

WETLAND MANAGEMENT PROFILE

COASTAL PALM SWAMPS

Feather and fan palm swamps were once a conspicuous feature of the coastal lowlands of North Queensland's Wet Tropics bioregion. Agricultural and urban clearing and wetland drainage over many years have significantly reduced the distribution of these wetlands to the point where they are now endangered communities. Ongoing threats to remaining feather and fan palm swamps include weed invasion, wind damage, hydrological changes and the impact of feral pigs. This profile covers the habitat type of wetlands termed coastal and sub-coastal tree swamps.

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

Description

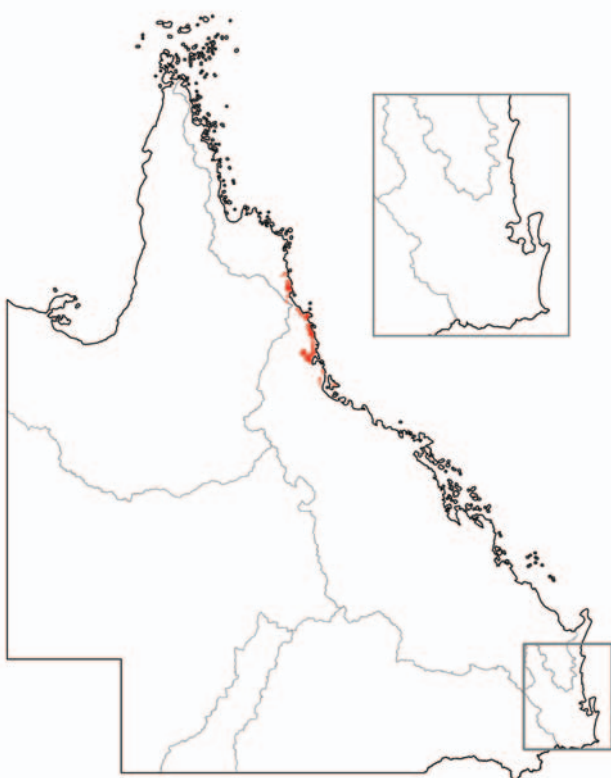
This wetland management profile describes the palm swamp habitat type that is predominately found in the Wet Tropics **bioregion** of North Queensland. This **palustrine** wetland habitat type occurs in **mesophyll** and **notophyll** vine forests and can be dominated by one or both of the following palm species: the feather palm *Archontophoenix alexandrae* (also commonly known as Alexandra palm), and the fan palm *Licuala ramsayi* (also commonly known as licuala palm). Both typically grow in areas with greater than 3000 mm annual rainfall on very wet poorly drained soils and on sand dunes with seasonally impeded drainage of the Wet Tropics coastal lowlands.

Feather palm swamps are found in the lowland floodplain and estuarine complexes of river drainage systems. They occur in very wet lowland areas, generally less than 15 m above sea level, on sand dunes with seasonally impeded drainage, or on waterlogged **alluvial** soils where the **watertable** is always very high. The soils of these areas are derived from **basaltic** and **granitic** parent material, and are generally highly fertile when drained.

The agricultural potential of these wetlands was recognised soon after European settlement and consequently they have largely been cleared. Those that remain today are generally on poorer soils.

Feather palms get their common name from their pinnate (featherlike) leaves that reach up to 2 m long. The palms grow to approximately 20 m tall and dominate the swamp, with up to 150 000 stems per hectare in some sites. Seedling palms form up to 95 per cent of the total number of palm stems.

Fan palm swamps are found below 150 m elevation on the foot slopes, **colluvial** fans and alluvial plains of coastal ranges with very poorly draining soils that are seasonally swampy.



Map showing the distribution of palm swamps in Queensland; grey lines indicate drainage basins. Map: From Queensland Wetlands Mapping v2.0 (September 2009)



A feather palm swamp

Photo: Roger Jaensch, Wetlands International



Featherlike leaves of the feather palm

Archontophoenix alexandrae

Photo: Sue Gardiner



Up to 150 000 feather palms can be found per hectare of feather palm swamp.

Photo: Roger Jaensch, Wetlands International

They are generally associated with poorer quality, **metamorphically** derived soils, when compared to feather palm swamps. The micro-relief of the palm swamps consists of small incised streams and associated flats and depressions between these.

Fan palms have almost circular fan-shaped leaves up to 2 m across. In palm swamps they are slow growing, reaching up to 20 m tall, with other scattered **emergent** trees, including **sclerophyllous** species, to 36 m. In contrast to feather palm swamps, fan palms constitute only up to 20 per cent of the total number of stems in any site, and these are predominantly mature trees rather than seedlings, since fan palms have low seedling numbers with commonly only 50–500 per hectare. There is greater plant species diversity here than in the feather palm swamps with 247 plant species recorded in recent studies. Of these 60 per cent are trees, with around 20 species present in most fan palm swamps and also in adjacent vine forest and swamp forest types. The fan palm swamps also host a variety of shrubs, vines, **epiphytes** and **herbs**.



Fan-shaped leaves of the fan palm *Licuala ramsayi*

Photo: Roger Jaensch, Wetlands International



Fan palms are found with other scattered emergent trees in fan palm swamps.

Photo: Sue Gardiner

FEATHER palm swamps formerly occurred on the coastal plain between Tully and Cairns, while fan palm swamps were distributed between Cape Tribulation and Innisfail. Only around 40 per cent of the original extent of these wetland habitats remains and they are restricted to small patches.

Distribution

Feather palm swamps formerly occurred on the coastal plain most frequently between Tully and Cairns, whereas fan palm swamps were distributed between Cape Tribulation and Innisfail. Both are now restricted to small patches only. The *WetlandInfo* website provides in-depth data, detailed mapping and distribution information for this wetland habitat type.

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Queensland status and legislation

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

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

The Queensland Government has direct responsibility for the protection, conservation and management of wetlands in Queensland, a responsibility shared with local government and the Australian Government (for some wetlands of international significance). These responsibilities are found in laws passed by the Queensland parliament, laws of the Commonwealth, international obligations and in agreements between

state, local and the federal governments. More information on relevant legislation is available from the *WetlandInfo* website <www.derm.qld.gov.au/wetlandinfo>.

National conservation status

Sixty per cent of palm swamps fall within the Wet Tropics of Queensland **World Heritage** Area. The Wet Tropics of Queensland was inscribed on the World Heritage List in 1988 in recognition of its outstanding natural universal values: as an outstanding example representing the major stages in the Earth's evolutionary history; as an outstanding example representing significant ongoing ecological and biological processes; as an example of superlative natural phenomena; and containing important and significant habitats for in situ conservation of biological diversity.

Some plants and animals of the palm swamps in Queensland are listed as endangered or threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the Queensland *Nature Conservation Act 1992* and/or the **IUCN Red List** (see Species of conservation significance). Recovery plans which set out research and management actions to support the recovery of threatened species under the EPBC Act are available for some of these species, for example the cassowary (see <www.environment.gov.au/biodiversity>).

World Heritage properties and threatened species 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 World Heritage property or threatened species will be subject to an environmental assessment and approval regime under the EPBC Act.

Cultural heritage values

Wetland ecosystems are of material and cultural importance to Indigenous people and many will have profound cultural significance and values. Indigenous and non-Indigenous (historic) cultural heritage sites have been recorded within palm swamps in Queensland. However, most palm swamps have not been systematically surveyed or assessed for cultural heritage significance.

Evidence of traditional occupation and use recorded within palm swamps include painted and engraved rock art, burials, ceremonial earth and stone arrangements, scarred and carved trees, quarries,

middens, stone artefacts and scatters, dwellings, open camps, fish traps, food and fibre resources and historic contact sites. Some palm swamp areas have particular significance as story places, landscape features and as sites for cultural activities.

Almost all plant and animal species have some form of traditional use or cultural significance (for example totemic significance). Many plant and animal species were used traditionally for food and fibre. For example, the seeds, fruits, leaves, shoots, stems, roots and tubers of plants were processed for food, used to make implements and for medicinal purposes.

Archaeological evidence of cultural sites, such as stone artefact scatters, are often concentrated along **ecotones** around the margins of palm swamps 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.

Ecological values

Both feather palm and fan palm swamps contain diverse vegetation, with fan palm swamps generally being greater in plant species diversity.

Feather palm swamp occur in different positions in the landscape: some occur in lowland swamps on alluvial soils derived from basaltic and granitic parent material, in the very wet rainfall zone and may have an *Acacia celsa* canopy. Others occur on steep upper slopes and gully bottoms of uplands, on granite and rhyolite in wet and very wet rainfall zones and a third type occur on seasonally impeded drainage on dune sands.

These **remnant** feather palm swamps can contain species that are shared with adjacent mesophyll vine forests such as northern silky oak *Cardwellia sublimis*,



Golden guinea flower *Dillenia alata* is typically found in feather palm swamps and has distinctive bark. Photos: Roger Jaensch, Wetlands International



Climbing swamp fern *Stenochlaena palustris* and bird's nest fern *Asplenium nidus* are commonly found in feather palm swamps. Photos: Roger Jaensch, Wetlands International

Beilschmiedia brunnea, cluster fig *Ficus racemosa*, white fig *F. virens*, and *Ilex arnhemensis*.

Other typical feather palm swamp species include: broad leaved lilly pilly *Acmena hemilampra*, pink ash *Alphitonia petriei*, white cheesewood *Alstonia scholaris*, feather palm *Archontophoenix alexandrae*, pink toriga *Calophyllum australianum*, carallia *Carallia brachiata*, rusty laurel *Cryptocarya mackinnoniana*, poison walnut *C. pleurosperma*, golden guinea flower *Dillenia alata*, *Dysoxylum excelsum*, spur mahogany *D. pettigrewianum*, northern rose walnut *Endiandra cowleyana*, blue walnut *E. hypotephra*, *E. montana*, fan palm *Licuala ramsayi*, swamp tea-tree *Melaleuca dealbata*, broad-leaved tea-tree *M. leucadendra*, pink euodia *Melicope elleryana*, native nutmeg *Myristica muelleri*, Leichhardt tree *Nauclea orientalis*, red silkwood *Palaquium galactoxylon*, thin-leaved coondoo *Pouteria chartacea*, and pink satinash *Syzygium sayeri*.

The most commonly occurring shrubs, vines, epiphytes and herbs include lawyer cane (wait-a-while) *Calamus moti*, whip vine *Flagellaria indica*, burnie vine *Trophis scandens*, candle plant *Pothos longipes*, bird's nest fern *Asplenium nidus*, climbing swamp fern *Stenochlaena palustris*, and dwarf pandan sedge *Hypolytrum nemorum*.

In a 1998 study, 191 species of plants were recorded in feather palm swamps. Of these, 60 per cent were scattered emergent trees, some reaching 36 m in height, each species generally occurring only in small numbers, and often in only a few individual sites. Other plants included a variety of shrubs, vines, epiphytes and herbs.

Most species in the palm swamps were found to be relatively widespread in other forest types beyond the feather palm swamps, and often reflected the species composition of neighbouring rainforest communities.

Floristically, there are two distinct fan palm swamp variants: a northern Daintree variant and a southern variant (for example in Mission Beach). Typical fan palm swamp species include *Acacia celsa*, brown salwood *A. mangium*, candlenut tree *Aleurites moluccana*, pink ash *Alphitonia petriei*, white cheesewood *A. scholaris*, *Chrysophyllum* sp., cinnamon laurel *Cryptocarya grandis*, rusty laurel *Cryptocarya mackinnonian*, spicy mahogany



Calamus spp. are climbing palms with spiny stems, leaves and entangling appendages. They are commonly known as 'hairy Mary', 'wait-a-while' or 'lawyer cane.' Photo: Roger Jaensch, Wetlands International

Dysoxylum papuanum, silver quandong *Elaeocarpus angustifolius*, blue walnut *Endiandra hypotephra*, tulip sterculia *Franciscodendron laurifolium*, silver ash *Flindersia bourjotiana*, maple silkwood *F. pimenteliana*, fan palm *Licuala ramsayi*, native nutmeg *Myristica muelleri*, brown pine *Podocarpus grayae*, celery wood *Polyscias elegans*, solitaire palm *Ptychosperma elegans*, black palm *Normanbya normanbyi*, Kuranda satinash *Syzygium kuranda* and river cherry *S. tierneyanum*.

Vines, shrubs and epiphytes include black tree fern *Cyathea rebecca*, *Mackinlaya confusa*, pepper vine *Piper caninum*, lawyer cane *Calamus australis* and *C. moti*, whip vine *Flagellaria indica*, small-leaved fire vine *Tetracera nordtiana*, climbing pandan *Freycinetia excelsa*, shell vine *Connarus conchocarpus*, Hope's cycad *Lepidozamia hopei*, banana bush *Tabernaemontana pandacaqui*, hairy gardenia *Randia hirta*, dwarf pandan sedge *Hypolytrum nemorum*, short-footed screw fern *Lindsaea brachypoda*, *Bowenia spectabilis*, palm lily *Cordyline cannifolia* and gristle fern *Blechnum cartilagineum*.

THE AUSTRALIAN PIED IMPERIAL PIGEON

Also known as the Torres Strait or nutmeg pigeon, the Australian pied imperial pigeon *Ducula bicolor*, is found in New Guinea, Indonesia and northern Australia. It is abundant along the Wet Tropics coast and islands of North Queensland between July and March, when tens of thousands of birds come from New Guinea to breed. In the morning large flocks are seen flying from the offshore islands where they breed to the mainland coastal rainforests and vine forests, including palm swamps, which are their main feeding areas. The pigeons feed on a wide variety of fruits from the mesophyll vine forest, such as native nutmeg *Myristica muelleri* (from which the pigeon derives one of its common names), blue walnut *Endiandra hypotephra* and the feather palm *Archontophoenix alexandrae*, and return to the islands each evening.

The pigeons are now considered common, but populations suffered dramatically in the past from hunters because the birds made easy targets with their daily commuting between the islands and the mainland, and from reduction of their feeding habitat due to clearing for agricultural and urban development. Numbers are now recovering.



The Australian pied imperial pigeon *Ducula bicolor* feeds in palm swamps. Photo: DERM

Dedicated members of local coastal communities have been counting pigeons during the breeding season since 1965.

Species of conservation significance

WetlandInfo provides full species lists of wetlands animals and plants.

Flora

Feather palm swamps provide habitat for rare and threatened flora including the endangered blue tassel fern *Huperzia dalhousieana* (NC and EPBC Acts), and the rare (NC Act) macaranga *Macaranga polyadenia* and long pepper *Piper mestonii*.

Fan palm swamps contain a number of rare and threatened species including the vulnerable vine *Freycinetia percostata* (NC Act) and vulnerable layered

tassel fern *Huperzia phlegmarioides* (NC and EPBC Acts), and the rare (NC Act) trees *Cleistanthus myrianthus*, *Diploglottis harpullioides*, coach walnut *Endiandra dichrophylla*, Noah's walnut *E. microneura*, Daintree foambark *Jagera javanica* subsp. *australiana*, macaranga *Macaranga polyadenia*, *Polyalthia* sp. (Wyvuri B.P.Hyland RFK2632) and fairies basket *Pseuduvaria froggattii*.

FEATHER palm and fan palm swamps provide habitat for rare and threatened flora and fauna.

BLUE TASSEL FERN—BACK FROM EXTINCTION

In January 2004, after searching for two years in North Queensland's rainforests, a James Cook University researcher rediscovered the endangered blue tassel fern *Huperzia dalhousieana* in the top of a tree in a palm swamp. Thought to have been extinct as a result of tree clearing, the fern had not been seen for 26 years. Illegal collection in the past may also have contributed to the demise of this species.

A further two years intense searching with help from Indigenous groups and a small team of dedicated researchers has located only nine blue tassel ferns in the wild.

The blue tassel fern is much admired as a potential ornamental plant, being a distinct and large species of tassel fern. In China, tassel ferns are harvested from the wild for the production of huperzine, a chemical compound used in the treatment of Alzheimer's disease. It may be possible to produce the drug from Queensland's blue tassel fern, and further study is currently being undertaken at James Cook University. The ferns are currently very difficult to propagate and keep alive in cultivation.



The endangered blue tassel fern *Huperzia dalhousieana* has recently been rediscovered in a palm swamp. Photo: Ashley Field, © James Cook University

Fauna

The cassowary *Casuarus casuarus johnsonii* (southern population) is listed as endangered under both the NC and EPBC Acts and listed as vulnerable on the IUCN Red List. At the time of European settlement, the cassowary lived in tropical rainforests from Paluma Range (north of Townsville) to the tip of Cape York. Subsequent habitat reduction by land clearing for agriculture and urban development has caused the population to plummet. Now two discrete populations remain—a southern population in the Wet Tropics and a northern population on the Cape York Peninsula. Both are threatened, but the Wet Tropics population is at greater risk.

At 2 m tall, and weighing up to 60 kg, the cassowary is the largest rainforest animal in Australia. The cassowary, known as the 'rainforest gardener', is an essential part of the ecology of the rainforest, because it eats, digests and disperses many rainforest seeds. The role of the cassowary in rainforest seed dispersal is especially

important because they eat fruit that are too large to be eaten by any other species, including the fruit of the fan palm. Cassowaries use a variety of habitat types, including rainforests, swamps, mangroves, melaleuca and various eucalypt woodlands.



Cassowaries play an important role in dispersing rainforest seeds. Photo: Sarah Young

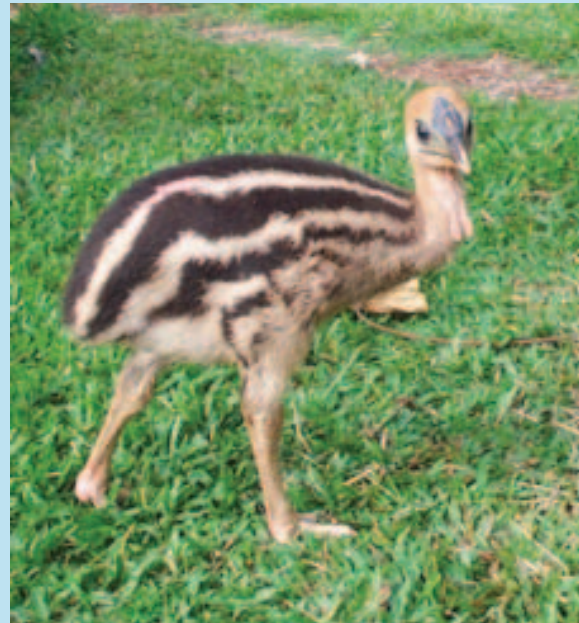
CASSOWARIES AND THE COMMUNITY

Living in close proximity to an endangered species such as the cassowary *Casuarius casuarius johnsonii* (southern population) poses a host of issues for local communities in North Queensland. Habitat reduction, fragmentation, road kill and dog attacks are the greatest threats to the cassowary's survival.

Many local people and organisations are working together to protect the cassowary, for example government agencies such as the Department of Environment and Resource Management (DERM) and Wet Tropics Management Authority (WTMA); research organisations such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Wildlife Research, and James Cook University; and community groups including Community for Coastal and Cassowary Conservation (C4), the Wildlife Preservation Society of Queensland (Wildlife Queensland), Daintree Cassowary Care and Kuranda Envirocare.

The Queensland Parks and Wildlife Service (QPWS), the WTMA and the Cassowary Advisory Group built a cassowary rehabilitation centre near Mission Beach in 2001 to manage the rehabilitation of sick, injured and orphaned cassowaries. Since 2002, seven cassowaries have been rescued and rehabilitated at the centre until they were well enough to be released back to the wild. Some shire councils, including Johnstone Shire, Cardwell Shire and Mareeba Shire have implemented voluntary conservation agreement programs linked to a rate deferral scheme. Protection of cassowary habitat through negotiating Nature Refuge Agreements is a priority for the QPWS and they have a regional extension officer dedicated to the Wet Tropics bioregion.

Areas of cassowary habitat on private land have been successfully targeted for a number of these agreements (for further information on nature refuges, see <www.derm.qld.gov.au>).



This cassowary chick was hand-raised and spent nine months in rehabilitation at Mission Beach's cassowary care facility after he was found with a broken leg when he was two days old. Photo: DERM



Traffic poses one of the greatest threats to the cassowary *Casuarius casuarius johnsonii*. Photo: Sue Gardiner

THE most significant threats to Queensland's palm swamps in the past have been large-scale clearing for agricultural and urban development, and associated wetland drainage.

Managing the palm swamps

The most significant threats to Queensland's palm swamps in the past have been large-scale clearing for agricultural and urban development, and associated wetland drainage. As palm swamps are now endangered there are legal restrictions on clearing within these ecosystems. The challenge will be to maintain the remaining fragments in as healthy a condition as possible and to re-establish linkages across the landscape where the wetlands have become isolated. This will not be possible in all cases, and a strategic, regional approach to the maintenance of the palm swamp is required.



The delineation between an intact palm swamp and land cleared for agriculture

Photo: Bob Smith, WetlandCare Australia

FEATHER palm swamps are particularly sensitive to drainage works on adjoining lands that alter the hydrological and water table relationships within this ecosystem.

Disturbance to hydrology

Feather palm swamps, because of their low position in the landscape, are particularly sensitive to drainage works on adjoining lands that alter the hydrological and water table relationships within this ecosystem. Agricultural drainage, construction of levee banks and artificial wetlands all have the potential to further damage this fragile ecosystem and care should be taken in the location and maintenance of any such structures. Fan palm swamps have naturally occurring deeply dissected drainage channels and are more resistant to the affects of adjacent agricultural drainage and other disturbances to hydrology, however the full range of potential impacts should always be considered before undertaking activities close to fan palm swamps to prevent or minimise disturbance to their hydrology.

POND apple is capable of growing prolifically in feather palm swamps, particularly if the swamps have been disturbed and weakened by hydrological change or wind damage. It is difficult to control pond apple, particularly in sensitive environmental areas.

Wind damage

Palm swamps are prone to wind damage, as they are more exposed in the landscape than in the past. Natural events such as cyclones can also cause damage, again exacerbated by the fragmented nature of the remaining vegetation. Revegetation around palm swamps may be a longer-term solution.

Weeds

In a 1998 study of feather palm swamps, 16 species of exotic plants (mostly herbs and forbs of the ground layer) and two exotic tree species were found. All were present only as occasional species except the pond apple *Annona glabra*, which is a declared Class 2 pest under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002*, and one of 20 Weeds of National Significance. Under this Act it is a serious offence to introduce, keep or supply Class 2 pests without a permit. The pond apple is capable of growing prolifically in feather palm swamps, particularly if they have been disturbed and weakened by hydrological change or wind damage.

In one site, pond apple was found to exceed 25 000 stems per hectare. Control of pond apple is difficult, particularly in sensitive environmental areas. Pulling and dozing have been successful in agricultural ditches and drains, and some herbicides used for the control of other woody weed species have been trialled on pond apple with some success. Fire is known to control pond apple trees and seeds; however it should not be used in palm swamp wetlands due to their intolerance of regular burning. For further information on the control of pond apple see <www.weeds.gov.au>

Other potentially aggressive exotic plants that were identified in the study include the herb *Dracaena cannifolia*, the guava tree *Psidium guajava* and the grass *Arundo donax*. These plants pose most threat after canopy damage such as from a cyclone, or if there are any changes to water or nutrient characteristics which

weaken the condition of the natural ecosystem. Susceptibility to other weed species beyond those above could also occur if the natural environmental conditions are disturbed. For example a number of large exotic grasses which flourish in the Wet Tropics lowlands such as the **ponded pasture** grasses para grass *Brachiaria mutica* and hymenachne *Hymenachne amplexicaulis* are capable of establishing in disturbed feather palm swamps.

No exotic species were noted in fan palm swamps in the 1998 study and this regional ecosystem seems to be more resistant to weed invasion. However, if natural drainage in these swamps is impeded and surface ponding increases in depth and/or duration this could lead to incursions of weeds possibly including the native swamp paperbark *Melaleuca quinquenervia*.

AN AGGRESSIVE INVADER—THE POND APPLE

Originally from the Americas and West Africa, pond apple *Annona glabra* was introduced to Queensland in 1912 to be used as grafting stock for the custard apple industry. It is spreading aggressively through wetlands between Ingham and Cooktown in the Wet Tropics, and has also been found further north on Cape York Peninsula, and south to Mackay.

Pond apple thrives in very wet conditions, reaching reproductive maturity in two years and

producing copious amounts of large spherical green fruits 5–15 cm in diameter. Each fruit contains at least 100 large seeds that can germinate in thick carpets up to 20 cm deep, suppressing the germination of other species by their abundance. The fruits and seeds can survive in fresh to salt water for months and in that time can be transported considerable distances by water. Seed is also spread by feral pigs and native animals, including the cassowary.



A pond apple seedling growing on a palm stump, with a large pond apple in the background. It is believed that the palms were destroyed in a cyclone (1956) but due to the presence of pond apple seeds, the site is now almost exclusively pond apple and the palm swamp has not been able to regenerate.

Photo: Ian Holloway, DERM



Pond apple seeds are distributed by feral pigs through their faeces. Photo: Ian Holloway, DERM

FERAL pigs are considered the major pest animal of the Wet Tropics. They root around the edges of watercourses and swamps, which disturbs the natural vegetation, degrades water quality, causes soil erosion, and promotes conditions that favour weed growth.

Feral animals

Feral pigs *Sus scrofa* cause problems in wetlands by damaging habitat, competing for food with native species, disturbing nests, feeding on eggs and young of native animals, and spreading disease. They are considered the major pest animal of the Wet Tropics, particularly because of their fondness for rooting around the edges of watercourses and swamps, which disturbs the natural vegetation, degrades water quality, causes soil erosion, and promotes conditions that favour weed growth.



Feral pigs *Sus scrofa* can damage all types of wetlands. Photo: DERM

Feral pigs are a declared Class 2 pest under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* and must be controlled by law. Trapping of pigs is difficult in palm swamps and other cassowary habitat areas, because of the impenetrability of the habitat, and because cassowaries have been injured or killed by being caught accidentally in traps. Care should be taken with the design of traps, including the type of bait used, and the trigger mechanism, to reduce the risk of capture of non-target species. For further information on feral pigs, see the DEEDI website <www.deedi.qld.gov.au>.

The introduced cane toad *Rhinella marina* is also identified as one of the most significant pests of the Wet Tropics however it is not a declared pest in Queensland and there is no legal requirement to control it. Cane toads compete with native amphibians and reptiles for food and breeding sites, and prey on many varieties of small native fauna including amphibians, insects and reptiles.

They are known to poison most native species that attempt to feed on them, although some species, including predatory birds such as the white-faced heron *Egretta novaehollandiae*, the tawny frogmouth *Podargus strigoides* and bush stone-curlew *Burhinus grallarius*, have learned to eat the less poisonous parts such as the underbelly. Keelback snakes *Tropidonophis mairii* are also known to feed on young toads and it seems that they can tolerate low levels of toad toxin.

There is no effective broad-scale control for the cane toad. Some areas have bounties for their collection but this has not been a successful, sustainable management strategy. CSIRO and the University of Adelaide are researching biological control methods using gene technology and disruption of breeding cycles by pheromones. Both the cane toad and feral pig are listed as key threatening processes under the Commonwealth's EPBC Act. For further information see <www.environment.gov.au>

BIOLOGICAL CONTROL EXPERIMENT BECOMES PEST SPECIES

A small number of cane toads *Rhinella marina* were introduced from Hawaii to North Queensland in June 1935 to control the grey-backed cane beetle *Dermolepida albohirtum* and the French's cane beetle *Lepidiota frenchi* that were major sugar cane pests at the time. The cane toad was a failure as a biological control agent because it did not target cane beetles. The toads adapted extremely well however to the Australian environment and have spread widely through Queensland and into New South Wales and the Northern Territory. Cane toads breed more prolifically than native species, producing up to 35 000 eggs in a single clutch.

Cane toads are now found in habitats ranging from sand dunes and coastal heath to rainforest margins and mangroves. Their advance will only be limited by availability of water for breeding, food supply and a tolerable temperature range. As the toads can survive temperatures from five to 40 degrees Celsius, and can lose up to half of



Cane toads *Rhinella marina* were originally introduced to North Queensland to control sugar cane pests and have now become one of the most significant pests of the Wet Tropics. Photo: DERM

their body water with little ill effect, this hardy species is predicted to continue its spread across Australia for quite some time to come, with potentially devastating consequences for native fauna and ecological systems.

Illegal collection

The vulnerable layered tassel fern *Huperzia phlegmarioides* is being illegally collected, and it is suspected that the population of the endangered blue tassel fern *Huperzia dalhousieana* was also affected by collectors in the past. This threat will continue, and may increase with increasing development pressure along the Wet Tropics coast. Unauthorised collection of protected plants is prohibited under the NC Act and the maximum penalty is \$225 000 or two years imprisonment.

CONSERVING FAN PALM SWAMPS IN THE DAINTREE

In 1993, the Australian Bush Heritage Fund, a philanthropic organisation with a business charter to invest in the protection of biodiversity values, purchased an 8 ha block of fan palm swamps in Queensland's Daintree lowland rainforest. Ongoing fauna survey and feral animal and weed control is contributing to the study and protection of this significant community.

Glossary

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

Basaltic Relating to or containing basalt, which is a fine-grained igneous rock composed of the minerals plagioclase and pyroxene.

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.

Colluvial Rock detritus and soil accumulated at the foot of a slope.

Ecotone A transition zone between two or more ecological communities.

Emergent An individual tree growing higher than others in its vicinity within a forest, so that its crown rises markedly above the adjacent overstorey.

Epiphyte Any plant that does not root in soil but rather uses another plant species for support. Among flowering plants, the best-known epiphytes are orchids and bromeliads.

Forbs Soft-stemmed, broad-leaved, low-growing annual or perennial herbs.

Granitic Relating to or containing granite, an intrusive igneous rock that forms at great depths and pressures under continents. Granite consists of orthoclase and plagioclase feldspars, quartz, hornblende, biotite, muscovite and other minor accessory minerals.

Herbs Plants with soft, non-woody stems, like wildflowers and ferns.

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.

Mesophyll Vegetation with leaves longer than 12.5cm but less than 25cm.

Metamorphic Rocks which have been reformed by pressure, heat, or water to become more compact and crystalline.

Notophyll Vegetation with leaves longer than 7.5 cm but less than 12.5 cm.

Palustrine Pertaining to marshes, swamps, bogs and fens.

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

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

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

Sclerophyllous Leathery type leaves with a thick waxy cuticle that reduces water loss in plants.

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.

Watertable The level below the land surface at which the subsurface material is fully saturated with water. The depth of the water table reflects the minimum level to which wells must be drilled for water extraction.

World Heritage 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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Appendixes

Appendix 1: Threatened flora and fauna commonly associated with Queensland's palm swamps.

Taxon group	Common name	Scientific name	NC Act status*	EPBC Act status*	IUCN Red List of threatened species status **
Ferns	blue tassel fern	<i>Huperzia dalhousieana</i>	endangered	endangered	—
	layered tassel fern	<i>Huperzia phlegmarioides</i>	vulnerable	vulnerable	—
Vine		<i>Freycinetia percostata</i>	vulnerable	—	—
Bird	southern cassowary	<i>Casuaris casuarius johnsonii</i> (southern population)	endangered	endangered	vulnerable

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

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

Appendix 2: Coastal palm swamps in Queensland that are listed in *A Directory of Important Wetlands in Australia (2005)*

Bioregion	Directory reference	Directory wetlands
Wet Tropics	QLD137	Alexandra Bay
	QLD138	Alexandra Palm Forest
	QLD142	Cowley Area
	QLD143	Edmund Kennedy Wetlands
	QLD144	Ella Bay Swamp
	QLD145	Eubenangee — Alice River
	QLD146	Herbert River Floodplain
	QLD149	Innisfail Area
	QLD153	Licuala Palm Forest
	QLD158	Russell River
	QLD161	Tully River — Murray River Floodplains
	QLD163	Wyvuri Swamp

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