauna associated with these habitats are also diverse. Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes and their surrounding wetlands are a unique and aesthetically valued component of the Queensland landscape and provide **ecosystem services** that include:

- **provisioning services**—such as water extraction
- **regulating services**—including sediment and nutrient retention

- **supporting services**—such as breeding/nursery habitat for waterbirds and fish, providing a source of water for other wildlife
- **cultural services**—such as Indigenous cultural values and sites, tourism and recreation.

Lakes are described as lentic, meaning that they are standing (that is, not flowing) bodies of water. They have three physical zones:

- a littoral or shallow area—this zone has rooted plants and extends to depths of around 3 m
- limnetic or open water area—no rooted plants are found in this area
- profundal or deep water area—this lies below the limnetic zone and only occurs in deeper lakes. Sunlight does not penetrate to this layer.

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes contain open water vegetation communities with submerged or floating **macrophytic** plants (such as *Monochoria* spp., *Nymphaea* spp., and *Nymphoides* spp.). These species play a fundamental role in the coastal and sub-coastal floodplain lake and coastal and sub-coastal non-floodplain lake food webs because they, along with **phytoplankton**, are the primary producers of the system. These plants are consumed by **zooplankton** and other herbivores (that is plant eating animals such as insects and crustaceans), which are in turn consumed by carnivorous (flesh eating) animals such as fish and birds. Aquatic insects that are found in these lakes include dragonflies and damselflies (Order Odonata), bugs (Order Hemiptera), flies (Order Diptera) and beetles (Coleoptera)—most of these are aquatic only during the larval stage of their life cycle. Bacteria and fungi within the lake break down dead organisms into simple substances that can then be re-used by primary producer organisms.

These species provide important habitat for a variety of aquatic **invertebrates** and both food and shelter for higher order organisms such as fish, frogs and turtles. The deeper areas of larger lakes are generally vegetation free. Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are also commonly surrounded by mixed, open woodland communities of *Melaleuca* spp., *Eucalyptus* spp. and *Corymbia* spp. Others are surrounded by grasses, sedges, herbs and/or wet heath. For further information about these wetland habitat types that can fringe lakes and additional species information, see the WetlandInfo website's management profiles <www.derm.qld.gov.au/wetlandinfo>.



Aquatic plants such as water snowflake *Nymphoides indica* and waterlilies *Nymphaea* sp. are found on some coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes. Photos: Roger Jaensch, Wetlands International

Queensland's coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes form a network of feeding and breeding habitats for migratory and non-migratory waterbirds, which integrates with other networks across the continent. In favourable conditions, particular lakes may support populations of tens to hundreds of thousands of waterbirds, of which non-migratory species form a large proportion. Typical non-migratory representatives of the major waterbird groups include:

- swans, geese and ducks—such as the plumed whistling-duck *Dendrocygna eytoni*, black swan *Cygnus atratus*, pink-eared duck *Malacorhynchus membranaceus* and Pacific black duck *Anas superciliosa*
- grebes—including the great crested grebe *Podiceps cristatus*
- fish eaters—such as the pied cormorant *Phalacrocorax varius*, little black cormorant *P. sulcirostris* and Australian pelican *Pelecanus conspicillatus*

- herons and allies—such as white-faced heron *Egretta novaehollandiae*, straw-necked ibis *Threskiornis spinicollis* and yellow-billed spoonbill *Platalea flavipes*
- shorebirds—such as black-winged stilt *Himantopus himantopus*
- terns—such as the whiskered tern *Chlidonias hybridus*
- the brolga *Grus rubicundus*.

Migratory shorebirds recognised under the JAMBA, CAMBA and/or the Bonn Convention that occur at coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes include the common greenshank *Tringa nebularia* and Latham's snipe *Gallinago hardwickii* (see Appendix). Although not proven to be truly migratory, several birds associated coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes, notably the great egret *Ardea alba*, glossy ibis *Plegadis falcinellus* and Caspian tern *Sterna caspia*, are listed as migratory under the EPBC Act because they are included in the lists of JAMBA and/or CAMBA.

Vegetation surrounding coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes is diverse and dependent on their location. Where lake levels fluctuate, vegetation is either highly water tolerant or seasonal. The outer margins of lakes are commonly, but not always surrounded and invaded by dense stands of sedges and grasses of the families Poaceae and Cyperaceae (for example *Lepironia articulata*, *Eleocharis* spp., *Baumea* spp., *Cyperus* spp., *Oryza* spp., *Panicum* spp. and *Juncus* spp.).

QUEENSLAND'S coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes form a network of feeding and breeding habitats for migratory and non-migratory waterbirds.

While waterbirds are the most conspicuous component of the fauna of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes a variety of taxonomic groups (including mammals, birds, amphibians, fish, reptiles and invertebrates) are found there. These fauna drink, feed and/or utilise habitat surrounding the lakes and many are an important source of food for waterbirds.



Non-migratory waterbirds—brolgas *Grus rubicundus* performing an elaborate courtship and bonding dance. Photo: DERM



Freshwater mussels and a turtle carapace found around the edge of Lake Mary. Photo: Marion Saunders, DERM

MIGRATORY FLYWAYS

A number of shorebirds found on Queensland's coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes migrate across the world between their breeding grounds in the Arctic and non-breeding grounds in the southern hemisphere. The routes that the birds follow are known as flyways, and eight main flyways can be identified across the world. Australia lies at the southern end of the East Asian–Australasian Flyway, which originates in Russia and Alaska, crossing 22 countries along its path. Flyways include chains of wetlands, which contain food sources such as aquatic worms, molluscs and crustaceans to sustain travelling birds during their journey. These journeys may take two months to complete.

Caring for the wetlands along the flyways, and the migratory birds that use them, needs international



Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are important habitat for many bird species—thousands of birds may congregate at any one time.

Photo: Roger Jaensch, Wetlands International

cooperation, hence the development of migratory bird agreements such as JAMBA and CAMBA, to which Australia is a signatory.

Species associated with floodplain lakes and soil lakes

A range of species including plants, mammals, birds, reptiles, fish and amphibians are either found or utilise coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes habitat. These wetlands provide important feeding, **moulting** and breeding sites for waterbirds (and probably a range of other species) and are a drought refuge for all animals.

Preservation of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes is important for protecting species that are dependent on these wetlands for nesting, breeding and/or feeding, particularly species threatened with extinction. A number of species associated with Queensland's coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are listed as threatened under State (NC Act) and Commonwealth (EPBC Act) legislation and/or recognised under international conventions or agreements such as the IUCN Red List, JAMBA, CAMBA or the Bonn Convention.

Some of the species associated with these lakes and their surrounding area are listed below. These species may not be found in all coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes REs.

WetlandInfo provides full species lists of wetlands animals and plants.

Fauna

Birds

- Australasian grebe *Tachybaptus novaehollandiae*
- Australasian shoveler *Anas rhynchos*
- Australian pelican *Pelecanus conspicillatus*
- Australian white ibis *Threskiornis molucca*
- Australian wood duck *Chenonetta jubata*
- black swan *Cygnus atratus*
- black-necked stork *Ephippiorhynchus asiaticus*
- black-winged stilt *Himantopus himantopus*
- brolga *Grus rubicunda*
- cattle egret *Ardea ibis*
- clamorous reed-warbler *Acrocephalus stentoreus*
- common greenshank *Tringa nebularia*
- common sandpiper *Actitis hypoleucos*
- cotton pygmy-goose *Nettapus coromandelianus*
- darter *Anhinga melanogaster*
- glossy ibis *Plegadis falcinellus*

- great cormorant *Phalacrocorax carbo*
- great crested grebe *Podiceps cristatus*
- great egret *Ardea alba*
- grey teal *Anas gracilis*
- gull-billed tern *Sterna nilotica*
- intermediate egret *Ardea intermedia*
- Latham's snipe *Gallinago hardwickii*
- little black cormorant *Phalacrocorax sulcirostris*
- little egret *Egretta garzetta*
- little pied cormorant *Phalacrocorax melanoleucos*
- magpie goose *Anseranas semipalmata*
- masked lapwing *Vanellus miles*
- nankeen night heron *Nycticorax caledonicus*
- osprey *Pandion haliaetus*
- Pacific black duck *Anas superciliosa*
- pied cormorant *Phalacrocorax varius*
- pink-eared duck *Malacorhynchus membranaceus*

- plumed whistling-duck *Dendrocygna eytoni*
- purple swamphen *Porphyrio porphyrio*
- royal spoonbill *Platalea regia*
- straw-necked ibis *Threskiornis spinicollis*
- wandering whistling-duck *Dendrocygna arcuata*
- whiskered tern *Chlidonias hybridus*
- white-bellied sea-eagle *Haliaeetus leucogaster*
- white-faced heron *Egretta novaehollandiae*
- white-necked heron *Ardea pacifica*
- yellow-billed spoonbill *Platalea flavipes*

Amphibians

- eastern snapping frog *Cyclorana novaehollandiae*
- ornate burrowing frog *Limnodynastes ornatus*
- salmon striped frog *Limnodynastes salmini*

Reptiles

- Dunmall's snake *Furina dunmali*
- ornamental snake *Denisonia maculata*



Coastal and sub-coastal floodplain and coastal and sub-coastal non-floodplain soil lakes attract birds such as the white-necked heron *Ardea pacifica*. Photo: DERM



The salmon striped frog *Limnodynastes salmini* can be found in association with coastal and sub-coastal floodplain and coastal and sub-coastal non-floodplain soil lakes. Photo: DERM

AUSTRALIAN PELICAN

Pelicans *Pelecanus conspicillatus* are found in freshwater and saltwater lakes throughout Australia, often on waterbodies that are free of vegetation. They are a heavy bird (weighing up to 13 kg) but with a wingspan of up to 3 m are capable of soaring to great heights for extended periods of time. They will travel long distances to suitable breeding and feeding grounds. Pelicans are social animals usually living in small to large groups—the largest (up to 50 000 pairs) occurring on lakes of the Lake Eyre Basin.

Pelicans build nests at secluded sites such as small islands or spits. Both male and female birds build the nest—a hollow scraped in bare ground or among low-lying vegetation, and sometimes lined with plants and feathers. One to four white eggs are incubated for about 32–35 days before hatching. When the chicks are about a month old they gather together in crèches of up to 100 individuals, where they stay for a further two months until they are able to fly.



Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes provide habitat for the Australian pelican *Pelecanus conspicillatus*.

Photo: Roger Jaensch, Wetlands International

Pelicans are carnivorous (flesh eating), feeding mostly on fish but also on insects and small crustaceans. Pesticide and other chemical residues, arising from adjacent land use, can concentrate within fish that are eaten by pelicans and lead to egg shell thinning and egg loss during the breeding season.

LATHAM'S SNIPE

Latham's snipe *Gallinago hardwickii*, formerly named 'Japanese snipe' because a large proportion of its population breeds in Japan, is a migratory shorebird that utilises freshwater or brackish wetlands. During the non-breeding period (August to April) it may be found in wetlands in eastern Australia—preferring sites with protective vegetation such as grasses and sedges.

Displaying barred and streaked, brown and white plumage, the Latham's snipe can be distinguished from the distantly related, Australian painted snipe *Rostratula australis* by its longer straight bill, short rasping call and typical fast, towering escape flight. The bird was formerly a popular target for recreational hunting.

Many Latham's snipe occur in Queensland only during migration, spending the summer in southern Australia. Although able to find its preferred invertebrate food in a variety of



Latham's snipe *Gallinago hardwickii* migrate to Australia in summer, from their breeding grounds in Japan.

Photo: DERM

freshwater and brackish habitats, including artificial and highly disturbed wetlands, the species has probably declined in numbers due to a steady loss of wetlands through drainage alterations and changing land use patterns (that is for agriculture and urban development).

Flora

Some of the flora species associated with coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes and their surrounding area include:

Aquatic plants

- *Aponogeton elongatus*
- *Aponogeton queenslandicus*
- *Astonia australiensis*
- Ferny azolla *Azolla pinnata*
- *Blyxa* sp.
- *Caldesia oligococca*
- *Chara* spp.
- frogbit *Hydrocharis dubia*
- *Ludwigia perennis*
- *Monochoria* spp. (including *M. cyanea*)
- *Myriophyllum verrucosum*
- water nymph *Najas tenuifolia*
- pink waterlily *Nelumbo nucifera*
- *Nitella* spp.
- *Nymphaea* spp. (including *N. violacea*)
- *Nymphoides* spp. (including water snowflake *N. indica*)
- swamp lily *Ottelia ovalifolia*
- *Potamogeton* spp.
- *Vallisneria caulescens*
- *Vallisneria gracilis*

Sedges/grasses

- cockatoo grass *Alloteropsis semialata*
- *Arthraxon hispidus*
- *Baumea teretifolia*
- barbed-wire grass *Cymbopogon refractus*
- *Cyperus* spp. (including rice sedge *C. difformis*)
- *Eleocharis* spp. (including *E. blakeana*)
- black speargrass *Heteropogon contortus*
- giant speargrass *Heteropogon triticeus*
- blady grass *Imperata cylindrica*
- *Lepironia articulata*

- *Oryza* spp. (including *O. rufipogon*)
- *Panicum trichoides*
- *Paspalidium udum*
- *Schoenus calostachyus*
- *Setaria surgens*

Forbs

- *Aeschynomene* spp.
- *Dapsilanthus elatior*
- *Melochia corchorifolia*
- *Sesbania* spp.

Trees/shrubs

- brigalow *Acacia harpophylla*
- beefwood *Grevillea striata*
- bushy's clothes peg *Grevillea glauca*
- *Casuarina cunninghamiana*
- *Corymbia* spp. (including *C. polycarpa*, and *C. tessellaris*)
- *Eucalyptus* spp. (including *E. coolabah*, *E. platyphylla*, *E. tereticornis*, *E. brownii*, *E. camaldulensis*, *E. leptophleba*, *E. moluccana* and *E. crebra*)
- *Melaleuca* spp. (including *M. arcana*, *M. leucadendra* and *M. viridiflora*)



Red blossoms of the broad-leaved tea-tree *Melaleuca viridiflora*—a species sometimes found on land surrounding coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes. Photo: DERM

Lepironia articulata

The sedge species, *Lepironia articulata* is commonly found in association with coastal non-floodplain sand lakes. This species, which is sometimes referred to as grey sedge, is a **perennial**, grasslike plant that forms clumps and dense thickets around the edges of lakes and swamps. It can also grow in water to a depth of approximately 1.5 m. *L. articulata* has hollow, blue-grey erect stems that reach a height of 2 m. The inflorescence, which refers to the group of flowers and the stalks and branches that support them, is reddish-brown in colour, cylindrical in shape, points sideways and is found about 5 cm below the stem tip.



Clump of *Lepironia articulata*.
Photos: Queensland Herbarium, DERM

The submerged parts of *L. articulata* provide habitat for **microinvertebrates** and **macroinvertebrates**, fish, frogs and other species. Decaying *L. articulata* and other plant matter also provides a valuable food source for aquatic invertebrates and other fauna.



Close-up of *Lepironia articulata* showing its inflorescence.

Aponogeton queenslandicus

Aponogeton queenslandicus is an aquatic species that is rooted in the substrate by a tuber stem, has floating elliptical-elongated leaves and small yellow flowers on a short erect stalk. It is seasonally emergent and has been recorded at scattered localities in eastern Queensland and is gazetted as 'rare' under the *Nature Conservation Act 1992*. Indigenous people used the tuberous stems of this plant as a source of food.



***Aponogeton queenslandicus* is a rare aquatic plant found in some coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes.** Photo: Roger Jaensch, Wetlands International

COASTAL and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are used for a variety of activities including tourism, recreation, agriculture and water extraction.

Threats to floodplain lakes and soil lakes

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes areas are used for a variety of activities including tourism and recreation (fishing, swimming and boating), agriculture (crops and grazing) and water extraction (for irrigation and mining).

These activities can have detrimental impacts on the environment and future land production values if they are not adequately managed. Therefore, it is essential that wetland and land managers consider potential threats to coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes and their local **catchment** area before undertaking them.

Other threats to these lakes include: invasive weeds, feral animals, inappropriate fire regimes, and alterations to lake **hydrology** and drainage through human activities or climate change.

Managing floodplain lakes and coastal and soil lakes

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes occur on a range of tenures including freehold, leasehold, local, state and Australian government land. Within the category of private owners/stakeholders, Indigenous ownership applies to some of these lakes. For example, Bull Lake in the Cape York Peninsula bioregion is used and managed by the Thaayorre and Mungkan Aboriginal peoples of the Pormpuraaw (Edward River) community.

Permits, State and Commonwealth legislation and industry guidelines determine how land managers can best manage resources, businesses and industries (including recreation and tourism) to maintain the sustainable use and environmental integrity of the lake landscape.

Various covenants and agreements (both binding and non-binding on title) are also available to landholders in Queensland to protect wildlife and their habitat while maintaining viable production enterprises (for example grazing, farming, horticulture and forestry). Where the biodiversity values on a property are particularly significant it may be appropriate to negotiate a nature refuge agreement (see below).

WHAT ARE RIPARIAN ZONES AND WHY ARE THEY IMPORTANT?

Riparian zones are the areas adjacent to creeks, rivers, lakes and wetlands, including banks and floodplains, which exert a direct influence on the water and aquatic ecosystems. Riparian zones support high plant and animal biodiversity. They are also important areas for maintaining water quality in waterways and protecting banks from erosion. Riparian vegetation provides natural wildlife corridors up and down waterways from gullies and creeks at catchment headwaters through to major rivers and coastal estuaries. Riparian vegetation plays an important role in catchment health and water quality, as well as providing benefits at the property level. Landholders who have retained riparian vegetation have avoided the problems of bank erosion, sediment and nutrient runoff, reduction in water quality and weed invasion along waterways.

Many landholders are moving to re-establish natural drainage flows, revegetate riparian zones and create or manage wetlands to improve water



Land adjacent to wetlands (riparian zones) play an important role in maintaining the integrity of wetlands.
Photo: David Cameron

quality, combat erosion and shade out weeds. In the process, they are turning unproductive areas into productive land, with improvements in water quality and wildlife habitat.

NATURE REFUGES CAN HELP PROTECT WETLANDS

A nature refuge is an area of land actively managed to balance the needs of the environment with the needs of the landholder. This management is formalised through a signed conservation agreement between the Queensland Government and the landholder—providing the land with protected area status under the *Nature Conservation Act 1992*. This agreement demonstrates a mutual commitment to sustainably manage the land's natural and cultural values.

Each agreement is tailored to suit the management needs of the particular area and needs of the landholder. It is important to remember that the existing ownership and management rights do not change as a result of the nature refuge. In most cases the agreement allows for the ecologically sustainable use of natural resources to continue.

A nature refuge can cover all or part of a property and in doing so, provides protection for wildlife and wildlife habitat, emphasising biodiversity conservation as an important part of property management.

More than 200 landholders across Queensland manage nature refuges on their properties, protecting rare and threatened ecosystems, plants and animals, while maintaining and enhancing property enterprises as diverse as grazing, cropping, horticulture and ecotourism.

Once a nature refuge is declared, the Queensland Parks and Wildlife Service (QPWS) maintains contact with the landholder to provide advice and assistance with ongoing management of the area, such as specialist advice on plant and animal identification, pest control and fire management.



QPWS ranger and a nature refuge landholder.
Photo: DERM

There may be opportunity for landholders to apply to the QPWS for financial assistance for certain management activities. Other incentives, such as tax and transfer duty reimbursement, may also be available for landholders entering into conservation agreements.

Landowners with a property that has outstanding natural values might consider a nature refuge agreement as a way of contributing to the conservation and protection of Queensland's biodiversity, knowing that their property will be sustainably managed for those values forever. Even if a property does not qualify for nature refuge status it still may be suitable for other conservation agreements. Other state departments and some local governments offer a range of products that assist habitat protection on private lands. For further information see the DERM website <www.derm.qld.gov.au>.

The severity of threats to individual coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes is dependent on the lake's location within the Queensland landscape and adjacent land use. In some cases a lake may be managed by more than one stakeholder, so an integrated management approach is needed. In addition coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are likely to be part of broader wetland complexes so management strategies should be considered at the landscape level.

A BUFFER zone of intact native (or other) vegetation is an effective way of helping to maintain the ecological and hydrological functioning of a wetland—it also reduces impacts from adjacent land uses.

Managing alterations to hydrology and drainage

Like all wetlands, coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are dependent on water, and if the natural flow of this water is altered so are the characteristics or existence of the wetland. Changes in the hydrology of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes can occur naturally through climate changes (that is drought and flooding) or through human activities related to development such as: road building; building artificial barriers; installing drainage; land clearing and water extraction (for mining, irrigation or domestic use). While many of these activities may have already occurred, or be seen as necessary, future impacts can be minimised by considering the full hydrological and environmental impact prior to undertaking an activity.

Catchment-based planning for water allocation addresses water flow issues in a number of catchments. Water Resource Plans, and where necessary Resource Operational Plans, are prepared under the Queensland *Water Act 2000* in catchments where human consumptive needs have had a measurable impact or where rivers and wetlands have significant ecological or social values. A water resource plan details what the government aims to achieve for a catchment's social, economic and environmental needs, while a resource operational plan details how water resources will be managed from day to day to meet these objectives. For further information on water resource planning in Queensland, see the DERM website <www.derm.qld.gov.au>.

In the past many parts of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes Queensland have been extensively cleared for agriculture (cropping and grazing). However, under the Queensland *Vegetation Management Act 1999* all proposals for clearing **remnant** vegetation are subject to formal approval, and for many REs clearing is prohibited.

An effective way of maintaining the ecological and hydrological functioning of a wetland is the provision of a buffer zone of intact native or other vegetation. Buffer zones can maintain ecological functionality and reduce impacts from adjacent land uses. DERM is currently investigating buffer zones to assist best practice management.

A buffer around a wetland can help maintain the environmental values of the wetland and protect it from current and future threats from adjacent land uses.

Designing an effective wetland buffer relies upon many factors, including the wetland's characteristics, environmental values, location, surrounding land uses, and the current and future impacts on the wetland.

Queensland already has legislative mechanisms that specify buffer distances. The *WetlandInfo* website <www.derm.qld.gov.au/wetlandinfo> contains the latest information on legislation and buffer guidelines.



Maintaining a buffer zone of vegetation around wetlands can help maintain their ecology and hydrological functioning. Photo: DERM

DESCRIBING THE NUTRIENT STATUS OF LAKES

Lakes are often classified according to their nutrient or trophic status. Oligotrophic lakes are characterised by having low levels of nutrients (such as phosphorus and nitrogen) and plant growth, and high oxygen concentrations, while eutrophic lakes have high levels of nutrients and plant growth and low oxygen concentrations. Between these extremes are mesotrophic lakes.

Factors that contribute to the nutrient status of a lake include:

- climate—this includes temperature, amount of sunlight, rainfall and hydrology of the lake
- lake morphometry—this is based on the depth, volume and surface area of the lake, and the lake surface area to catchment size ratio
- nutrient supply—dependent on soil type, geology of the landscape, vegetation, and land use and management.

The process by which a lake moves from an oligotrophic to eutrophic condition is known as **eutrophication**. Lakes that occur in catchments that have rich organic soils or agricultural areas enriched with fertilisers are likely to be more eutrophic than those that occur on infertile soils or sand dunes.

Eutrophic lakes are also susceptible to algal blooms—a condition where the number of algal cells has increased to such an extent that water quality is reduced. Algal blooms can discolour



Runoff from elevated areas can deposit sediment into lakes that can lead to a reduction in water quality.

Photo: DERM

water, form scums on the lake surface and produce unpleasant odours. While they are not always toxic, algal blooms can also harm aquatic life (such as fish and frogs) and be a human health issue.

Since harmful algal blooms can have detrimental economic, environmental and social impacts the Queensland Government has developed a multiagency response plan to aid State and local governments and water storage operators manage them. For further information on harmful algal blooms see the DERM website <www.derm.qld.gov.au>.

EVEN minor additions of nutrients can have significant ecological impacts—potentially altering water quality and the composition of lake flora and fauna.

Managing water pollution

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes in particular can be essentially closed systems and even minor additions of nutrients can have significant ecological impacts, potentially altering a lake's chemistry and composition of its flora and fauna irreversibly. The process of nutrient enrichment is known as

eutrophication (see box) and most of the activities and threats to coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes, described in this profile, can either directly or indirectly cause this to occur. For example:

- tourism and recreation
- agriculture (cropping and grazing)
- land clearing
- water extraction (for irrigation, mining and domestic use)
- feral animals
- inappropriate fire regimes.

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are highly valued and popular sites for recreation and tourism-related pursuits such as swimming, boating, fishing, hiking, camping and day visitation. However, excessive and unmanaged use of these wetlands for these purposes can place a substantial strain on the quality of the lake environment. For example, direct nutrient enrichment (known as nutrification) in the form of urine, soaps, detergents, shampoos, sunscreen and other chemicals can lead to an increase in the amount of algae (known as an algal bloom) and cause water quality to decline. In coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes, blooms of algae are an obvious indication of an unbalanced ecosystem. This is not only a concern for maintaining the ecological integrity of the lake but also a human health issue.

Unhygienic camping practices in the lake's proximity can also lead to nutrification. To reduce the impact of human-induced pollution, land managers need to educate visitors about the susceptibility of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes to nutrification and where necessary conduct regular water and soil monitoring procedures. If conditions are severe or unsafe it may be necessary to close or restrict a lake's use. Other practices that should be adhered to include:

- using designated camping areas
- not using detergents, soaps, toothpastes, shampoos or other chemicals in lakes or waterways
- not urinating in or near inland non-arid lakes
- not camping or burying human faecal waste within 100 m of a lake
- not littering or burying rubbish near a lake—it should be taken off-site.

Infrastructure (such as roads, carparks, boat ramps, walking tracks and camping areas) associated with recreation and tourist activities can also impact inland non-arid lakes. For example runoff from poorly designed carparks and roads can cause **siltation** and pollution, leading to a reduction in water quality and affecting flora and fauna. Unregulated visitation can also lead to the trampling of fragile flora species, and soil erosion if walking is not conducted on properly constructed walking tracks. Inappropriately managed recreation and tourism activities can also pose fire threats and introduce weed species. It is suggested that roads, carparks, walking tracks and camping areas should be drained in a manner that captures stormwater, slows its progress and filters the water. Maintaining natural vegetation and installing drainage may assist this process.

LAND use and activities within lake catchments should be conducted in a manner that prevents or minimises soil disturbance, erosion and maintains water quantity and quality.

Increased pollution, sediment and nutrient concentrations in coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes can also arise from activities undertaken within the lake and on adjacent land. For example, unnatural chemicals such as oils (from boats and machinery), pesticides, fertilisers, septic tank seepage and heavy metals can be introduced into lakes through inappropriate development, industrial uses (such as mining) and agriculture (cropping, grazing and forestry). Over time, a build up of these chemicals can cause a reduction in the visual amenity of the lake environment, an imbalance in natural nutrient cycles



Urban development (including residential and road building) can have downstream effects on coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes.
Photos: DERM

within the lake, the proliferation of algae, death of sensitive flora and fauna (or a change in the composition and relative abundance of species within the lake environment), and cumulative impacts on fauna that feed on invertebrates and fish.

Increased sediment and nutrient loads in coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes can also result from fires in adjacent areas, land clearing, feral animals and grazing. Some of these issues are covered in more detail in Managing fire, Managing weeds and Managing grazing and feral animals.

To preserve the quality of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes, land use and activities within lake catchments should be conducted in a manner that prevents or minimises soil disturbance, erosion and maintains water quantity and quality. Wherever possible vegetation cover should be retained (see Managing alterations to hydrology and drainage). It is also essential that any activity (such as mining, forestry) occurring at or adjacent to an coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes comply with the appropriate legislation and industry codes of practice and guidelines. See the DERM website <www.derm.qld.gov.au>.

Property management plans are a useful tool that landholders can use to identify management issues related to their property. These plans are designed and implemented by individual landholders and may be a requirement for certain approvals under the *Queensland Vegetation Management Act 1999*, *Queensland Water Act 2000*, the *Queensland Sugar Industry Act 1999* and particular local government planning schemes. Property management plans should aim to reduce farm runoff to waterways and protect

wetlands and riparian zones. Greening Australia is one of a number of organisations that can assist landholders in preparing their own property management plan. For more information, see the Greening Australia website <www.greeningaustralia.org.au>.

Managing grazing and feral animals

Coastal floodplain and non-floodplain soil lakes are commonly used for beef cattle grazing and although this is an important and valuable industry it is vital that it is managed in an environmentally and economically sustainable way. Many of the impacts of grazing animals on wetlands are similar to those caused by feral animals so both of these issues are covered here.

Grazing can threaten the water quality and ecology of inland non-arid lake areas in a variety of ways including:

- trampling vegetation and reducing groundcover—creating conditions for soil erosion
- soil disturbance—causing erosion and increasing silt loads and water turbidity
- over-grazing new plant growth, preventing flowering or seed setting
- destabilising and eroding wetland edges
- ground compaction and **pugging**
- spreading weed species
- competing with native animals (for example waterbirds) for food and habitat
- increasing nutrient levels through defecation and urination, which can foul water, favour weed invasion and potentially harm native species that depend on inland non-arid lakes or their surrounding habitat
- altering fire fuel loads.

GREENING AUSTRALIA

Greening Australia is a not-for-profit organisation working in partnership with government, private enterprise and the community to achieve sustainable land and water resources by strategically managing native vegetation. They can assist landholders or groups with vegetation management and revegetation projects, and provide training and advice on plant identification, species selection, seed collection, plant propagation, site preparation and planting. See the Greening Australia website <www.greeningaustralia.org.au>.



Revegetation of disturbed landscapes can help establish buffer zones around wetlands.

Photo: Andi Yates

In addition to the above list of impacts, feral animals (particularly pigs) can also threaten inland non-arid lakes by:

- feeding on native wildlife
- carrying and transmitting diseases (such as vibriosis and leptospirosis) that can be passed on to cattle through water.

Given the importance of lakes in the landscape, particularly when they are associated with multiple land uses (such as recreation and grazing), it is important that land managers reduce or eliminate the likelihood of pollution and exotic plant and animal invasion. Where cattle grazing occurs, this may be achieved by restricting stock access to lakes either permanently or at strategic times — for example when edges are soft and liable to deep pugging and when wetland plants have not yet completed their seeding stage. Restricting stock access can be achieved through fencing the lake (or other methods) and providing water troughs at a distance from the lake.

It is more difficult to conserve wetlands on properties that lack upland grazing areas and rely totally on lowland grazing. Operating across a mix of upland and lowland country naturally facilitates seasonal ‘spelling’ of wetlands from grazing.

The Department of Employment, Economic Development and Innovation (DEEDI), in partnership with Meat and Livestock Australia, have investigated sustainable grazing regimes for inland regions. Information collected from scientific research and demonstration projects, in addition to grazer experience, is delivered through the Grazing Land Management (GLM) workshop series.

FERAL pigs can cause significant damage to lake margins and are a predator of ground-nesting birds, frogs and other animals.

Like grazing animals, feral animals also threaten the water quality and ecology of inland non-arid lakes. They are therefore an important management consideration for all landholders and land managers. The feral pig *Sus scrofa* is a significant pest species in inland non-arid lake areas, as it is for wetland and non-wetland areas across Queensland. They can cause significant damage to lake margins and are a

predator of ground-nesting birds, frogs and other animals. Additionally, feral pigs can carry the bacteria that cause vibriosis and leptospirosis—diseases that can be passed on to cattle through water. The species is declared as a Class 2 pest under the Queensland *Land Protection (Pest and Stock Management) Act 2002* and, under this Act, land managers are required to control feral pigs on land under their management.

In recognition of the severe impact of feral pigs on the Australian landscape, predation, habitat degradation, competition and disease transmission by feral pigs has also been listed as a key threatening process under the Commonwealth EPBC Act <www.environment.gov.au>. Under the Act, the Australian Government, in consultation with the states and territories, has developed a Threat Abatement Plan which outlines control techniques and stakeholder roles and responsibilities.



The feral pig *Sus scrofa* is a declared pest species in Queensland. Photo: DERM

Most landowners/land managers in Queensland have a feral pig control program in place, usually involving a combination of shooting, trapping and baiting to reduce pig numbers. Control programs may be most effective when considered as a part of a cooperative approach across a local area.

A list of declared animals (pests), pest animal strategies and fact sheets to assist land managers can be found on the DEEDI website <www.deedi.qld.gov.au> and further information on pest animal control (including feral pigs) can be obtained from Land Protection officers. Local government weed and pest officers are also a valuable source of pest animal information as they are responsible for ensuring declared weeds and

pest animals on all private and public land in their area are adequately controlled (see Managing weeds). See the DEEDI website <www.deedi.qld.gov.au> for more information.

Other pest species of particular significance in coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are the cane toad *Rhinella marina* and exotic fish species (such as the mosquitofish *Gambusia holbrooki*). Both of these species are widespread in Queensland. While the cane toad is not listed as a declared pest in Queensland and there is no legal requirement for landholders to control them, it is acknowledged that the species is a prolific breeder and a threat to native wildlife. Threats to native wildlife from cane toads include competition for food and habitat, poisoning and predation. The Brisbane City Council in south-east Queensland established a committee that urged all residents to take responsibility for controlling the pest. Freezing the animals is considered to be a humane form of euthanasia. Further information about the cane toad can be found on the DEEDI website <www.deedi.qld.gov.au> or directly from Land Protection officers and local government weed and pest officers.

Exotic fish species (such as mosquitofish *Gambusia* spp.) have been implicated in the decline of frog and native fish species within Queensland. Like the cane toad, mosquitofish have a high reproductive rate, flexible feeding and habitat requirements, prey on tadpoles and fish eggs, and compete with native fish for habitat and food. They also have an impact on invertebrates (for example, aquatic beetles, crustaceans, molluscs and backswimmers).



The cane toad *Rhinella marina* is a threat to native wildlife. Photo: DERM

Fish (or other species) that are not **endemic** should never be introduced to a lake or other wetland, as it can be extremely difficult to remove them without harming the ecosystem. For any species listed as a noxious fish in the Queensland Fisheries Regulation 1994 it is an offence to keep, hatch, rear or sell them. If caught, they should be destroyed immediately and must not be returned to the water or used as bait—whether alive or dead. For further information about noxious fish see the DEEDI website <www.deedi.qld.gov.au>.

BUSHFIRES and hazard reduction burning can affect coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes, animals and microorganisms by raising temperatures, altering microhabitats, and by increasing the level of siltation and amount of organic matter entering the lake.

Managing fire

Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes, like all lakes, are naturally fire tolerant when inundated, provide natural firebreaks and are a refuge for animals during bushfires. However, bushfires and hazard reduction burning in adjacent areas can affect lake biota (that is plants, animals and micro-organisms) by raising temperatures, altering micro-environments, and also by increasing the level of siltation and amount of organic matter (such as leaf litter and ash) that enters the lake. This in turn can alter nutrient cycles, and in particular increase the biological oxygen demand (BOD) of the water body. BOD, which can be directly quantitated from a water sample, is a measure of the oxygen used by microorganisms to decompose the nutrients (in this case fire-induced) entering a lake.

As the effects of fire on coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are not obvious it is important that land managers carefully consider the full spectrum of impacts a prescribed burn or naturally occurring bushfire can cause on both the lake itself and the surrounding vegetation and landscape (this may include a variety of wetland types). In drought conditions, wildfire can burn into the normally inundated areas and damage perennial vegetation.

Factors that need to be considered when planning a prescribed burn are:

- the vegetation types
- fire frequency
- fire intensity
- season
- wind speed
- temperature
- terrain
- soil and air moisture.

For further information about local requirements, restrictions and responsibilities with respect to prescribed burns and fire management, land managers should consult with their local council or rural fire brigade <www.ruralfire.qld.gov.au>.

Managing weeds

Weed encroachment into and around the edge of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes can have significant environmental, social and economic impacts, including reducing agricultural productivity and profitability and limiting the long-term sustainability of agricultural enterprises. Certain locations, particularly those that are intensively used for recreation or have been cleared of vegetation, or where cattle graze or have previously grazed, are susceptible to exotic weed invasion.

WEEDS can be spread by vehicles, native, domestic and feral animals, and by flowing water and wind.



The effect of a fire in 2003 on Jack Lakes (on Cape York Peninsula)—the above photograph shows the lake in 1990 prior to the fire; and the lower photograph shows regrowth of melaleuca trees surrounding the lake in 2004. Photos: DERM

Weeds displace native flora by competition, shading and altering vegetation fuel loads, and subsequently change the ecology and threaten the character of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes. They can be spread as live fragments or seed by vehicles, native, domestic and feral animals, by flowing water and wind. The introduction of aquatic weeds to lakes can affect water quality, impact wildlife habitat, and cause the local extinction of some species.

Weeds that threaten coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes in Queensland include the aquatic weed species water hyacinth *Eichhornia crassipes* and salvinia *Salvinia molesta*. Salvinia can choke waterways by floating on the surface and shading out native species below. Because of its very rapid growth, eradication is only likely early in its

spread—using an integrated mechanical and herbicide control program. Larger infestations are only likely to be halted by biological control with the salvinia weevil *Cyrtobagous salviniae*. The seed of water hyacinth can be viable for up to 15 years, which also makes eradication of this weed species difficult.

Salvinia molesta is one of 20 pest species classified as a Weed of National Significance (WoNS). See the Australian Government's Weeds in Australia website <www.weeds.gov.au> for further information. In Queensland both salvinia and water hyacinth are listed as declared plants under the *Land Protection (Pests and Stock Route Management) Act 2002* – *Salvinia molesta* (Class 2), *Salvinia* spp. (Class 1), water hyacinth (Class 2). By law all landholders must try to keep their land free of Class 2 pests and it is an offence to keep or sell these plants without a permit.



Despite its pretty purple flower (above) the water hyacinth *Eichhornia crassipes* is a threat to coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes and can readily cause an infestation (below). Photos: DERM



Salvinia *Salvinia molesta* is a rapidly growing aquatic weed species. Photo: DERM



Flower of the parthenium weed *Parthenium hysterophorus*. Photo: DERM

Many other weed species affect the surrounding terrain of coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes such as parthenium weed *Parthenium hysterophorus*, which threatens the area around Lake Nuga Nuga in the Brigalow Belt bioregion. Parthenium weed is a vigorously growing species that can readily take over land with sparse ground cover, particularly areas alongside roads, heavily stocked areas and watering points.

The species is a WoNS and Class 2 declared plant in Queensland. Further information about the pest (plant and animal) strategies in Queensland, declared plants (pests) and guidelines on their management can be found on the DEEDI website <www.deedi.qld.gov.au>.

Another threat to coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes from introduced plant species comes from two grasses commonly used as **ponded pasture**—para grass *Brachiaria mutica* and hymenachne *Hymenachne amplexicaulis*. Hymenachne is classified as a Class 2 declared plant in Queensland and a WoNS. Para grass and hymenachne are aggressive grasses that can completely dominate and choke coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes. As outlined under the Queensland Policy for Development and Use of Ponded Pastures, ponded pastures should not be established in or near natural wetlands due to their impacts (DNRM, 2001). Constant heavy grazing during the dry season is one method of controlling hymenachne—possibly eradicating it if the grazed plants are completely submerged in the following wet season.

Control methods for weeds vary and include manual or mechanical removal, chemical application, biological control (if available) and fire. Integrated weed control programs using more than one of these methods are likely to be the most effective. Although fire can be a highly effective control method its use needs to be thoroughly considered (see Managing fire). Similarly, it is important that land managers are well informed about chemicals used for control as they are toxic and penalties can apply if native plants and animals are harmed, particularly around wetland areas. Herbicides that only target the weed species and do not contaminate the area are preferred. All methods require follow-up and ongoing monitoring to ensure that weeds remain under control and that there are not unforeseen effects. Details about suitable herbicides and appropriate timing and methods to control most weeds can be obtained from Land Protection officers and the Australian Government's Weeds in Australia website <www.weeds.gov.au>.

Effective weed management requires coordinated planning at the national, state, regional, local and property level. Queensland pest management plans that are in place or being developed can be found on the DEEDI website <www.deedi.qld.gov.au>.

Under the *Land Protection (Pest and Stock Route Management) Act 2002* local governments must have pest management plans in place and are responsible for ensuring declared weeds and pest animals on all private and public land in their area are adequately controlled.



Para grass *Brachiaria mutica* (above) and hymenachne *Hymenachne amplexicaulis* (below) are two introduced plant species commonly used as ponded pasture. Photos: DERM



Hymenachne is an aggressive grass that can readily dominate coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes if unmanaged. Photo: DERM

Although a comprehensive list of weed species is not available for all coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes in Queensland, local Land Protection officers and local government weed and pest officers are a valuable starting point to aid land managers identify which weed species occur in their area, and can provide information about other pest plant and animal issues in Queensland. Greening Australia might also be able to provide advice <www.greeningaustralia.org.au>.



Coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes are a valuable resource and need to be managed sustainably. Photos: John McCabe, DERM

Glossary

Alluvial Soil that contains clay, silt, sand or gravel deposited by running water, for example by streams.

Biodiversity The variety of plants, animals and other living organisms that occur in a particular area or region. Biodiversity includes habitat diversity, species diversity and genetic diversity.

Bioregion (biogeographic region) An area of the continent defined by a combination of particular geology, landforms, climate and vegetation. For the definition of regional ecosystems, the bioregions of Sattler and Williams (1999) are adopted.

Bonn Convention The Convention on the Conservation of Migratory Species of Wild Animals, to which Australia is a signatory, and a Range State for many migratory species.

Brackish Water with a salt content between that of freshwater (0-5 parts per thousand) and normal marine water (35 parts per thousand).

CAMBA The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment is a treaty that aims to protect and conserve the birds and their habitat of those species that migrate between China and Australia.

Catchment The area of land that collects rain that then flows into a waterway.

Crustaceans Animals with jointed legs and segmented body, that have a hardened outer shell, for example, crabs and shrimps.

Cultural services Non-material benefits derived from ecosystems such as recreational, spiritual, religious benefits.

Ecosystem services The benefits people obtain from ecosystems including regulating, cultural, provisioning and supporting services.

Ecotone A transition zone between two or more ecological communities.

Endemic Found only in one particular area.

Environmental value Under the Queensland *Environmental Protection Act 1994*, an environmental value is defined as (a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or (b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation (see www.legislation.qld.gov.au).

Eutrophication The process by which lakes and ponds become enriched with dissolved nutrients, resulting in increased growth of algae and other microscopic plants.

Hydrology The science dealing with the properties, distribution and circulation of water.

Invertebrates Animals without a backbone (for example insects, worms and snails).

IUCN Red List A list of globally threatened species assessed and maintained by the World Conservation Union (IUCN). The List provides taxonomic, conservation status and distribution information and highlights those species or groups of species that are facing a higher risk of global extinction.

JAMBA The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment is a treaty that aims to protect and conserve the birds and their habitat of those species that migrate between Japan and Australia.

Lacustrine Pertaining to lakes – includes wetlands and deepwater habitats that might be tidal or non-tidal with ocean salinity less than 1 part per thousand.

Land zone This is a simplified geology/substrate landform classification developed for Queensland. There are twelve different land zones.

Macroinvertebrates Animals without a backbone that are visible to the naked eye.

Macrophytic An aquatic plant that can be seen without the aid of a microscope.

Microinvertebrates Animals without a backbone that cannot be seen without a microscope.

Middens An accumulation of debris and domestic refuse (such as shells and animal bones) which marks the site of prehistoric settlement or use.

Migratory (Bonn Convention definition) 'Migratory species' means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.

Moulting The process by which an outer body covering (such as fur, skin or feathers) is shed periodically.

Perennial Lasting throughout the year or through many years.

Phytoplankton Microscopic green plants such as algae.

Ponded pasture The practice developed by pastoralists to create an environment by either the construction of banks or the modification of naturally wet areas, in which freshwater is impounded or used primarily to grow suitably adapted plant species and produce fodder for grazing.

Provisioning services Products obtained from ecosystems such as food and water.

Pugging Soil damage (compaction) caused by grazing animals when their weight cannot be supported by the soil surface such as deep footprints of cattle in muddy areas.

Regional ecosystem The vegetation community that is consistently associated with a particular combination of geology, landform and soil (see Sattler and Williams 1999).

Regulating services Benefits obtained from the regulation of ecosystems processes such as regulation of floods, drought, land degradation and disease.

Remnant A small surviving component of an original extent; remnant vegetation includes all intact and predominantly intact vegetation communities, excluding young regrowth.

Riparian zones Areas adjacent to creeks, rivers, lakes and wetlands, including banks and floodplains, which exert a direct influence on the water and aquatic ecosystems.

Saline Water that contains salt (NaCl).

Siltation The process by which soil particles and small rock fragments are picked up by air or water and deposited as sediment on the beds of streams or lakes.

Sp./Spp. Sp. is an abbreviation for 'species' and is often used when the genus is known, but the species is not. For example, *Eucalyptus* sp. Means an undetermined species of *Eucalyptus*. Spp. is an abbreviation for more than one species without naming them individually.

Supporting services Ecosystem services that are necessary for the production of all other services such as soil formation, nutrient cycling and primary production.

Topographic Relating to the shape of the land in terms of elevation, slope and orientation.

Zooplankton Floating or weakly mobile microscopic or barely visible aquatic animals that eat algae.

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Appendixes

Appendix 1: Threatened and migratory fauna commonly associated with Queensland's coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes.

Taxon group	Common name	Scientific name	NC Act status*	EPBC Act status*	IUCN Red List of threatened species status **
Birds	common greenshank	<i>Tringa nebularia</i>	–	listed migratory species [‡]	–
	Latham's snipe	<i>Gallinago hardwickii</i>	–	listed migratory species [‡]	–
Reptiles	Dunmall's snake	<i>Furina dunmali</i>	vulnerable	vulnerable	vulnerable
	ornamental snake	<i>Denisonia maculata</i>	vulnerable	vulnerable	vulnerable

* Under the Queensland *Nature Conservation Act 1992* threatened wildlife are those species listed as presumed extinct, endangered or vulnerable. Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* threatened wildlife includes species listed as extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.

** The IUCN Red List of threatened species is an internationally recognised inventory for the conservation status of plant and animal species worldwide.

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* listed migratory species include those species listed in appendices to the Bonn Convention, and in CAMBA and JAMBA.

Appendix 2: Threatened flora commonly associated with Queensland's coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes.

Taxon group	Common name	Scientific name	NC Act status*	EPBC Act status*
Aquatic plant	frogbit	<i>Hydrocharis dubia</i>	vulnerable	vulnerable
Sedges/ grasses	–	<i>Arthraxon hispidus</i>	vulnerable	vulnerable
	–	<i>Paspalidium udum</i>	vulnerable	–

* Under the Queensland *Nature Conservation Act 1992* threatened wildlife are those species listed as presumed extinct, endangered or vulnerable. Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* threatened wildlife includes species listed as extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.

Appendix 3: Wetlands in Queensland which are listed in *A Directory of Important Wetlands in Australia* (2005) and/or are Ramsar sites and that include coastal and sub-coastal floodplain lakes and coastal and sub-coastal non-floodplain soil lakes.

Bioregion	Directory reference	Directory wetlands	Ramsar wetlands
Gulf Plains	QLD103	Buffalo Lake Aggregation	–
	QLD109	Mitchell River Fan Aggregation	–
Cape York Peninsula	QLD057	Archer River Aggregation	–
	QLD058	Bull Lake	–
	QLD065	Marina Plains — Lakefield Aggregation	–
	QLD068	Northern Holroyd Plain Aggregation	–
	QLD077	The Jack Lakes Aggregation	–
Einasleigh Uplands	QLD086	Great Basalt Wall	–
	QLD089	Lake Lucy Wetlands	–
	QLD091	Minnamoolka Area	–
	QLD092	Poison Lake	–
	QLD095	Valley of Lagoons	–
	QLD096	Wairuna Lake	–
	QLD097	Walters Plains Lake	–
Brigalow Belt	QLD006	Lake Dalrymple	–
	QLD007	Lake Elphinstone	–
	QLD013	Fitzroy River Floodplain	–
	QLD014	Hedlow Wetlands	–
	QLD015	Lake Broadwater	–
	QLD016	Lake Nuga Nuga	–
	QLD018	Palm Tree and Robinson Creeks	–
	QLD204	Scartwater Aggregation	–
	QLD206	The Serpentine Aggregation	–

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