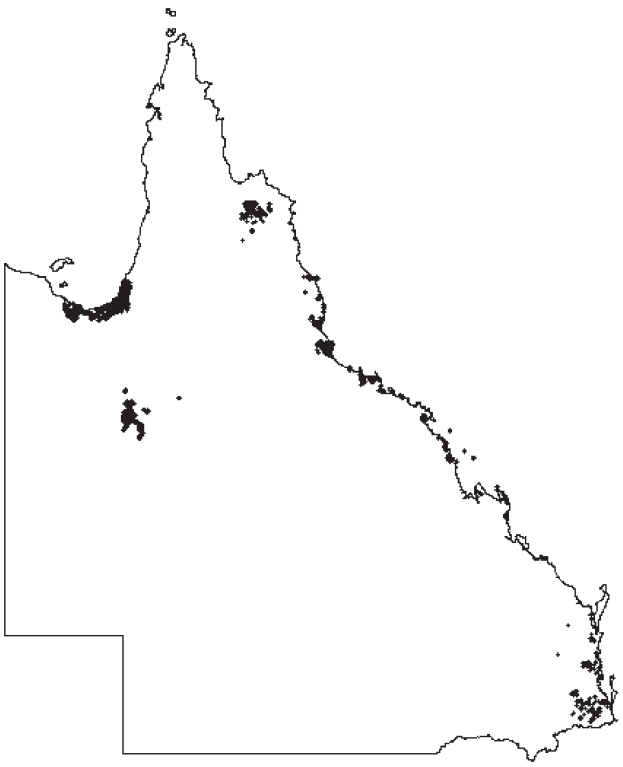
Australian Government

Queensland Government

WETLAND MANAGEMENT PROFILE

COASTAL GRASS-SEDGE WETLANDS

Coastal grass-sedge wetlands are typified by temporary inundation and seasonal dominance of grasses and sedges such as "bulkuru" spike-rush and Australian rice. They occur in all of Queensland's coastal bioregions, commonly within wetland complexes. Despite providing important feeding sites for magpie geese, other waterbirds and livestock, many have been drained, converted to cropland, infested with weeds, over-grazed or damaged by pigs. These impacts can be countered with well-informed property planning and coordinated management action across catchments.



Map showing the distribution of coastal grass-sedge wetlands in Queensland.
Map: EPA

Description

For the purpose of this wetland management profile, coastal grass-sedge wetlands have been defined as occurring in land zone 1 or land zone 3, in coastward draining catchments. Coastal grass-sedge wetlands in these land zones comprise the largest and most widespread examples of this type in Queensland. Wetlands that include grasses and/or sedges and that occur in land zone 2 or in inland draining catchments, or that are fed by springs of the Great Artesian Basin, are addressed in separate wetland management profiles in this series (see www.epa.qld.gov.au/nature_conservation/habitats/wetlands/wetland_management_profiles/ for further information).

The geomorphologic setting for coastal grass-sedge wetlands is minor basins, small depressions and poorly drained flats on marine or alluvial plains with gentle or minimal slope. They can be classified as palustrine wetlands ("swamps"), distinct from riverine wetlands (for example "billabongs"), which occur in channels, and from lacustrine wetlands ("lakes"), which occur in major basins and are for the greater part free of emergent vegetation.

The soil of coastal grass-sedge wetlands typically is heavy, dark clay that was originally deposited by streams or the ocean. On marine plains the underlying substrate may have a high salt content but may be overlaid with more recent alluvial deposits that are not saline. Although coastal grass-sedge wetlands support perennial vegetation, commonly the above-ground growth collapses and desiccates in the dry season and may be scattered by the wind.

THE most conspicuous feature of coastal grass-sedge wetlands is dominance by grasses and/or sedges with a general trend towards grass dominating in the north and sedges dominating in the east coast catchments.

The setting for coastal grass-sedge wetlands dictates that they do not have capacity to retain any great depth of water. Accordingly, inundation is usually temporary, ranging from a few weeks each year during periods of heavy rain and flash flooding, to many months. In some cases, the wetlands may dry out only for a short period in the dry season or may remain wet in the innermost parts.

Complex networks of shallow depressions and channels, Torilla Plain.
Photo: Roger Jaensch, Wetlands International

Coastal grass-sedge wetland dominated by spike-rush *Eleocharis* sp..
Photo: Roger Jaensch, Wetlands International

Aerial view of *Eleocharis* swamps.
Photo: Roger Jaensch, Wetlands International

All coastal grass-sedge wetlands are dominated by the influence of fresh water. Supply of this fresh water may be from streams leading directly to the site, sheet flow across floodplains, surface expression of groundwater, or a combination of these sources. Certain types of coastal grass-sedge wetlands on marine plains are also inundated during high or extremely high tides by saline water and the plants in them are salt tolerant.

A feature of some coastal grass-sedge wetlands is countless micro-depressions up to a few metres in diameter, known as "gilgai", "debil-debil" or "crab-hole" country. On some marine plains, notably the Torilla Plain in central Queensland, coastal grass-sedge wetlands occur within highly complex networks of shallow depressions and channels (see photo).

As implied by the name, the most conspicuous feature of coastal grass-sedge wetlands is dominance by grasses (family Poaceae) and/or sedges (principally, family Cyperaceae). Most examples include both grasses and sedges and there is no clear division of coastal grass-sedge wetlands into sub-types. However, in near-natural examples, there is a general trend towards grass dominating in the north (Gulf of Carpentaria catchments) and sedge dominating elsewhere (east coast catchments). Detail on species composition of the flora of these wetlands is given in the Ecological values sections, below.

Waterbirds are the most conspicuous component of the fauna of coastal grass-sedge wetlands. Most of the major waterbird groups are represented because these wetlands provide abundant food for species that feed in dense cover as well as those that prefer open areas. Open areas can exist as small features in these wetlands or can expand at the times when water is deepest (and much vegetation is submerged) and when vegetation has collapsed. Frogs can be abundant and evident in breeding season by their persistent calling; in turn they attract snake and bird predators. During inundation, invertebrates drive the food web and larger animals such as freshwater crayfish and crabs may occur. Where there is connectivity to streams and/or the sea, fish may occur in season, supporting waterbird predators. Rodents and other small mammals can exploit the dense cover and seasonal availability of food (for example seed) in coastal grass-sedge wetlands. Detail on species composition of fauna of these wetlands is given in the Ecological values sections, below.

Coastal grass-sedge wetlands adjoin or merge with a wide range of other wetland types. On marine plains, they lie between saltmarsh wetlands and upland (non-wetland) ecosystems; on alluvial plains they may lie between river channels/levees and the high ground at the floodplain edge, surrounded by infrequently inundated floodplain and often they occur patchily within complexes of wetland types such as coastal melaleuca swamps and braided river channels. Frequently, the boundaries of each type are not clear and may change over time as determined by patterns of rainfall and flooding. A consequence of these patterns is that coastal grass-sedge wetlands must be managed in an integrated way with other wetland types on marine and alluvial plains.

Transition from saltmarsh wetland to coastal grass-sedge wetland.
Photo: Roger Jaensch, Wetlands International

Distribution

All of Queensland's coastal bioregions include coastal grass-sedge wetlands though these wetlands tend to be distributed patchily and irregularly through the coastal zone. Many coastal grass-sedge wetlands, especially in remote areas, are too small to be mapped at the usual scales of vegetation mapping (1:100,000 or 1:250,000) conducted by the Queensland Herbarium (see www.epa.qld.gov.au/nature_conservation/plants/queensland_herbarium/survey_and_mapping/ for further information). Few specific coastal grass-sedge wetlands stand out as being notable for their large size. Preliminary investigations suggest the largest, intact, connected examples of coastal grass-sedge wetlands are not contained within protected areas, state forests or reserves, but on privately managed freehold or leasehold land.

PRELIMINARY investigations suggest the largest, intact, connected examples of coastal grass-sedge wetlands are not contained within protected areas, state forests or reserves, but on privately managed freehold or leasehold land.

Land managers who understand these values and implement good land management practices will contribute to the conservation of these wetlands.

The distribution of coastal grass-sedge wetlands largely matches the distribution of poorly drained, major alluvial and marine plains. Sections of coast lacking such plains, particularly high or sand-mass coast, therefore hold few coastal grass-sedge wetlands or only small examples. Coastal melaleuca swamp wetlands (see www.epa.qld.gov.au/nature_conservation/habitats/wetlands/wetland_management_profiles/ for further information) frequently occupy similar places in the landscape, so wherever they are prominent, coastal grass-sedge wetlands may be less common, though complexes comprising both types are widespread.

No well-defined links between rainfall quantity or seasonality and the distribution of coastal grass-sedge wetlands have been identified. However, in keeping with the general pattern of vegetation distribution in Queensland, it is likely that (in the pre-clearing scenario) coastal plains in areas with highest or least seasonal rainfall tended to support forested/wooded wetlands more so than tree-less wetlands.

Queensland conservation status

There are 16 regional ecosystems (REs), or units within regional ecosystems, that contain coastal grass-sedge wetlands in Queensland (see Appendix 1). Ten of these (REs 2.3.2, 7.1.3, 7.3.1, 8.1.4, 8.3.4, 11.1.3, 11.3.27x1a, 11.3.27x1b, 11.3.27x1c and 12.3.8) have been assigned as "of concern" or "endangered" under the Queensland *Vegetation Management Act 1999* (VM Act) and/or by the Environmental Protection Agency (EPA) (see www.epa.qld.gov.au/nature_conservation/biodiversity/regional_ecosystems/ and Appendix 1).

Grasses and/or sedges are prominent components of some REs that occur in other land zones or catchments (see Description section, above).

FISH habitats and marine plants, including saltwater couch (common in coastal grass-sedge wetlands), are protected under the Queensland *Fisheries Act 1994*.

A number of protected areas in Queensland contain small examples of coastal grass-sedge wetlands (see Appendix 1) such as Lakefield, Eubenangee Swamp and Bowling Green Bay National Parks and the Townsville Town Common in the north. In central Queensland conservation parks on Curtis Island, at Bakers Creek and in Sandringham Bay and Curtis Island National Park provide examples of coastal grass-sedge wetlands in protected areas. Examples of these wetlands in south-east Queensland do exist, but are small and part of broader wetland complexes such as those in Noosa National Park and Toolara State Forest.

Coastal grass-sedge wetlands are represented in 47 nationally important wetlands listed in *A Directory of Important Wetlands in Australia* (2005) (see Appendix 4). There are a number of pieces of legislation such as the Queensland *Integrated Planning Act 1997* that include planning, assessment and permit requirements relating to wetlands listed in the Directory. Any activities that may impact on Directory wetlands (and potentially wetlands in general) must be consistent with this legislation.

The *State Coastal Management Plan — Queensland's Coastal Policy* (2001) and regional coastal management plans provide direction for conserving, protecting and managing coastal wetlands, including coastal grass-sedge wetlands. These plans are statutory documents under the Queensland *Coastal Protection and Management Act 1995* which guide activities undertaken in coastal areas of the state.

Fish habitats are managed under the Queensland *Fisheries Act 1994* by the Department of Primary Industries and Fisheries. This act protects and manages marine plants, including saltwater couch (also known as sand or marine couch) *Sporobolus virginicus*, which commonly occurs in coastal grass-sedge wetlands. Important areas of fish habitat including coastal grass-sedge wetlands are also protected within declared Fish Habitat Areas (FHAs; see Appendix 1).

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 and their environmental values, having considered such things as the sensitivity of the wetland, recommended practices and financial implications. Coastal grass-sedge wetlands have a range of environmental values related to ecological health, public amenity and safety. Some of these values are described in the Cultural heritage values and Ecological values sections below.

Coastal grass-sedge wetlands in Eubenangee Swamp National Park. Photo: EPA

National conservation status

Bowling Green Bay, the Shoalwater and Corio Bays and Moreton Bay are Ramsar sites (Wetlands of International Importance under the Ramsar Convention) that contain coastal grass-sedge wetlands. The Wet Tropics and Great Barrier Reef World Heritage Areas as defined in the World Heritage List maintained by the World Heritage Convention, also include areas of grass-sedge wetland. The Shoalwater Bay Training Area (Byfield) is a Commonwealth heritage place under the Commonwealth Heritage List, and includes coastal grass-sedge wetlands. There are also migratory shorebirds that inhabit coastal grass-sedge wetlands in Queensland, which are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (that is, they are listed under the Japan-Australia and China-Australia Migratory Bird Agreements (JAMBA/CAMBA respectively) and/or the Bonn Convention) (see Species of conservation significance and Appendix 2).

Five plants and 12 animals that inhabit coastal grass-sedge wetlands in Queensland are listed as threatened under the EPBC Act, the Queensland *Nature Conservation Act 1992* (NC Act) and/or the IUCN Red List (see Species of conservation significance and Appendices 2 and 3).

Ramsar wetlands, listed migratory species, threatened species, World Heritage properties and Commonwealth heritage places are matters of national environmental significance under the EPBC Act and, as such, are afforded protection under the Act. Any action that will, or is likely to, have a significant impact on a declared Ramsar wetland, listed migratory species, threatened species, World Heritage property, or Commonwealth heritage place will be subject to an environmental assessment and approval regime under the EPBC Act.

For each of these Ramsar and World Heritage sites, management plans or equivalent are in place; in some instances they may not apply to the entire Ramsar site.

Cultural heritage values

All wetland ecosystems are of material and cultural importance to Indigenous people and many will have profound cultural significance and values. Less than 20 Indigenous cultural heritage sites have been formally documented within coastal grass-sedge wetlands in Queensland. However, most coastal grass-sedge wetlands have not been systematically surveyed or assessed for cultural heritage significance.

THE most commonly recorded cultural heritage sites in coastal grass-sedge wetlands are stone artefact scatters associated with on-site food and fibre processing and open camp occupation sites. These are likely to be found on higher ground.

There is a moderate likelihood of encountering cultural heritage sites within and adjacent to coastal grass-sedge wetlands. Evidence of traditional occupation and use recorded within coastal grass-sedge wetlands includes burials, middens, stone artefacts and scatters, story places and sites for cultural activities. The most commonly recorded sites within coastal grass-sedge wetlands are stone artefact scatters associated with on-site food and fibre processing and open camp occupation sites.

Cumbungi *Typha* sp. was traditionally used by Indigenous people as a food source (roots and pollen).
Photo: Roger Jaensch, Wetlands International

These sites are likely to be found in areas of higher ground within or along the margins of coastal grass-sedge wetlands.

Coastal grass-sedge wetlands are moderately productive traditional food and fibre resource areas providing a range of animal and plant species. For example, the following were all staple or supplementary food sources: the seeds of saltwater couch *Sporobolus virginicus*; the roots, tubers and bulbs of bulkuru *Eleocharus dulcis*; the tubers of water ribbons *Triglochin procerum*; seeds of wild rice *Oryza* spp. (reportedly sometimes stored for up to four years); leaves and shoots of the common reed *Phragmites australis*; seeds of nutgrass sedges *Cyperus* spp. and the young shoots, roots and pollen of cumbungi *Typha* spp.. The sap of cumbungi was used for leech protection and cordage was made from the plant fibre. *Pandanus* spp. were also useful food trees of high nutritional value. Many other species were also used traditionally for food and shelter, for making implements, bags and nets, and for medicinal purposes.

Archaeological evidence of cultural sites, such as stone artefacts and shells, are often concentrated along ecotones around the margins of coastal grass-sedge wetlands 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 grass-sedge wetlands also have non-Indigenous (historic) cultural heritage significance, although most have not been surveyed or assessed for historic heritage values. The historic heritage values of coastal grass-sedge wetlands will demonstrate past occupation and use associated primarily with livestock grazing and agriculture. It is important to note that evidence of Aboriginal occupation is often encountered at historic sites.

Ecological values — introduction

Coastal grass-sedge wetlands are key components of the landscape of the coastal zone and provide ecosystem services that include:

- provisioning services, such as fodder for livestock;
- regulating services, such as retention of nutrients and sediments;
- cultural services, such as opportunities for nature observation; and
- supporting services, such as breeding/nursery habitat for waterbirds and fishes.

Across the range of occurrence of coastal grass-sedge wetlands in Queensland, a moderate number of plant, bird and other animal species occur.
Like some other wetland types, plant communities in coastal grass-sedge wetlands are not as rich in species as some dry-land ecosystems, but coastal grass-sedge wetlands hold more plant species than some other coastal wetland types, notably saltmarshes. The total number of waterbird species occurring is usually higher in coastal grass-sedge wetlands than in saltmarshes or mangroves, probably due to the presence of fresh water in most coastal grass-sedge wetlands. During high tides and wet season floods, some coastal grass-sedge wetlands may be interconnected with mangroves and saltmarshes and some fishes that tolerate lower salinities and exposed habitats will move from the mangroves into the coastal grass-sedge wetlands.

Given the high mobility of birds and fishes that inhabit coastal grass-sedge wetlands and the connectivity of many coastal wetlands, not surprisingly, there are no birds or fishes that occur exclusively in coastal grass-sedge wetlands. Proximity of other wetland types also contributes to the lack of plants that are endemic to coastal grass-sedge wetlands.

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Ecological values — flora

In the Gulf Plains and Cape York bioregions, prominent components of coastal grass-sedge wetlands are indigenous grasses of the rice *Oryza* and panic *Panicum* genera (*O. rufipogon, O. australiensis, P. trachyrhachis, P. trichoides*, pepper grass *P. laevinode*). Other grasses likely to be present include *Xerochloa imberbis* and saltwater couch *Sporobolus virginicus* in more saline areas and spiny mudgrass *Pseudoraphis spinescens* and some widespread grasses such as *Dicanthium* spp. in non-saline areas. In regard to sedges, bulkuru *Eleocharis dulcis*, often with *E. spiralis*, may dominate in some sites especially those with saline influence and coastal grass-sedge wetlands in these bioregions commonly include *Fimbristylis* spp..

A typical grass found in northern coastal grass-sedge wetlands, *Panicum trachyrhachis*.
Photo: Roger Jaensch, Wetlands International

Along the east coast of Queensland, undisturbed coastal grass-sedge wetlands are commonly dominated by the sedges *Schoenoplectus litoralis* (where saline influence is greatest) and bulkuru (moderate or low saline influence). Other sedges in the more saline sites include *Eleocharis philippensis*, *Cyperus scariosus* and *Fimbristylis ferruginea*. Moving into the coastal grass-sedge wetlands that are influenced more by fresh water, these sedges may be replaced by tall spikerush *Eleocharis sphacelata*, *Cyperus alopecuroides*, bunchy sedge *C. polystachyos*, soft twigrush *Baumea rubiginosa*, *Bolboschoenus fluviatilis*, *Juncus* spp., and *Scleria* spp.. Cumbungi *Typha* spp. and the tall robust sedges — jointed twigrush *Baumea articulata* and *Lepironia articulata* — may dominate in patches. As for grasses, saltwater couch and *Paspalum vaginatum* typically occur in saline coastal grass-sedge wetlands along the east coast. These give way to water couch *P. distichum*, swamp ricegrass *Leersia hexandra*, *Ischaemum* spp. and some widespread grasses such as *Chloris* spp. in the freshwater regimes. Common reed may occur in tall clumps in both saline and freshwater sites.

Seed head of the sedge *Cyperus alopecuroides*.
Photo: Roger Jaensch, Wetlands International

Sedge *Schoenoplectus litoralis* swamp.
Photo: Roger Jaensch, Wetlands International

Depending on substrate, temperature, water depth, and frequency and duration of inundation, coastal grass-sedge wetlands in north Queensland may support thickets of tall forbs such as the legumes sesbania pea *Sesbania cannabina* and budda pea *Aeschynomene indica* (which tend not to be prolific in consecutive years), and other erect forbs notably *Ludwigia perennis*, *Melochia corchorifolia* and *Caldesia oligococca*.

Budda pea *Aeschynomene indica* is a legume that can be found in coastal grass-sedge wetlands.
Photo: Roger Jaensch, Wetlands International

They can also include floating marshworts *Nymphoides* spp., tiny waterlily *Nymphaea nouchali* (Wet Tropics) and bog lily or native water hyacinth *Monochoria cyanea* in deeper or more open parts of the wetland; also the water fern *Ceratopteris thalictroides* (see box). Many of the forbs also occur in coastal grass-sedge wetlands along the central and south-east coast.

Aquatic plants such as water snowflake *Nymphoides indica* are found in some coastal grass-sedge wetlands. Photo: Roger Jaensch, Wetlands International

Waterlilies *Nymphaea* sp. are found in some coastal grass-sedge wetlands.
Photo: Roger Jaensch, Wetlands International

Notable additions include: the erect smartweeds *Persicaria* spp., also willow primrose *Ludwigia octovalvis* and jerry-jerry *Ammannia multiflora*; mat forming nardoo *Marsilea mutica* (a fern) and *Phyla* spp.; and floating *Ottelia* spp., water primrose *Ludwigia peploides* and water ribbons *Triglochin procerum*.

Occasional trees and shrubs may be encountered in coastal grass-sedge wetlands, especially along traversing channels. Examples include *Pandanus* spp., gutta-percha *Excoecaria parvifolia* and the palm *Corypha utan* in the north, and mangroves (in saline sites), *Melaleuca* spp. and *Eucalyptus* spp. throughout Queensland coastal areas.

At the late stages of the wet season, plant communities are in full vigour and can occupy most if not all of the wetland area. Vegetation rarely exceeds 2m in height and is mostly below 1m; often the tallest dominant plants are of a uniform height across the wetland. At the driest time of year, some coastal grass-sedge wetlands may display a persistent cover of erect (though partly collapsed) vegetation whereas others may have little if any erect vegetation. The vegetation communities include both perennial and annual plants, so the return of inundation will enable perennials to re-shoot from below-ground rhizomes or tubers or above-ground tussocks and annuals will grow from seed in the soil or carried in flood waters.

BULKURU

The sedge "bulkuru" *Eleocharis dulcis* is widespread in the Asia Pacific region including northern Australia. Named as a "spike-rush" by botanists, the common name "bulkuru" has long been applied in Queensland. Usually this plant grows on marine plains subject to a past or present regime of tidal inundation, often together with other salt tolerant species such as *E. spiralis*, whereas other common members of the genus — notably, tall spikerush *E. sphacelata* — prefer freshwater regimes. In the wet season its hollow, erect stems form dense green swards that may totally occupy a wetland. The most important feature of bulkuru is its substantial below-ground tuber — this was sought after by Aboriginal people and in parts of Asia, forms of this plant with large tubers have been cultivated to produce edible water chestnuts. Tubers are dug up in the dry season by magpie geese *Anseranas semipalmata* and brolgas *Grus rubicunda*, also by feral pigs *Sus scrofa* (see below), leaving a churned soil surface.

Bulkuru *Eleocharis dulcis* in a typical coastal grass-sedge wetland. Photo: Roger Jaensch, Wetlands International

However a greater threat is replacement by exotic pasture grasses (see below). In parts of south-east Asia and some Pacific Islands, the green stems of this plant are woven into mats. In some respects bulkuru is a resilient component of coastal grass-sedge wetlands under pastoral grazing regimes because it regrows from below ground parts in the wet season, when inundation restricts stock access.

AUSTRALIAN RICE

The original source of rice that is grown commercially in Australia today is the Asian wetland plant *Oryza sativa*. In tropical Australia, several species of this genus naturally occur, including *O. australiensis* and *O. rufipogon*. In the wet season, these plants may grow to 1m or 2m in height, either as isolated tussocks or in dense patches or swards, but they bend under the weight of mature stalks and seeds and eventually collapse and dry out. The seeds are attached to long silvery awns (forming "beards") and are smaller than commercial rice grains. In coastal floodplains of the Northern Territory, Australian rice is a key component of the food chain, providing food for young magpie geese, and for native rats that, in turn, are predated by snakes and other animals. In Queensland, the plant mainly occurs in Gulf of Carpentaria catchments and is a prominent feature of four REs (see Appendix 1). Little is known about management issues in Queensland but the disappearance of wild rice from some large wetlands of the Barkly Tableland of the Northern Territory has been attributed to unsustainable grazing practices.

Spikelet of Australian rice *Oryza australiensis.*
Photo: Watson and Dallwitz

WATER FERN

The water fern *Ceratopteris thalictroides* is widespread in Queensland's coastal grass-sedge wetlands and occurs in many tropical countries. It is a small, brittle fern that may be erect, floating or submerged and it reproduces both by spores and fragments. It is edible to humans and the leafy parts are commonly eaten raw or as cooked green vegetable; it is also used in Chinese medicine and cultivated as an aquarium plant.

Water fern *Ceratopteris thalictroides.*
Photo: Roger Jaensch, Wetlands International

WHEN water depth and food resources are optimal an abundance of large waterbirds comprising magpie geese, ducks, egrets, ibises, cranes, stilts and/or terns may be encountered in coastal grass-sedge wetlands.

Ecological values — fauna

Visitors to coastal grass-sedge wetlands may, at times, see little evidence of animal life. However, when water depth and food resources are optimal, an abundance of large waterbirds comprising magpie geese, ducks, egrets, ibises, cranes, stilts and/or terns may be encountered.

Abundant waterbirds that commonly feed in coastal grass-sedge wetlands in Queensland include: magpie goose *Anseranas semipalmata* (see box), plumed whistling-duck *Dendrocygna eytoni* and Pacific black duck *Anas superciliosa* (principally vegetarian); great egret *Ardea alba*, intermediate egret *A. intermedia* and the aerial-feeding white-winged black tern *Chlidonias leucopterus* (carnivorous/insectivorous); and glossy ibis *Plegadis falcinellus* and purple swamphen *Porphyrio porphyrio* (omnivorous). Some species, generally less abundant, are principally found in coastal grass-sedge wetlands in tropical regions, for example wandering whistling-duck *D. arcuata* and green pygmy-goose *Nettapus pulchellus* (vegetarian); and pied heron *Ardea picata* and black-necked stork *Ephippiorhynchus asiaticus* (carnivorous). Though probably plentiful overall, the small rails such as buff-banded rail *Gallirallus philippensis*, Baillon's crake *Porzana pusilla*, and white-browed crake *Porzana cinerea* (northern areas) are rarely-seen but typical inhabitants of coastal grass-sedge wetlands. In coastal Queensland, one bird of prey, the swamp harrier *Circus approximans*, obtains its animal food mainly in coastal grass-sedge wetlands. A suite of migratory shorebird species feeds in muddy, shallow parts of coastal grass-sedge wetlands (see Species of conservation significance).

Some waterbirds depend on or frequently use coastal grass-sedge wetlands for breeding: magpie geese and whiskered terns *Chlidonias hybridus* nest in colonies in bulkuru swamps around the time of peak water depth; radjah shelducks *Tadorna radjah* raise crèches of juveniles in sheltered channels through saline swamps; brolgas (tropical coast) and sarus cranes *Grus antigone* (on western Cape York, which is the

Intermediate egret *Ardea intermedia* feed in coastal grass-sedge wetlands. Photo: EPA

Buff-banded rail *Gallirallus philippensis* prefers habitat of dense vegetation or tussock grasses close to swamps, watercourses or on coastal islands. Photo: EPA

species' core breeding area in Australia) attend their nest mounds in coastal grass-sedge wetlands; and comb-crested jacanas *Irediparra gallinacea* place floating nests among waterlilies within grass-sedge swamps. Black swans *Cygnus atratus* and black-winged stilts *Himantopus himantopus* often nest in coastal grass-sedge wetlands, on mounds in more open parts that have been established, for example, because of saline inundation.

The little bittern *Ixobrychus minutus*, occurs principally in coastal grass-sedge wetlands in Queensland but, being secretive, is not often reported. This tiny heron favours inundated dense beds of tall common reed, cumbungi and probably *Lepironia articulata*, where it feeds on tadpoles, fish and invertebrates and may place its nest. Birds on migration to or from southern Australia and (presumably) New Guinea may occur in dense cover in other wetland or non-wetland habitats.

Brolga *Grus rubicunda* nest and eggs in a coastal grass-sedge wetland.
Photo: Roger Jaensch, Wetlands International

Brolgas *Grus rubicunda* performing the elaborate courtship and bonding dance. During the dry season brolgas may congregate in flocks of several hundreds, but during the wet season, form territorial pairs in shallow wetlands to breed. Photo: EPA

Black-winged stilts *Himantopus himantopus* in a coastal grass-sedge wetland.
Photo: Roger Jaensch, Wetlands International

A small number of other bird species are common inhabitants of coastal grass-sedge wetlands, for example clamorous reed-warblers *Acrocephalus stentoreus* (insectivorous) and chestnut-breasted mannikins *Lonchura castaneothorax* and other finches (seed-eaters). Two shy insectivorous species, the zitting cisticola *Cisticola juncidis* and yellow chat *Epthianura crocea*, each have two subspecies that are patchily distributed in coastal grass-sedge wetlands and adjacent saltmarsh grassland in Queensland (see Species of conservation significance section).

Relatively little information is available about other animals in coastal grass-sedge wetlands. A range of snakes, frogs, fishes and invertebrates occur, with many being important food items for waterbirds. The eastern snapping frog *Cyclorana novaehollandiae* and the green striped burrowing frog *Cyclorana alboguttata* are typical frogs of coastal grass-sedge wetlands, as are the northern dwarf tree frog *Litoria bicolour*, eastern dwarf tree frog *Litoria fallax*, tawny rocket frog *Litoria nigrofrenata* and the bumpy rocket frog *Litoria inermis*. Freshwater crayfish and crabs, leeches and dragonflies (nymphs and adults) are typical inhabitants. In sites that are connected by channels to tidal areas, juveniles of barramundi *Lates calcarifer*, mullets and other fishes may use coastal grass-sedge wetlands (especially saline examples) as nursery areas (see *Saltmarsh wetlands* management profile www.epa.qld.gov.au/nature_conservation/habitats/wetlands/wetland_management_profiles/).

Bumpy rocket frog *Litoria inermis*. Photo: EPA

Eastern snapping frog *Cyclorana novaehollandiae*.
Photo: Craig Eddie, EPA

MAGPIE GOOSE

With an estimated population size exceeding one million birds, considerable body size and pied plumage, the magpie goose *Anseranas semipalmata* is one of Australia's most abundant and recognisable waterbirds. It occurs patchily throughout coastal Queensland with largest aggregations on western Cape York. Flocks of thousands still occur on the east coast, notably in the lower Fitzroy River wetlands, Torilla Plain, Goorganga Plain and Townsville to Bowen wetlands, but loss of wetland habitats to agriculture has reduced numbers. Magpie geese favour coastal grass-sedge wetlands dominated by bulkuru *Eleocharis dulcis* because they consume the mature bulkuru tubers and may nest in the bulkuru (as isolated pairs or small loose colonies) when it is inundated; nesting also sometimes occurs in *Schoenoplectus litoralis* beds and in other grass-sedge habitats. Although it is a versatile opportunist, the ecology of the magpie goose is strongly linked to the seasonal availability of bulkuru and movements around

A flock of magpie geese *Anseranas semipalmata* in a coastal grass-sedge wetland. Photo: Roger Jaensch, Wetlands International

Queensland and farther a field (possibly some to New Guinea) are likely timed in part to exploit this resource. Ongoing loss of bulkuru wetlands and replacement by exotic pasture grasses (see below) therefore will continue to put pressure on magpie goose sub-populations in Queensland.

Species of conservation significance

Five threatened plant species and 12 threatened animal taxa (see box and below) are known to occur, or probably occur, in Queensland's coastal grass-sedge wetlands (Appendices 2 and 3).

Threatened flora that are known or thought to occur in coastal grass-sedge wetlands in Queensland comprise one aquatic plant (frogbit *Hydrocharis dubia*), three sedges (*Eleocharis blakeana, E. retroflexa* and *Fimbristylis adjuncta*) and two grasses (*Arthraxon hispidus* and *Paspalidium udum*). *P. udum* has been identified in the Townsville Town Common (see box) and surveying of locations and monitoring is ongoing, especially due to the increased competition of exotic pasture grasses.

The false water-rat (water mouse) *Xeromys myoides* (vulnerable, EPBC and NC Acts and IUCN Red List) mainly inhabits mangroves, which provide feeding habitat, and adjoining ecosystems, notably saltmarshes and coastal grass-sedge wetlands, which provide sites for this animal's nest mounds (see the *Saltmarsh wetlands* management profile www.epa.qld.gov.au/nature_conservation/habitats/wetlands/wetland_management_profiles/ for further information).
It depends on coastal landscapes where these wetland types persist as connected and fully functioning

The vulnerable frogbit *Hydrocharis dubia* occurs in coastal grass-sedge wetlands.
Photo: Paul Williams, EPA

ecosystems and is threatened by predatory animals and loss of invertebrate animals
(a food resource) due to water pollution. It is vital that water quality and natural hydrology (normal tidal and freshwater patterns and an undisturbed water table) be maintained when conducting activities on or adjacent to false water-rat habitat.

The Capricorn (Dawson) subspecies of the yellow chat *Epthianura crocea macgregori* (critically endangered, EPBC Act; endangered, NC Act) inhabits both saltmarsh and coastal grass-sedge wetlands on the Torilla Plain, Fitzroy Delta and Curtis Island of central Queensland and its population size is apparently only several hundred birds (see the *Saltmarsh wetlands* management profile www.epa.qld.gov.au/nature_conservation/habitats/wetlands/wetland_management_profiles/ for further information). In coastal grass-sedge wetlands it prefers tall stands of *Schoenoplectus litoralis* (occurring in saline wetlands) and *Cyperus alopecuroides* (lining channels and depressions in freshwater wetlands) on marine plains; it seems that after breeding in *Schoenoplectus* and saltmarsh habitats in the wet season, many birds retreat to the *Cyperus* habitats in the drier months. The gulf subspecies of yellow chat *E. c. crocea* is listed as vulnerable in Queensland (NC Act) and a poorly known population occurs, probably in coastal grass-sedge wetlands, on the Gulf Plains.

Coastal grass-sedge wetlands provide habitat for the critically endangered yellow chat *Epthianura crocea macgregori* (Capricorn/Dawson subspecies). Photo: Roger Jaensch, Wetlands International

The secretive Australasian bittern *Botaurus poiciloptilus* (endangered, IUCN Red List), is typically found in coastal grass-sedge wetlands in south-east Australia as far north as the coast of south-east Queensland but it is rarely reported and its population size and habitat preferences in this State are poorly known.

Other animals that may occur in some Queensland coastal grass-sedge wetlands and that are threatened are the crimson finch *Neochmia phaeton* (vulnerable, NC Act) and the star finch (eastern subspecies) *Neochmia ruficauda ruficauda* (endangered, NC and EPBC Acts).

Migratory shorebirds that commonly feed on exposed mud, in wet grass or sedge and/or in shallow water within coastal grass-sedge wetlands include Latham's snipe *Gallinago hardwickii*, black-tailed godwit *Limosa limosa*, marsh sandpiper *Tringa stagnatilis*, common greenshank *T. nebularia* and sharp-tailed sandpiper *Calidris acuminata*. These birds breed in Asia and are listed as migratory species under the EPBC Act (see Appendix 2). Many coastal grass-sedge wetlands in Queensland are dry in August-September, when shorebirds are migrating into Australia, but in March-April they are wet and may be key staging areas for northward migration. A number of coastal wetlands in Queensland qualify for listing in the Shorebird Site Network of the East Asian — Australasian Flyway www.deh.gov.au/biodiversity/migratory/waterbirds/infosrn1.html#sites and some include coastal grass-sedge wetlands; so far, Moreton Bay has been included in this non-regulatory network.

Though not proven to be truly migratory several waterbirds of coastal grass-sedge wetlands, notably the great egret and glossy ibis, are listed as migratory under the EPBC Act because they are included in the lists of JAMBA and/or CAMBA.

Waterbird species listed as rare in Queensland and that use coastal grass-sedge wetlands are radjah shelduck, cotton pygmy-goose *Nettapus coromandelianus*, black-necked stork, Lewin's rail *Rallus pectoralis* (east coast) and the Normanton subspecies of zitting cisticola *Cisticola juncidis normani*. The tall legume *Sesbania erubescens*, a plant found in some Gulf Plains wetlands, is also listed as rare.

AUSTRALIAN PAINTED SNIPE

The plumage of the Australian painted snipe *Rostratula benghalensis australis* (vulnerable, EPBC and NC Acts) provides good camouflage: green-brown upper parts, barred or spotted wings and grey or dark brown hood. Because of its secretive habits, the species is not often reported. In coastal regions, it inhabits coastal grass-sedge wetlands in both freshwater and saline environments, as well as lakes and saltmarshes. Recent surveys of waterbirds on marine plains in central Queensland (REs 11.1.3 and 11.3.27x1a-c) have revealed small numbers of this non-migratory shorebird and it has occasionally been reported at other coastal grass-sedge wetlands on Queensland's east coast from near Townsville to near Brisbane. Nests and/or young have been recorded from about December to May and small muddy islands with short couch grass and sparse sedge are favoured nest sites. There is no robust estimate of the population size of this species but a decline in numbers across Australia has been documented. This nomadic snipe apparently depends on networks of inland and coastal, small and large wetlands.

Nest and eggs of Australian painted snipe *Rostratula benghalensis australis.*
Photo: Roger Jaensch, Wetlands International

Major threats to its survival are reduced inundations of inland floodplains (due to river regulation and water harvesting) and loss of many coastal wetlands through drainage and agricultural development. A national recovery plan for the species is being developed and landholders can assist by halting wetland loss, optimising diversity of habitats in wetlands and minimising trampling of nesting sites by livestock.

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 commonly occurs in coastal grass-sedge wetlands in eastern Australia during the non-breeding period (August to April). Displaying barred and streaked, brown and white plumage, the Latham's snipe can also be distinguished from the (only) distantly related Australian painted snipe *Rostratula benghalensis 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 austral summer in southern Australia; some extensive coastal grass-sedge wetlands in Queensland may be important staging areas during northward migration. Although able to find its preferred invertebrate food in a variety of freshwater wetland types, including artificial and

Latham's snipe *Gallinago hardwickii* migrate from their breeding grounds in Japan for the austral summer. Photo: EPA

highly disturbed wetlands, the species has probably declined in numbers due to steady loss of coastal wetlands through drainage and conversion for agriculture and urban areas. In coastal grass-sedge wetlands, maintenance of a mosaic of dense cover and more open areas may favour this species.

Managing coastal grass-sedge wetlands

Coastal grass-sedge wetlands in Queensland occur mainly on freehold/leasehold lands (often managed as part of agricultural or grazing enterprises) but with some on government land (either local, State or Australian). The lack of grass-sedge wetland communities in protected areas highlights the importance of broader groups of land managers recognising these wetland's characteristics and managing for the values they contain. In terms of private owners/stakeholders, Indigenous ownership applies to some coastal grass-sedge wetlands on Cape York.

In some cases, a single coastal grass-sedge wetland may be managed by more than one of these stakeholders so an integrated management approach is needed. The grass-sedge wetland may also be a part of a broader wetland complex including saltmarshes, wet heath and/or coastal melaleuca swamps so management strategies may need to consider adjacent wetland types and incorporate management across this mix.

The following sections address specific management issues and responses in relation to coastal grass-sedge wetlands in Queensland.

IT is important for land managers to recognise the characteristics of coastal grass-sedge wetlands and to manage their values using an integrated approach.

Control of water flows

The most significant issue for maintaining coastal grass-sedge wetlands is cessation or reduction of water supply. This problem is prevalent in east coast catchments where agriculture has been highly developed.

Changes to water flows can occur through drainage (hence shallower and shorter inundation), as has commonly occurred on waterlogged coastal plains to provide greater access by livestock or to facilitate conversion to cropland. Draining coastal grass-sedge wetlands can favour an increase in dryland pasture species that are more susceptible to damage from deep flood events and that (not being adapted to inundation) tend to decompose rapidly accelerating oxygen depletion in the water and killing aquatic fauna that can't escape.

Water supply also can be altered by construction of roads and levee-banks through the wetlands — these actions can deprive some parts of the wetland of water while deepening other parts. Emplacement of sizeable dams on creeks that previously flowed freely into the wetlands can starve the downstream wetlands of water.

Flow-on effects of cessation or reduction of water supply include changes in grazing pressure, changes to plant species composition, and shortening or cessation of ecological processes in affected coastal grass-sedge wetlands. Examples of the latter are the inability of wetland animals to complete their life cycles and in many cases animals no longer use the wetland because food supplies are absent or inadequate. Where water levels in swamps are highly managed, gradual raising of the water level during the growing season can encourage water-tolerant plants to grow taller and thereby better survive the main flood season (when deep flooding can retard or prevent plant growth).

Of special significance in Queensland has been the effect of ponded pasture projects on coastal grass-sedge wetlands, that is, the effect of constructing walls or channel block banks on coastal plains to facilitate growing of exotic pasture grasses in persistent freshwater impoundments. This practice formerly was common on the edges of marine plains and denied upstream movement of saline tidal water while prolonging freshwater inundation on the upstream side. Consequently, affected coastal grass-sedge wetlands that were subject to periodic tidal inundation now experience less saline regimes and connectivity between freshwater and tidal wetlands has been broken. Fishes of importance to commercial and recreational fisheries, such as barramundi *Lates calcarifer*, have been denied access to saline coastal grass-sedge wetlands and saltmarshes that were formerly vital nurseries for fingerlings.

In order to redress these changes, land managers should be aware of the values of coastal grass-sedge wetlands and of the duty of care needed to maintain their ecological integrity and functioning. Property planning can allow for representative coastal grass-sedge wetlands to be maintained in good condition. In regard to ponded pastures, the Queensland *Policy for Development and Use of Ponded Pastures* (DNRM, 2001) and the Queensland *Fisheries Act 1994* prevent and control the construction of barriers to tidal flows in wetlands subject to tidal inundation.

A Development Approval for Waterway Barrier Works is required under the Queensland *Integrated Planning Act 1997* for the building of a new barrier, or raising an existing structure across a waterway (freshwater or tidal). Fish movement issues need to be addressed as part of the approval process and in the event of approval, applicants may be required to construct a "fishway" to enable fish migration into and out of grass-sedge nursery areas.

As coastal grass-sedge wetlands are found on the marine and alluvial plains across the landscape, the underlying substrate may consist of acid sulfate soils (ASS). Draining grass-sedge wetlands can change water flows and disturb naturally occurring but potentially destructive ASS. When exposed to air these soils produce acid and can cause significant environmental and economic impacts such as the poisoning of aquatic species and the degradation of concrete and steel structures. Swamps that have been drained support more frequent and more severe fires, which in turn can lead to the exposure of ASS.

Potential acid sulfate soils (also called "marine mud" or "mangrove mud") are typically dark grey, wet and sticky. They can range from sand to clays. Photo: Queensland Acid Sulfate Soils Investigation Team (QASSIT), NR&M

FLOW-ON effects of the cessation or reduction of water supply to coastal grass-sedge wetlands include changes in plant species composition and the inability of wetland animals to complete their life cycles — in many cases animals no longer use the wetland because food supplies are absent or inadequate.

Wetlands degraded by deep drainage may export acid water and black (de-oxygenated) water to estuarine ecosystems. Potential acid sulfate soils are a problem when exposed to air by excavation or lowering of the water table. Bacteria in estuarine sediments turn sulfates into sulfides under anaerobic conditions. Once exposed to air, the iron sulfides (pyrite) in the soils react with oxygen to form sulfuric acid. After rain the acid can be flushed into creeks where the water turns so acidic fish may be killed. In addition, toxic metals may be dissolved out of the soils by the acid, and leach into the environment.

A State planning policy for ASS (*State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils* and associated *State Planning Policy 2/02 Guideline: Acid Sulfate Soils* — www.nrm.qld.gov.au/land/ass/qassit/planning_policy.html) came into effect in 2002. For any development on land, soil or sediment at or below five metres above sea level the policy requires that the release of acid and associated metal contaminants into the environment be avoided by either not disturbing the soils, or by treating and managing the soil and associated drainage water. Prior to disturbing the soil a management plan must be developed in consultation with a soil scientist or engineer with experience in ASS. After disturbance, ongoing monitoring at the site is essential. Further information regarding ASS and its management is available from the Queensland Department of Natural Resources and Mines www.nrm.qld.gov.au/land/ass/what_are_ass/index.html) and WetlandCare Australia (see Smith, 2002 under Information sources). Local development control plans, regional coastal zone plans and building codes may also provide additional information.

WHAT ARE ACID SULFATE SOILS?

Acid sulfate soils (ASS) are a natural phenomenon, with an estimated 2.3 million hectares occurring along the Queensland coast. The acid sulfate soils found today have predominately formed over the last 20,000 years as mangroves and other organic matter accumulated on tidal flats and mixed with saline water under anaerobic conditions. ASS usually occur at elevations less than five metres above sea level (reflecting the extent or sea level and tidal influence in recent times) and are common under low lying areas such as estuaries, saltmarshes, floodplains, tidal and brackish lakes, mangrove flats, coastal melaleuca swamp wetlands and coastal grass-sedge wetlands.

ASS is highly variable in form, ranging from mud to sand and peat, however they all contain iron sulfide. In their normal waterlogged state, ASS are harmless to the environment, however when disturbed by drainage, excavation or other activities, the sulfides in the soil are exposed and react with oxygen in air to produce sulfuric acid. Sulfuric acid breaks down the soil and releases toxins such as aluminium, iron and other metals. These toxins leach into waterways and can cause serious consequences such as poisoning of fish, oysters, crabs and other aquatic life.

Sulfuric acid produced during the oxidation of acid sulfate soils strips iron from the soil and toxic amounts of the colourless iron can then be washed into waterways. The colourless iron in the acid water changes to rust red when it contacts less acid water, such as rainwater or seawater. This results in a rust-coloured iron oxide scum or "floc" which can smother vegetation and stain concrete and soil.

ASS can also promote diseases such as fish red-spot, and corrode and destroy concrete and steel structures. Exposed acid sulfate soils often irreversibly shrink and crack, causing building foundations or roads to subside or split.

Tall dense native vegetation such as the reed *Phragmites* sp. serves to immobilise ASS products that have accumulated on a swamp surface, due to previous deep drainage, blanketing them under a mat of organic matter that also stores moisture and limits the drying-out and oxidation of wetland soil.

Exposure to acid water and toxic heavy metals associated with disturbed acid sulfate soils damages fish skin and gills, increasing the susceptibility of fish to fungal infections such as "red-spot" disease. Red-spot disease results in red ulcerative lesions, leaving them unsaleable and may result in fish death.

Concrete bridge pylons in the Pimpama River, south-east Queensland, corroded by acid sulfate soils. Photos: Queensland Acid Sulfate Soils Investigation Team (QASSIT), NR&M

Sustainable grazing and fire management

Coastal grass-sedge wetlands provide fodder for livestock, principally cattle, throughout coastal regions of Queensland and pastoral grazing has been practiced in these ecosystems since the 1800s. Though comprehensive systematic studies of ecologically sustainable grazing methods relevant to the coastal grass-sedge wetlands are generally lacking, anecdotal observations have supported the view that it is possible to concurrently achieve economic and biodiversity outcomes under grazing regimes. Excessively high grazing pressure can permanently alter the ecological character of coastal grass-sedge wetlands. Where exotic pasture grasses such as para grass *Bracharia mutica*, aleman grass *Echinochloa polystachya* and Olive hymenachne *Hymenachne amplexicaulis* have become established in coastal grass-sedge wetlands, an appropriate level of grazing pressure on those grasses will be necessary to ensure they do not spread and overrun the wetland, to the exclusion of indigenous plants (see Weeds section for further information).

A key strategy for management of grazing in wetlands is to have fencing that enables wetlands to be excluded from grazing at strategic times, particularly when their edges are soft and liable to deep pugging and when wetland plants have not yet completed the seeding stage. 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. Utilising the native freshwater couch grass in wetland areas can provide optimal conditions for grazing and biodiversity, whereas dryland grasses in modified (partly drained) wetland areas may create poor conditions for grazing and biodiversity following wet periods.

The use of fire to control rank growth of wetland vegetation and to encourage fresh new growth is a technique that has been used by Aboriginal people and subsequently by European managers of coastal grass-sedge wetlands. However, the frequency, intensity and timing of fires has changed since European settlement and research is needed to determine the fire regime that will produce optimal outcomes for both graziers and biodiversity. Fires should be carefully planned around the season and conditions for burning. The reeds *Phragmites* sp. and the sedge *Bolboschoenus fluviatilis* are very susceptible to frequent fire and may disappear from the wetland over time.

Olive hymenachne *Hymenachne amplexicaulis* is difficult to control once established in wetlands including coastal grass-sedge wetlands.
Photo: Roger Jaensch, Wetlands International

Cattle pugging in a coastal grass-sedge wetland.
Photo: Roger Jaensch, Wetlands International

Common reed *Phragmites australis* is sensitive to frequent fire.
Photo: Roger Jaensch, Wetlands International

THOUGH studies of grazing methods in coastal grass-sedge wetlands are lacking, anecdotal observations suggest that it is possible to achieve both economic and biodiversity outcomes when grazing these areas.

The use of fire to manage coastal grass-sedge wetlands will vary according to local conditions. Research at particular locations is showing that using fire as a management tool in coastal grass-sedge wetlands may be highly specific to those locations. Fire monitoring by the Queensland Parks and Wildlife Service (QPWS) in the Wet Tropics and Central Queensland Coast bioregions suggests that grass-sedge communities may not be fire sensitive except where the ground layers are composed of peat. Too frequent firing can degrade these wetlands' habitat and food values for wading birds and other species and open the areas up to weed invasion. Generally, in these communities fire exclusion is recommended, though if burning must be undertaken, it should be done early in the year, when water levels are high enough to cover both peat surfaces and sedge bases and conducted using a mosaic burning technique. Whereas in Townsville, some research has indicated coastal grass-sedge wetlands respond well to a mid to late dry season fire (that is, June to October) when bulkuru and some sedges have died back to subsoil bulbs and are not susceptible to fire damage. It appears that it is best to undertake burns every two to seven years, depending on the site. This promotes flowering of species such as sedges and most wetland plants regrow after fire including the vulnerable grass *Paspalidium udum*. The recently burnt areas provide suitable feeding areas for birds such as brolgas. However care should be taken to ensure that other birds such as magpie geese are not nesting in these areas when burns are undertaken.

Given these different findings, more research is required to develop robust and broadly applicable guidelines for the use of fire in coastal grass-sedge wetlands.

The vulnerable grass *Paspalidium udum* responds well to fire on the Townsville Town Common.
Photo: Paul Williams, EPA

Brolgas *Grus rubicunda* feeding post fire, Townsville Town Common.
Photo: Paul Williams, EPA

A PLACE OF "COMMON INTEREST"

The Townsville Town Common is located 6km north-west of the centre of Townsville on marine plain associated with the Bohle River. Its expansive wetland complex includes mangrove, saltmarsh and coastal grass-sedge wetlands and supports breeding brolgas *Grus rubicunda* and magpie geese *Anseranas semipalmata* and over 26 JAMBA/CAMBA listed species. The Common is an important site in the network of wetlands used by migratory waterbirds on the east coast of Queensland. From the 1880s to the 1970s the Common was used as a communal area for landholders to agist livestock. In 1980 the Common was gazetted as an Environmental Park, primarily in recognition of its waterbird habitat, and in 1994 it became a Conservation Park (3245ha) managed by the QPWS.

The location of the Common and its history of land use, presents its current managers with a number of management issues. Increased water flow (sewage outflow) has resulted in expansion of mangroves into former coastal grass-sedge wetlands. Removal of grazing from the Common in the late 1970s saw exotic para grass *Brachiaria mutica* and guinea grass *Panicum maximum* expand over a broader area and increase in density, crowding out native grasses and sedges, reducing waterbird populations, and increasing fire fuel loads. Location of the wetlands next to an international airport complex requires that certain management actions must take into account the safety of air traffic, such as burning only with south-east winds and often after the last flight has taken off for the evening. In 2002, QPWS in partnership with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) initiated a trial to assess the impacts of grazing on para grass, native couch *Cynodon dactylon* and common reed *Phragmites australis* at the Common.

Para grass *Brachiaria mutica* control trials at Townsville Town Common — undisturbed para grass paddock on the left and burned paddock on the right.
Photo: Paul Williams, EPA

Results from trials in 2003 and 2004 indicated that short-term grazing impacted para grass to a greater extent than some native grasses and herbs and may help reduce exotic grass and encourage re-establishment of native plants. The trial will continue for another few years and and has been expanded to investigate the value of combining burning with grazing to reduce the biomass of paragrass and promote native grasses and sedges. The effects of burning and grazing para grass-infested swamps is also being evaluated for water birds, small mammals, reptiles and amphibian abundance. Meanwhile, the "Revive our Wetlands" program of BHP Billiton and Conservation Volunteers Australia, has run a "Common Interest" program at the Common. Through engagement of the local community, students, Townsville City Council and the QPWS, the Revive team has propagated native plants, conducted general maintenance and increased community "ownership" of the site and awareness of the importance of wetlands (see www.reviveourwetlands.net/revive/index.htm for further information on the "Revive our Wetlands" program and the "Common Interest" project).

THE LOWER BURDEKIN GRAZING PROJECT

Grass-sedge wetlands and waterways in the Lower Burdekin area have been modified under intensive use of land and water resources for sugar cane farming. WetlandCare Australia, with funding from the Department of Primary Industry and Fisheries *Burdekin Rangeland to Reef Initiative* and the regional natural resource management body (Burdekin Dry Tropics Board), has been investigating grazing management in these wetlands since late 2003. The project aims "to assess existing and trial grazing regimes to develop published guidelines for the use of grazing as an environmental management tool for exotic pasture weeds in riparian and wetland areas in the lower Burdekin" (for further information see www.wetlandcare.com.au). Some of the study plots include bulkuru sedge swamp. Early results confirm that alternating regimes of (re-introduced) seasonal grazing and longer-term spelling increase the diversity of native wetland plants and reduce the biomass of exotic grasses that reduce water quality and degrade fish habitat. An optimal balance between these regimes and complimentary control techniques such as burning remains to be determined.

Control of weeds

Introduced plants (weeds) replace native plants and change the ecology of wetlands. Weeds that threaten coastal grass-sedge wetlands in Queensland include water hyacinth *Eichhornia crassipes*, parkinsonia *Parkinsonia aculeata*, common sensitive plant *Mimosa pudica*, Mackie's pest *Chrysopogon aciculatus*, giant rat's-tail grass *Sporobolus natalensis*, prickly acacia *Acacia nilotica*, mimosa bush *Acacia farnesiana*, lippia *Lippia alba* and guava *Psidium guajava*. These weeds are spread as live fragments or seed by vehicles, native, domestic and feral animals and by flowing water and the wind.

However, the greatest threat to coastal grass-sedge wetlands from introduced species comes from two grasses commonly used as ponded pasture — para grass and Olive hymenachne. Olive hymenachne is one of 20 pest species classified as Weeds of National Significance (WoNS) (see www.deh.gov.au/biodiversity/invasive/weeds/wons.html for further information), and it is an offence to sell, keep or release Olive hymenachne under the Queensland *Land Protection (Pest and Stock Route Management) Regulation 2003* without a permit. These aggressive grasses can completely dominate and choke coastal grass-sedge wetlands, even when the wetland is being grazed. Ponded pastures should not be established in or near natural wetlands due to their impacts on wetlands, as outlined under the Queensland *Policy for Development and Use of Ponded Pastures* (DNRM, 2001).

Some native plants, notably cumbungi, can overrun coastal grass-sedge wetlands especially where disturbance or nutrient enrichment have occurred.

Para grass *Brachiaria mutica* (foreground) in a coastal grass-sedge wetland (background). Photo: Roger Jaensch, Wetlands International

QPWS rangers removing Olive hymenachne *Hymenachne amplexicaulis* from the Townsville Town Common. Photo: Paul Williams, EPA

THE greatest threat to coastal grass-sedge wetlands comes from introduced species commonly used as ponded pastures — para grass and Olive hymenachne.

Control methods for weeds include manual or mechanical removal, chemical application and biological control (if available). Constant heavy grazing during the dry season is one method of controlling Olive hymenachne and can possibly eradicate it if the grazed plants are completely submerged in the ensuing wet season (also see box on Lower Burdekin grazing project). *Typha* plants can be cut below the water line in autumn.

Fire can be an effective method of controlling weeds but its use needs careful consideration (see Sustainable grazing section). Integrated weed control programs using more than one method may be most effective. All methods require follow-up and ongoing observation to ensure the weed infestations are under control; seed of water hyacinth can be viable for up to 15 years.

It is important to be well informed about chemicals used in weed control as penalties can apply if native plants and animals are harmed, particularly around wetland areas. Herbicides that target the weed species and will not contaminate the area are preferred.

Details about suitable herbicides and appropriate timing and methods to control most weeds can be obtained from local Land Protection officers of the Department of Natural Resources and Mines (NR&M), or from the websites of the NR&M or the Australian Government Department of the Environment and Heritage:

www.nrm.qld.gov.au/pests/environmental_weeds/weed_info_series.html

www.deh.gov.au/biodiversity/invasive/publications/#weeds.

Control of feral pigs

Feral pigs *Sus scrofa* are common on many of the alluvial and marine plains where coastal grass-sedge wetlands occur in Queensland. They forage in muddy shallows and edges of these wetlands and create extensive damage to the substrate and vegetation by rooting out the tubers of bulkuru and other plants (see photo). Additionally, pigs are thought to carry the bacteria that cause vibriosis and leptospirosis — diseases that can be passed on to cattle through water. While the long term effects of this impact are not fully known, control of pigs is desirable for landholders and the wider community for a host of reasons.

As both wetlands and pigs can occur across several properties, effective control of pigs depends on coordinated management by networks of land managers. For information on control programs contact NR&M Land Protection officers (www.nrm.qld.gov.au/pests/contact_list.html) and local government weed and pest officers. For further information on feral animal management, see the NR&M website www.nrm.qld.gov.au/pests/pest_animals/.

Feral pig diggings in *Eleocharis* sedgeland.
Photo: Roger Jaensch, Wetlands International

A NEIGHBOURLY APPROACH TO FERAL PIG MANAGEMENT

Cape Upstart National Park and its neighbour Cape Upstart Station contain an interlinked complex of grass-sedge and other wetlands. A "Natural Resource Management Agreement" between the two land managers identifies feral pig control as a priority because of the impact pigs have on these wetlands and adjacent coastal dunes. The pigs disturb the wetland vegetation and can spread weeds. As part of the joint control program, QPWS staff regularly undertake trapping and opportunistic shooting of feral pigs. During the control program early in 2005, staff observed a boar digging up and eating greenstripe frogs *Cyclorana alboguttata*, eastern snapping frogs *Cyclorana novaehollandiae* and northern snapping frogs *Cyclorana australis*. An autopsy conducted on the pig later that day found a total of 21 of these burrowing frogs in its stomach, all with their heads bitten off. After further examination of the site, staff theorised the boar was actively searching for the frogs because the site showed evidence of digging over several weeks, whilst extensive surrounding areas of dried bulkuru wetland had not been dug up. Further observations of pig feeding habits are necessary to ascertain if such predation is a major threat to burrowing frog populations. Another boar was autopsied the week before in the same area however this pig had not been eating frogs. Its stomach, instead, was full of seeds of the weed chinee apple *Ziziphus mauritiana* — the trees of which were fruiting several hundred metres away. This is an example of the capacity for pigs to spread weeds from one vegetation type to another.

QPWS staff are currently conducting a number of State and Natural Heritage Trust funded pig management projects at multiple parks sites throughout central Queensland. One example is the "Judas Sow" project in Kroombit Tops National Park, which aims to improve knowledge of feral pig feeding habits by radio tracking a number of sows in known pig populations. Seasonal movements of these pigs will be monitored for a designated period, for example three weeks, for up to 18 months. Other pig monitoring projects underway will provide data on where the pigs shelter and feed and at what times of day. This may offer some information on how the pigs adapt to seasonal changes in weather or food resources. Such information will provide a better understanding of feral pig habits and optimise the effectiveness of pig control programs both in national parks and other tenures. In areas such as the Whitsunday Shire, this information will be shared with the local Council and park neighbours and assist with setting management actions under the shire's Pest Management Plan.

Feral pigs impacting wetlands.
Photo: Shaun Seymour, NR&M

Gut contents (frogs) of a feral pig.
Photo: Shaun Seymour, NR&M

Protecting water quality

As coastal grass-sedge wetlands on the east coast are often close to or downstream of land that is cultivated for sugar cane and other crops, transmission of agricultural chemicals and nutrients to the wetlands through runoff from cropland can occur. Urban and industrial areas close to coastal grass-sedge wetlands can be the source of similar inputs but with addition of pollutants such as oils and heavy metals. These changes to water quality of the wetlands can lead to imbalance in nutrient cycles, proliferation of algae, death of sensitive wetland organisms and cumulative impacts on animals that feed on wetland invertebrates and fish. Unless inflows from cropland and via stormwater are directed away from the wetlands or filtered beforehand by specially designed traps, such as artificial wetlands, the health of impacted coastal grass-sedge wetlands will deteriorate. Industry-specific initiatives to address runoff and water quality across rural landscapes could substantially address this wetland management problem.

A NUMBER of rural industries are working on or have in place codes of practice that are industry specific and are a method of addressing their "duty of care" in coastal grass-sedge wetlands.

A number of rural industries are working on or have in place codes of practice that are industry specific and are a method of addressing their "duty of care" under the Queensland *Environmental Protection Act 1994*. The sugar cane industry, for example, in partnership with the Queensland Environmental Protection Agency has developed a code of practice, which provides information on best practice sugar cane farming techniques to optimise productivity and profitability and minimise effects on the environment www.canegrowers.com.au/Default.asp?page=232). The code also provides valuable information about farm plans and addresses management issues such as drainage, acid sulfate soils, chemical use, and fire, feral animal and weed control.

Property management plans, designed and implemented by individual farmers, may contain elements to reduce farm run-off to waterways and protect wetlands and riparian zones. They are also a requirement for certain approvals under the Queensland *Vegetation Management Act 1999*, Queensland *Water Act 2000* and the Queensland *Sugar Industry Act 1999* and under existing local government planning schemes. A number of organisations can assist landholders in preparing their own property management plans (for more information see www.regional.org.au/au/roc/1993/roc1993073.htm — property management planning or Greening Australia at www.greeningaustralia.org.au/GA/QLD/OnGroundAction/Our+Services/Property+Planning+Service/Property+and+Vegetation+Management+Plans/).

AN effective way of maintaining the ecological and hydrological functioning of a wetland is the provision of a buffer zone of intact native vegetation.

Using buffers to protect wetlands

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

In regions where vegetation clearing is occurring, *Regional vegetation management codes for ongoing clearing purposes* may restrict clearing of remnant vegetation adjacent to a natural or purpose built wetland. The restriction on clearing effectively maintains a buffer around the wetland.

The codes specify the distance from a wetland where clearing is not acceptable. These distances range from 50 to 200 metres (for example, the *Wet Tropics Bioregion regional management code for ongoing clearing purposes* provides, as an acceptable solution, that clearing should not occur within 50 metres of natural wetlands including coastal grass-sedge wetlands). See the NR&M website www.nrm.qld.gov.au/vegetation/regional_codes.html) for the code that is applicable to your area and its associated buffer zones.

Buffer zones are recognised as being vital to maintain the ecological values of waterways. The Department of Primary Industries and Fisheries also has a policy on buffer zones entitled *Fish Habitat Buffer Zones* (2001). This policy mainly pertains to the provision of naturally vegetated buffer zones between developments (for example urban areas or agricultural areas) and natural waterways, including coastal grass-sedge wetlands. See the DPI&F website (www.dpi.qld.gov.au/fishweb/4253.html) for further information.

Regional planning

Another sector of the community with an interest in protecting the values of wetlands, including coastal grass-sedge wetlands, are the regional natural resource management (NRM) bodies. These are community-based organisations in various regions across the state, established to promote sustainable development through integrated catchment management processes. This involves the development of federally accredited NRM plans and sub-catchment plans that provide an integrated approach for on-ground actions and identifying where Natural Heritage Trust (NHT2) and National Action Plan for Salinity and Water Quality (NAP) funding will be invested to achieve the identified outcomes.

REGIONAL natural resource management bodies have trained project officers who co-ordinate field days, conduct property visits and assist landholders and councils in accessing current land management information as well as providing incentive funding to complete on-ground works.

The NRM plans produced by the regional bodies are designed to focus on catchment assets and pressures and are part of a larger picture for natural resource management. The plans operate within other local, regional, State and Australian Government planning processes (legislation, policies and strategies) and industry codes of practice. These regional bodies have trained project officers who co-ordinate field days, conduct property visits and assist landholders and councils in accessing current land management information as well as providing incentive funding to complete on-ground works. For more information on the regional body operating in your catchment and their funding opportunities go to www.nrm.gov.au/state/qld/index.html#regions.

QPWS ranger and a nature refuge landholder.
Photo: EPA

Conservation agreements

Various covenants and agreements (both binding and non-binding on title) are now available to landholders in Queensland to assist in the protection of wildlife and their habitat whilst 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. For further information on nature refuges, see www.epa.qld.gov.au/nature_conservation/nature refuges/.

Glossary

Acid sulfate soils (ASS) Soils which are potentially extremely acidic (pH <3.5) because of large amounts of reduced forms of sulfur that are oxidised to sulfuric acid if the soils are exposed to oxygen when they are drained or excavated.

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

Anaerobic Without oxygen.

Annual Plants that complete the cycle of germination, growth, reproduction and death in one year (growing season). The species persists from year to year through seeds that can lie dormant for decades.

Block banks Small earthen walls laid across channels and used to retain freshwater flows or impede tidal saline influence.

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.

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.

CAMBA The Agreement between the Government of Australia and the Government of the People's 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.

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

Desiccates To dry thoroughly.

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

Ecotone A transition zone between two or more ecological communities.

Endemic Found only in one particular area.

Environmental values 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/LEGISLTN/CURRENT/E/EnvProtA94.pdf and www.legislation.qld.gov.au/Legislation%20Docs/CurrentE.htm).

Forbs Small, non-woody, broad-leaved vascular plants, excluding grasses, rushes and sedges.

Geomorphologic Pertaining to geological structure.

Gilgai Hummocky micro-relief pattern on a soil surface produced by expansion and contraction during wetting and drying (usually in regions with distinct, seasonal rainfall); common in heavy alluvial clays.

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 may be tidal or non-tidal but ocean derived salinity is less than one part per thousand (1 ppt). 1 ppt is the equivalent of one gram of sodium chloride (salt) per litre of water.

Land zone 1 Marine deposits, subject to periodic inundation by saline or brackish marine waters.

Land zone 2 Coastal sand dunes and swales.

Land zone 3 Near-level alluvial plains with riverine patterns, wetlands and lakeside dunes.

Marine Pertaining to seas or oceans.

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.

Mosaic A method of patchy burning which creates areas of burnt and unburnt country across a landscape.

Palustrine Pertaining to marshes, bogs, swamps and fens.

Peat Partially decomposed organic matter (mostly plant material) which has accumulated in water-saturated environments, deficient in oxygen; resulting from anaerobic respiration.

Perennial Plants that persist for several years, usually dying back to perennial crowns during the winter and initiating new growth each spring.

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 fresh water 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.

Ramsar Convention The Convention on Wetlands (Ramsar, Iran, 1971) is an international treaty that aims to halt the worldwide loss of wetlands and to conserve those that remain through wise use and management.

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.

Rhizomes Root-like stems with nodes which grow under or along the ground and are capable of forming new plants.

Riverine Pertaining to rivers.

Saltmarsh Saltwater wetland occupied mainly by herbs and dwarf shrubs, characteristically able to tolerate extremes of environmental conditions, notably waterlogging and salinity.

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.

Substrate The surface or material on which an organism lives — rock, sand, mud, pilings, shells.

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

World Heritage Convention The Convention Concerning the Protection of the World Cultural and Natural Heritage is an international treaty that seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity.

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Appendices

Appendix 1: Description and status of coastal grass-sedge wetland regional ecosystems (REs) in Queensland and examples in protected areas.

Bioregion	Regional ecosystem (RE)	RE description	Queensland Biodiversity Status*	Queensland Vegetation Management Status**	Examples of protected areas that include coastal grass-sedge wetlands^
Gulf Plains	2.3.1	Grasslands on low plains adjacent to estuarine zone.	No concern at present	Not of concern	Mutton Hole Wetlands CP, Morning Inlet - Bynoe River FHA.
	2.3.2	Freshwater and brackish wetlands in old river channels on low plains adjacent to estuarine zone.	Of concern	Of concern	No representation.
	2.3.34x31	Open-tussock grassland of *Ectrosia* sp. (hare's foot grass) or *Leptochloa fusca* (beetle grass).	No concern at present	Not of concern	Mutton Hole Wetlands CP, Morning Inlet- Bynoe River FHA.
Cape York Peninsula	3.3.58	*Oryza rufipogon* and/or *Eleocharis* spp. closed tussock grassland in seasonally inundated depressions.	No concern at present	Not of concern	Lakefield NP.
	3.3.61	*Panicum* spp., *Fimbristylis* spp. tussock grassland on coastal alluvial plains.	No concern at present	Not of concern	Lakefield NP.
	3.3.63	Closed sedge land dominated by *Eleocharis dulcis*. Occurs on seasonally flooded marine plains.	No concern at present	Not of concern	Jardine River NP, Jardine River RR, Anaan River FHA.
	3.3.65	Ephemeral lakes and lagoons on alluvial plains and depressions.	No concern at present	Not of concern	Lakefield NP, Mungkan Kandju NP.
Wet Tropics	7.1.3	Bulkuru (*Eleocharis dulcis*) swamp on poorly drained acid peats.	Of concern	Of concern	Hull River NP, Edmund Kennedy NP, Halifax Bay Wetlands NP, Palm Creek CP, Hull River FHA, Wreck Creek FHA, Dallachy Creek FHA, Tully River FHA, Wet Tropics WHA.

Bioregion	Regional ecosystem (RE)	RE description	Queensland Biodiversity Status*	Queensland Vegetation Management Status**	Examples of protected areas that include coastal grass-sedge wetlands^
Wet Tropics (continued)	7.3.1	Sedgeland (*Cyperus* spp., *Eleocharis dulcis, Baumea* spp., *Scleria poiformis*) and grassland (*Ischaemum villosum, Imperata cylindrica, Cynodon dactylon*) freshwater swamps of seasonally inundated coastal lowlands.	Endangered	Endangered	Russell River NP, Maria Creek NP, Eubenangee Swamp NP, Etty Bay Road CP, Cattle Creek FHA, Palm Creek FHA, Wet Tropics WHA.
Central Queensland Coast	8.1.4	*Paspalum* spp. and *Fimbristylis ferruginea* sedgeland/grassland (estuarine wetland). Includes areas of deep open water with clumps of *Schoenoplectus litoralis* and/or *Eleocharis dulcis*.	Endangered	Of concern	Cape Palmerston NP, Byfield NP, Bassett Basin FHA, Corio Bay FHA, Rocky Dam FHA, Sand Bay FHA, Great Barrier Reef WHA.
	8.3.4	Freshwater wetlands with permanent water and aquatic vegetation including *Phragmites australis, Nymphaea gigantea, Nymphoides indica, Eleocharis* spp., *Cyperus* spp., and *Juncus* spp.	Endangered	Of concern	Cape Palmerston NP, Great Barrier Reef WHA.
Brigalow Belt	11.1.3	Sedgelands on marine clay plains.	Of concern	Of concern	Bowling Green Bay NP, Cape Upstart NP, Bowling Green Bay CP, Horseshoe Lagoon CP, Townsville Town Common CP, Burdekin FHA, Broad Sound FHA.
	11.3.27x1a 11.3.27x1b 11.3.27x1c	Sedgelands to grasslands on Quaternary estuarine deposits.	Of concern	Not of concern	Bowling Green Bay NP.
Southeast Queensland	12.3.8	Swamps with *Cyperus* spp., *Schoenoplectus* spp. and *Eleocharis* spp.	Of concern	Of concern	Moreton Island NP, Great Sandy NP, Noosa NP, Toolara SF, Beerwah SF, Pumicestone Channel FHA.

* Biodiversity Status as listed by the Environmental Protection Agency.

** Queensland *Vegetation Management Act 1999* status as of September 2003.

^ Protected areas include national parks (NP), resources reserves (RR), conservation parks (CP), Fish Habitat Areas (FHA), state forests (SF) and World Heritage areas (WHA).

Appendix 2: Threatened and migratory fauna commonly associated with Queensland's coastal grass-sedge wetlands.

Taxon group	Common name	Scientific name	NC Act status*	EPBC Act status*	IUCN Red List of threatened species status **
Mammals	false water-rat	*Xeromys myoides*	vulnerable	vulnerable	—
Birds	Australian painted snipe	*Rostratula benghalensis australis*	vulnerable	vulnerable	—
	Australasian bittern	*Botaurus poiciloptilus*	—	—	endangered
	Latham's snipe	*Gallinago hardwickii*	—	listed migratory species#	—
	black-tailed godwit	*Limosa limosa*	—	listed migratory species#	—
	marsh sandpiper	*Tringa stagnatilis*	—	listed migratory species#	—
	common greenshank	*Tringa nebularia*	—	listed migratory species#	—
	sharp-tailed sandpiper	*Calidris acuminata*	—	listed migratory species#	—
	Capricorn yellow chat (Dawson)	*Epthianura crocea macgregori*	endangered	critically endangered	—
	yellow chat (Gulf)	*Epthianura crocea crocea*	vulnerable	—	—
	crimson finch	*Neochmia phaeton*	vulnerable	—	—
	star finch (eastern subspecies)	*Neochmia ruficauda ruficauda*	endangered	endangered	near threatened (for *Neochmia ruficauda*)

* 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 3: Threatened flora commonly associated with Queensland's coastal grass-sedge wetlands.

Taxon group	Common name	Scientific name	NC Act status*	EPBC Act status*	IUCN Red List of threatened species status **
Aquatic plant	frogbit	*Hydrocharis dubia*	vulnerable	vulnerable	—
Sedges		*Eleocharis retroflexa*	vulnerable	vulnerable	—
		Fimbristylis adjuncta	endangered	endangered	—
Grasses		*Arthraxon hispidus*	vulnerable	vulnerable	—
		Paspalidium udum	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 4: Wetlands in Queensland that are listed in *A Directory of Important Wetlands in Australia* (2005) and/or are Ramsar sites and that include coastal grass-sedge wetlands.

Bioregion	Directory reference	Directory wetlands	Ramsar wetlands
Brigalow Belt North	QLD001	Abbot Point — Caley Valley	—
	QLD002	Bowling Green Bay	Bowling Green Bay
	QLD003	Broad Sound	—
	QLD004	Burdekin Delta Aggregation	—
	QLD005	Burdekin — Townsville Coastal Aggregation	Bowling Green Bay
	QLD009	Southern Upstart Bay	—
	QLD012	Fitzroy River Delta	—
	QLD013	Fitzroy River Floodplain	—
	QLD181	RAAF Townsville	—
	QLD210	Wongaloo Fans Aggregation	Bowling Green Bay
Cape York Peninsula	QLD063	Jardine River Wetlands Aggregation	—
	QLD065	Marina Plains — Lakefield Aggregation	—
	QLD066	Newcastle Bay — Escape River Estuarine Complex	—
	QLD070	Orford Bay — Sharp Point Dunefield Aggregation	—
	QLD073	Silver Plains — Nesbit River Aggregation	—
	QLD075	Somerset Dunefield Aggregation	—
	QLD077	The Jack Lakes Aggregation	—
	QLD100	Great Barrier Reef Marine Park	—
Central Queensland Coast	QLD043	Corio Bay Wetlands	Shoalwater and Corio Bays Area
	QLD048	Island Head Creek — Port Clinton Area	Shoalwater and Corio Bays Area
	QLD050	Proserpine — Goorganga Plain	—
	QLD051	Sand Bay	—
	QLD052	Sandringham Bay — Bakers Creek Aggregation	—
	QLD053	Sarina Inlet — Ince Bay Aggregation	—
	QLD054	Shoalwater Bay	Shoalwater and Corio Bays Area
	QLD137	Iwasaki Wetlands	—
	QLD178	Shoalwater Bay Training Area Overview	Shoalwater and Corio Bays Area

Bioregion	Directory reference	Directory wetlands	Ramsar wetlands
Gulf Plains	QLD103	Buffalo Lake Aggregation	—
	QLD111	Nicholson Delta Aggregation	—
	QLD112	Smithburne — Gilbert Fan Aggregation	—
	QLD113	Southeast Karumba Plain Aggregation	—
	QLD114	Southern Gulf Aggregation	—
South East Queensland	QLD128	Carbrook Wetlands Aggregation	—
	QLD133	Lake Weyba	—
	QLD134	Moreton Bay Aggregation	Moreton Bay Queensland
	QLD180	Greenbank Army Training Area	—
	QLD185	Coolum Creek and Lower Maroochy River	—
	QLD188	Upper Pumicestone Coastal Plain	—
Wet Tropics	QLD139	Bambaroo Coastal Aggregation	—
	QLD142	Cowley Area	—
	QLD143	Edmund Kennedy Wetlands	—
	QLD145	Eubenangee — Alice River	—
	QLD146	Herbert River Floodplain	—
	QLD149	Innisfail Area	—
	QLD150	Kurrimine Area	—
	QLD161	Tully River — Murray River Floodplains	—
	QLD163	Wyvuri Swamp	—

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