## 7. Methods

Wetlands that are included in the report were identified from maps, aerial photographs and from anecdotal evidence from people in the study area, including government and local council officers and long-term local residents who had extensive knowledge of their local wetlands. Researchers who have worked on wetlands were also consulted.

Existing documents on wetlands were reviewed. These included research papers, catchment management reports and other reports on wetlands. Relevant research papers and technical reports on marine fish species' use of estuaries and wetlands were also reviewed and historic records of early explorer Robert Arthur Johnstone were reviewed for descriptions of wetlands as he found them in the 19th century.

Data on fish movement to and from wetlands was obtained from the ANSA Qld Suntag database and from published reports. Details of fish tagged in wetlands and movements to and from wetlands are contained in the Appendices of this report.

Field inspections of wetlands were undertaken during December 2003 and January 2004. Wetlands from Mossman in the north to Turkey Beach in the south were visited. These visits were mostly conducted in the company of local experts. Information provided by local experts has been invaluable in the compilation of this report. It should be noted that the inspections followed the driest two years on record for most of the Wet Tropics and some of the Dry Tropics while other areas had average or above average rainfall, particularly south of Mackay.

In order for this report to be viewed in the context of wider activities in relation to wetlands, other initiatives that are currently in progress, commencing or planned for the near future have been identified in Section 8.

## 8. Related Initiatives on Fisheries Values of Wetlands in the Study Area

During the course of the research undertaken for this report a number of related initiatives on the fishery and broader values of wetlands have been identified. These initiatives are currently in progress, commencing shortly or being planned. This report needs to be viewed in the context of these initiatives that are summarised below. This summary is based on the information that was available at the time of preparation of this report and is not considered to be an exhaustive record.

- This report should be read in conjunction with the Reef Water Quality Protection Plan (RWQPP). The goal of the RWQPP is "Halting and reversing the decline in water quality entering the Reef within ten years." The primary objectives identified to achieve the goal are to reduce diffuse sources of pollutants in water entering the Reef, and to rehabilitate and conserve areas of the GBR catchment that have a role in removing water borne pollutants. Restoration of wetlands has been linked to the RWQPP as a component activity for improving water quality (Baker *et al*, 2002)
- Capricorn Sunfish has been monitoring barramundi use of wetlands in Central Queensland since 1999 to determine when and how juvenile barramundi access wetlands. This monitoring is ongoing and two reports have been produced.
- The Coastal CRC has recently commenced a project titled "*Contribution of Wetland Habitats to Fisheries Output and Food Chains in the Fitzroy River Estuary*". This project will look at the contribution of wetlands to the fishery production of the Fitzroy River.
- The EPA is currently coordinating a project to map wetlands along the entire Queensland coast and to identify demonstration sites that could be used to promote the benefits of productive wetlands and be used as education tools for the community.
- DPI&F has submitted a proposal titled "*Great Barrier Reef – Freshwater Fish Habitat Strategic Investment Proposal*" (*pers comm.* T Marsden) for NHT funding. This project aims to develop a strategic approach to wetlands management and undertake rehabilitation work on identified key wetlands.
- ACTFR has developed a proposal for NHT funding to look at the tolerance of fish species to low levels of dissolved oxygen. This project is awaiting consideration by NHT.
- Sunfish Queensland, in partnership with the ACTFR, is seeking Envirofund funding for a project titled "*Recognising the Fishery Value of Wet Tropics Coastal Swamp Wetlands*". This project will assess the use of key tropical wetlands by fish and fill some of the knowledge gaps identified in this report. (*NB. This project did not get funded.*)
- WCA is undertaking a project in the Burdekin area to assess grazing as a management tool for control of exotic pasture weeds. This project is not directly related to fish, but addresses both water and habitat quality which are essential to fish.

- The DPI&F is currently working on a policy document for dealing with ponded pastures. It is expected that the document will be available in August 2004.

## 9. Use of Freshwater and Marine Habitats by Fish Species

Fish species can be categorised by the way they use freshwater and marine habitats during their life cycle. All categories of species are found in the rivers and creeks adjacent to the GBR; however, different species use different habitats to varying degrees. The terminology used to describe their behaviour is:

- Anadromous fish (eg snubnose garfish) spend most of their lives in coastal or estuarine habitat and migrate to freshwater to breed.
- Catadromous species spend most of their lives in freshwater and migrate to saltwater to breed. For example, eels, particularly the longfinned eel (*Anguilla reinhardti*), pacific eel (*Anguilla obscura*) and shortfinned eel (*Anguilia australis*) live in freshwater but breed in the Coral Sea beyond the GBR (Allen *et al*, 2002; Pease *et al*, 2003; Shiao *et al*, 2002).
- Amphidromous species migrate between between freshwater and saltwater but not for the purposes of breeding. For example, mangrove jack (*Lutjanus argentimaculatus*) (*figure 2*) use all habitats from freshwater to offshore coral reefs where they breed (Russell *et al*, 2003).
- Euryhaline species such as bream can tolerate a wide range of salinities without necessarily migrating between freshwater and saltwater to breed.
- Potamodromous species such as golden perch migrate wholly in freshwater and marine species including threadfin and red emperor migrate between different saltwater habitats.


Figure 2: Mangrove jack and barramundi are important species that use marine and freshwater habitats

A total of 79 species have been identified as using both freshwater and marine habitats along the GBR coast within the last 15 years. A complete list of marine species recorded from both freshwater and saltwater within regions of the study area is contained in Appendix 1. A summary of key or representative species and the range of habitats that they use is shown in *table 1*. One example of a marine pelagic fish that inhabit coral reefs and are known to enter freshwater on an opportunistic basis are trevally species (Herbert and Peters, 1995; Allen and Coates, 1990).

The use of wetlands by barramundi is becoming well understood. Juvenile barramundi enter freshwater and brackish wetlands from January to April during local freshwater flows, especially if associated with king tides. Fish sizes generally range from 50 to 450mm. These fish remain in these habitats for 1 or more years before returning to the estuary on subsequent flows (Russell and Garrett, 1983, 1985, 1998; Sawynok, 1998, 2002, 2003). In 1986, Russell suggested a correlation between commercial landings of barramundi on Queensland's east coast and the loss of wetlands (Garrett, 1991) highlighting the need for barramundi to access wetlands and for these wetlands to be protected.

Stocking of marine species, particularly barramundi, has been used to restore fish to freshwater wetlands where they were previously found but have become locally extinct due to loss of connectivity. With artifical breeding of mangrove jack there is some possibility that this species could also be stocked in freshwater wetlands where it is locally extinct. However stocking is unlikely for the full range of marine species that previously used these areas as the full life cycle for many species is not known and artificial breeding of most species may not be possible or be too costly to be economically viable.

There is a matrix of interaction between species across this chain of habitats that shows the necessity for connectivity to allow fish to move between these habitats. Connectivity between these habitats can be affected by both physical and water quality barriers (see Section 10.1 below).

| Species | Scientific name | Habitats |
|---|---|---|
| Barramundi | *Lates calcarifer* | FW/ES/CS |
| Mullet | *Mugil spp* | FW/ES/CS |
| Tarpon | *Megalops cyprinoides* | FW/ES/CS |
| Giant herring | *Elops hawaiensis* | FW/ES/CS |
| Milkfish | *Chanos chanos* | FW/ES/CS |
| Mangrove jack | *Lutjanus argentimaculatus* | FW/ES/CS/RF |
| Eel | *Anguilla spp* | FW/ES/RF/OC |
| Jungle Perch | *Kahlia rupestris* | FW/ES |

| | | |
|---|---|---|
| Australian bass | *Macquaria novemaculeata* | FW/ES |
| Yellowfin bream | *Acanthropagrus australis* | FW/ES/CS |
| Bull shark | *Carcharhinus leucas* | FW/ES/CS |
| Subnose garfish | *Arrhamphus sclerolepis* | FW/ES |
| Forktail catfish | *Arius graffei* | FW/ES |
| Bony bream | *Nematalosa spp* | FW/ES |
| Butterfish | *Selenotoca spp* | FW/ES |
| Archer fish | *Toxotes chatareus* | FW/ES |
| Glass perchlet | *Ambassis spp* | FW/ES |
| Trevally | *Caranx spp* | FW/ES/CS/PL/RF |
| Flathead | *Platycephalus spp* | FW/ES/CS |
| Whiting | *Sillago spp* | FW/ES/CS |
| Snapper | *Pagrus australis* | ES/CS/RF |
| Coral trout | *Plectropomus spp* | ES/CS/RF |
| Grass emperor | *Lethrinus fletus* | ES/CS/RF |
| Pinkear emperor | *Lethrinus lentjan* | ES/CS/RF |
| Nannygai/Fingermark | *Lutjanus spp* | ES/CS/RF |
| Estuary cod | *Epinephalus spp* | ES/CS/RF |
| Black spinefoot | *Siganus spinus* | ES/CS/RF |
| Mackerel | *Scomberomorus spp* | ES/CS/PL/RF |
| Barracuda | *Sphyreana spp* | ES/CS/PL/RF |
| Queenfish | *Scomberoides spp* | ES/CS/PL/RF |
| Javelinfish | *Pomadsys spp* | ES/CS |
| Jewfish | *Protoibea/Argyrosomus spp* | ES/CS |
| Threadfin | *Eleutheronema/Polynemus spp* | ES/CS |

FW=freshwater ES=estuary CS=coastal PL=pelagic RF=reef OC=oceanic

Table 1: Key species using a range of habitats from freshwater to reef

## 10.Impacts on the Function of Freshwater Wetlands

There are a range of factors that affect the function of wetlands in relation to their use by fish. While the issue of global warming is acknowledged its affects have not been specifically included; however, the general effect of increased temperatures such as reduced available oxygen, an increase in algal blooms and more variable water supply are likely to have further adverse impacts on freshwater wetlands (US EPA, 1995; Lake *et al*, 2000) and many of these impacts are interrelated with water quality.

### 10.1. Connectivity

Connectivity is the extent to which fish and other biota can move between different habitat types. The period of time water flows between wetlands, in-stream pools and estuaries and the extent and effectiveness of barriers determines the level of connectivity. In the Wet Tropics there are often permanent flows in rivers and larger creeks that provide continuous connectivity although off-stream wetlands may be isolated for long periods. In the dry tropics most waterways flow intermittently with sporadic connectivity.

The extent of connectivity between freshwater wetlands and the marine system is a primary factor in determining the value of wetlands to marine fish. Physical barriers affect connectivity and in some waterways there are natural barriers such as rock bars and waterfalls. However artificial barriers such as dams, weirs, barrages, causeways and ponded pastures have the greatest impact on connectivity (Anon, 2000). The effect of artificial barriers can range from minor obstacles to completely stopping fish passage (Clague, 1991; White *et al*, 1999). Loss of connectivity can be mitigated by barrier designs that reduce the impact on fish passage or by providing fishways that allow fish to bypass the barrier (White *et al*, 1999; Marsden *et al*, 2003a, 2003b, 2003c).

Barriers not only impact on upstream migration of marine species but can also affect freshwater species (Anon, 2000). During flooding, freshwater species are often washed downstream past barriers and are then unable to migrate back upstream. However, even on barriers where there are fishways adult fish may not be able to use them. In the Burnett River following flooding in 1999 lungfish were trapped in the tidal waters below the Burnett River barrage and could not use the fishway to get back up to the freshwater (Stuart and Berghuis, 1999). Freshwater fish trapped this way may perish when salinity levels return to normal, through reduced oxygen levels in shallow warm water or through predation by birds and terrestrial animals.

There are also less obvious causes for reduction of connectivity. Culverts under roadways may not physically stop connectivity but may effectively block fish passage if the water velocity through these culverts exceeds the swimming ability of fish (Clague, 1991). This effectively prevents or severely limits fish movement through the culvert. Native fish avoid swimming through darkened areas and this has been recognised as a barrier in long culverts (Cotterell, 1998). Water quality can also create a barrier with limited studies showing avoidance behaviour by juvenile fish (Kroon *et al*, 2004) that may prevent access to important habitat. Weeds are also an effective barrier (Perna, 2003).

Changes to hydrology and flow regimes can reduce connectivity. Floodplain drainage lines have been used for irrigation supply channels to assist with farm production in some areas i.e. lower Burdekin. These drainage lines can result in changes to the flow regime from an intermittent flow associated with rainfall to a constant flow throughout the year (Perna, 2003). Many native fish species using freshwater wetlands use natural intermittent flows as spawning and migration triggers and these triggers are therefore affected by constant flows (Anon, 2000). Constant flows may also result in water velocities that inhibit migration. Water running at a velocity of greater that 0.3 metres per second for any significant distance is not conducive to migration as most native fish cannot sustain a swimming speed to overcome the flow (Clague, 1991).

## 10.2. Water Quality

Poor water quality often results from poor land management (Roth *et al*, 2003). A comparison of flood plumes from a small undeveloped catchment (Ella Bay) and a developed catchment (Johnstone River) is shown in *figure 3*. This highlights the different water quality associated with developed and undeveloped catchments during the same rain event.


Figure 3: Comparison of flood plumes from a pristine catchment (left) and a developed catchment (right)
Photographs © Great Barrier Reef Marine Park Authority

Water quality can be affected by habitat quality, prevailing climatic conditions such as long periods without rain, high temperatures causing evaporation and reduced oxygen concentrations, decomposition of organic material in the water which uses up dissolved oxygen, the composition of soils over or through which the water moves (especially acid sulfate soils), sediment and nutrient loads, in-stream aquatic vegetation and algae, and pollutants such as herbicides and pesticides (Lukacs, 1997).

Water quality is generally the key determinant of the in-stream capacity of a waterway to support fish populations if habitat is suitable. Suitable water quality in a waterway is more likely to hold a healthy population of fish. Dissolved oxygen and water temperatures are the most important factors that affect fish. As water quality deteriorates the population is likely to decrease and change in species composition can occur as some species can tolerate changes in water quality better than others (Perna, 2003).

In freshwater wetlands of coastal GBR waterways, water quality can naturally fluctuate considerably (Hunt and Christiansen, 2000) and many species that use these areas are tolerant of large variations. Chronic low levels of dissolved oxygen and high temperatures have been identified as limiting the range of species in many wetlands (Hogan and Graham, 1994). Bony bream are one species that are sensitive to poor water quality and should be used as an indicator species (Allen *et al*, 2002). The absence of bony bream in a wetland not impacted by connectivity is likely to be attributed to the presence of poor water quality (Allen *et al*, 2002).

Deterioration in water quality beyond that within the range that fish can tolerate often results in fish kills (Veitch, 1999). Bony bream are often the first species to die in fish kills related to water quality (Allen *et al*, 2002) (*pers obs* Sawynok). While some fish kills are a natural occurrence it is likely that their frequency and severity have increased as a result of changes to wetlands functional values and catchment sediment and nutrient loads (Wannamaker and Rice, 2000).

## 10.3. Habitat Quality

Habitat quality relates to the status of the in-stream habitat and the adjacent riparian and floodplain habitat. Habitat quality is at its best when the area adjacent to and upstream of a wetland is in its natural state. When a wetland has been filled in or shallowed by siltation, choked by aquatic weeds and riparian vegetation has been removed, habitat quality is at its poorest.

Figure 4: Invasion by woody weeds such as pond apple and complete removal of trees from a catchment are two extremes of the impact on riparian vegetation

Habitat quality directly affects water quality. A critical factor in habitat quality is the use of the surrounding land. Generally, large areas of natural vegetation surrounding a waterway will enhance water quality (Bunn *et al*, 1997). Where adjoining land use has removed vegetation but retained a natural riparian zone a buffer is formed between the waterway and the adjacent land use (Johnson *et al*, 1997; Giller and Malmqvist, 1998). Wide natural riparian zones are particularly important for lower order streams and contribute significantly to stream health (Giller and Malmqvist, 1998).

Riparian vegetation supplies organic matter to the food chain and harbour important food sources such as insects (Pearson and Connolly, 2004), acts as a filter for water entering the waterway, provide shade that reduces water temperature and can also provide in-stream cover for fish when trees fall into the waterway (Johnson *et al*, 1997; Giller and Malmqvist, 1998). Many fish species are known to use in-stream snags as cover (Russell and Hales, 1996) and they are recognised as important in both erosion control and as a food source (Giller and Malmqvist, 1998).

Invasive weeds are often the result of riparian zone damage (Bunn *et al*, 1997). These weeds fall into two categories being woody weeds (*figure 4*) and grasses. Woody weeds that are of concern in riparian zones of wetlands adjacent to the GBR include mimosa, rubber vine, pond apple, chinee apple and numerous others. Woody weeds can often out-compete native riparian vegetation as they grow more quickly, seed more prolifically and are more tolerant of a wide range of environmental conditions. Woody weeds can increase erosion as a result of land degradation.

Not all invasive weeds are introduced. In some areas where flow regimes in wetlands have been altered native species such as cumbungi and typha have proliferated and reduced the area of wetlands that fish can use (Perna, 2003).

Aquatic weeds affect both the water quality and the physical area of a waterway available to fish. Weed growth and associated organic loading in the water uses oxygen and reduces the area available for oxygen uptake from wind action. Proliferation of weeds can affect dissolved oxygen levels (Roth *et al*, 2003; Perna, 2003). High nutrient loads can rapidly increase weed growth and result in waterways being choked with weeds and reducing the physical area available to fish (Perna, 2003). Areas of waterways darkened by dense coverage of floating aquatic weeds may inhibit fish use of these areas (Cotterell, 1998). The main issue with these 'darkened' areas is the development of completely anoxic reaches which effectively form chemical barriers to fish movement and also result in the increased liberation of nutrients from the bottom sediment – further exacerbating weed infestation problem (Perna, 2003).

Feral animals, particularly pigs can affect riparian zones by digging up the ground. This can increase sedimentation and nutrients in the waterway if there is rainfall while the ground is dug up and exposed.

## 10.4. Risks and Threats

There are a wide range of risks and threats that affect the fisheries values of freshwater wetlands. The following is a summary of the risks and threats that were identified in this study:

1. Continuing poor recognition by the broader community of the value of wetlands, especially their use by and importance to fish.
2. Lack of recognition of the importance of wetlands in local authority and catchment management plans.
3. Lack of reference sites that can be used to demonstrate the value of wetlands.
4. Limited knowledge of fish use of some important wetlands.
5. Expansion of residential and industrial land use adjacent to waterways.
6. Practices associated with rural land uses in catchments that may impact on the functioning of wetlands, particularly agriculture and irrigation.
7. Vegetation clearing and changes in land use from grazing to intensive agricultural activities.
8. Litter, rubbish and illegal waste dumping, especially in urban areas.
9. Drainage of wetlands for conversion of land for other uses such as industry and agriculture.
10. Adjacent mining activities.
11. Continuing changes to drainage patterns in catchments and flood mitigation works.
12. Water extraction for rural and urban use.
13. Disturbance and/or exposure of ASS.
14. Large and small barriers to fish migration including tidal barrages, dams, weirs, floodgates, tide gates and road culverts.
15. Reduced ability of fish to migrate as a result of changes in water velocities from “improved” drainage.
16. Impacts on fish migration and spawning triggers due to changes from natural flow patterns associated with use of water for irrigation and power generation.
17. Connection of wetlands by artificial channels and altered flow regimes for irrigation that restrict migration.

18. Use of wetlands for ponded pastures that block fish migration or if they allow fish migration do not support survival of fish (through drying out).
19. Reduction of the extent of riparian zones and degradation through invasion by woody weed such as pond apple, introduced grasses such as para grass, and the impact of feral animals such as pigs.
20. Increase in in-stream introduced weeds such as water hyacinth and hymenacne.
21. Expansion of native aquatic plants such as cumbungi and water lily as a result of increased nutrients and reduced water depths in wetlands.
22. Introduced noxious fish such as tilapia and gambusia.
23. Removal of in-stream cover such as snags.
24. Reduction in water quality, especially dissolved oxygen from increased nutrient loads, algae and plant growth, and water temperatures.
25. Sediment inputs that accumulate and reduce water depths in wetlands.
26. Pesticide, herbicide and other contaminant residuals entering wetlands.
27. Inappropriate fire management practices in and adjacent to wetlands.

## 11. Wetlands and their Connectivity to the Great Barrier Reef

This section outlines the status of wetlands in the GBR catchment including the extent of habitation by fish species and the importance of these wetlands as a connection between the freshwater and marine environments.

### 11.1. Wet Tropics Region

The Wet Tropics region, for the purpose of this report, extends from the Daintree River in the north to Ingham in the south. A report prepared for the EPA (formally Department of Environment) in Cairns provides details of waterways from the Daintree River catchment to Cardwell. This report identified key waterways and wetlands and provided rehabilitation priorities. It also identified freshwater fish species using these waterways (Burrows, 1998).

In his series Spinifex and Wattle originally printed in "Queenslander" from 1903 to 1905, early explorer Robert Arthur Johnstone described the Barron District. His reports included reference to "crossing a piece of open forest" after cutting though much thicker vegetation, "shallow, isolated lagoons" which were made muddy to catch the fish and, "a chain of blue lily lagoons" … feet deep where "immersed blacks" hid by using reed stems to breath under the water. From Johnstone's descriptions of the region, it was a mixture of extensive lowland rainforest and ephemeral and permanent wetlands perhaps much like what is left in remnant areas such as the Mount Coom area on the Tully flood plain.

### 11.1.1. Daintree River to Mossman

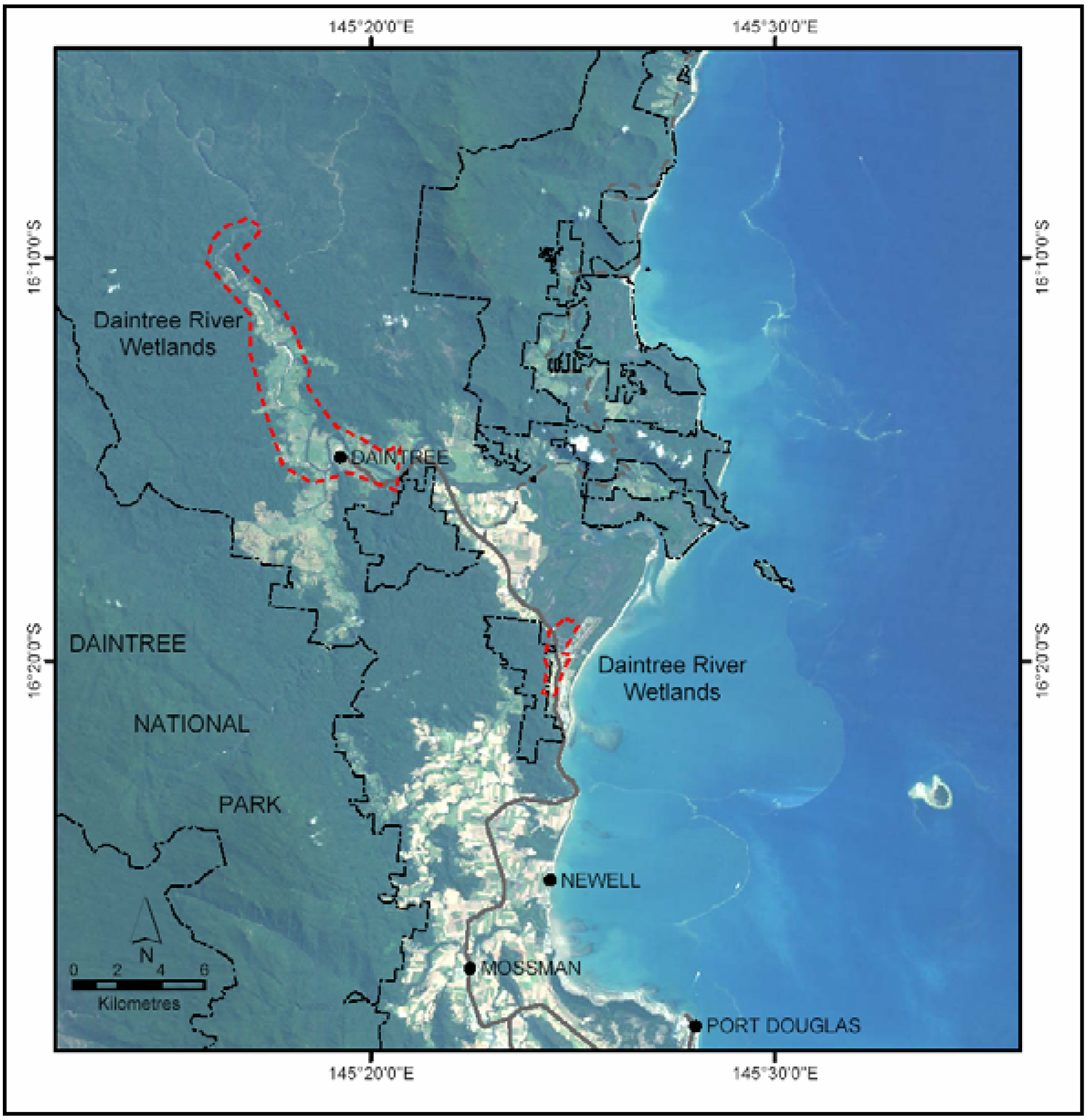


Figure 5: Wetland areas associated with the Daintree River

North of Cairns there are few off-stream wetlands remaining that are significant to fish. While the Daintree River is a permanent flowing river it is considered to be the most important freshwater habitat for marine and freshwater species in this district (Russell *et al*, 1998). Its upper reaches are in pristine rainforest that is part of the WTWHA and is protected from future impacts. While the lower reaches have been developed along the narrow floodplain the condition of the riparian zone varies from good to non-existent.

The Daintree River has some of the best examples of tidally influenced freshwater wetlands in the Wet Tropics but they are relatively narrow and confined within the lower banks of the river. The riparian zones in the developed middle section of the catchment are not contiguous. In many areas the vegetation has been cleared to the water's edge for agriculture and grazing. The Daintree River has a large oxbow lagoon in its middle reaches that is separated from the main river. This is now a melaleuca swamp with no permanent deep water that could be suitable for fish. Invasive weeds, including para grass and pond apple, dominate the understorey. This wetland presently has limited fishery values but in heavy rain may still function effectively as a sediment and nutrient trap (*pers obs* Veitch).

An important but presently degraded wetland area remains in the upper reaches of the south arm of the Daintree River. It is sited behind beach sand ridges adjacent to the Wonga Beach township (*figure 5*). Strong consideration should be given to restoring and protecting this area as it is a high profile site that could be used as a demonstration site for the district.

The Daintree River remains important to fish as connectivity with the estuarine part of the river has not been altered and there are no impoundments on the river. A survey of fishery resource identified 132 fish species in the Daintree River, Saltwater Creek (*figure 6*), Mossman River and Mowbray River catchments (Russell *et al*, 1998). Of these at least 20 use both freshwater and marine habitats.

Figure 6: Well shaded freshwater section of Saltwater Creek in the Mossman area

Both the Mossman and Mowbray Rivers are also important freshwater resources for fish. In-stream habitat is mostly only lightly impacted; however, riparian vegetation is confined to between the banks of the streams in many areas of the floodplain. Of concern are the numerous culverts (*figure 7*), most of which are likely to make fish passage difficult except in major floods. Invasive weeds including hymenacne, para grass, Singapore daisy and a range of other weeds narrow the waterways at critical flow points.

Figure 7: Culvert with high velocity water flow that reduces fish migration on a Saltwater Creek tributary

The original extent of wetlands in the Douglas Shire could not be established and the relatively short catchment areas may have restricted the original extent of natural freshwater wetlands. It is likely, however, that changing river courses would have resulted in some remnant lagoons. There are no natural off-stream wetlands that are significant to fishery resources remaining in the district.

Presently, the Douglas Shire Council promotes a high level of environmental awareness and there is little threat of further destruction of waterways. Restoration projects to re-establish quality habitat areas along watercourses are strongly encouraged within Douglas Shire.

As there are no off-stream wetlands of significance remaining in the Daintree and Mossman River area that presently have fishery values, the perceived risks or threats to off stream wetlands are limited. However, the freshwater reaches of waterways are therefore of high importance and a number of risks and threats to these areas are identified. They are:

1. Continued pressures on the riparian zone from adjacent land use and pest animals such as feral pigs.
2. Increase in in-stream weeds such as para grass, Singapore daisy, hymenacne, pond apple and numerous other invasive species.
3. Culverts that impede fish migration.
4. Expansion of horticulture where many crops require higher levels of pesticides, herbicides and fertilisers, and management practices may increase sheet soil erosion.

On-farm improvements on cane farms have been extensive in the district but habitat restoration projects are still limited in extent. Restoration of the wetland at Wonga Beach would benefit fishery resources. Major improvements to fish productivity could also be achieved through improvements to passage at culverts to reduce water velocity during flow periods and through an intensive, in-stream weed management program.

#### 11.1.2. Barron River and Trinity Inlet

The City of Cairns has the largest population in the Queensland Wet Tropics. Its land use is highly diversified with some extensive rural areas and other highly developed residential, tourist and industrial areas. Impacts on wetlands are complex and are related to adjacent land uses. Only very small remnant pockets of the habitat described by Spinifex and Wattle now remain and no freshwater wetlands, other than in-stream habitat such as Lake Placid on the Barron River, could be found in the Barron district that may be significant to fishery resources (*figure 8, 9*).

Some native fish species continue to occupy various habitats but the full diversity of native fish is restricted by poor habitat quality and the inability of most fish species to negotiate degraded sections linking areas of good habitat (*figure 10*). Such degraded habitats cannot sustain healthy and diverse fish populations due to inadequate food supplies and subsequent water quality impacts including anoxic water (Bunn et al, 1997). These areas are likely to suffer significant problems from mosquitoes and other disease vectors that can thrive in such habitat and require expensive, and environmentally damaging pesticide control programs that further increase the impact on native fish. Introduced fish species such as tilapia and gambusia thrive in these degraded urban aquatic habitats (*pers comm*. John Russell).

Large areas around Cairns including East Trinity (Fitzpatrick *et al*, 1999), Earl Hill (Skells, 2000) and parts of Cairns City are underlain by coastal acid sulfate soils

(ASS). East Trinity has been used to investigate the impacts of large scale ASS disturbance including a 3 year study by CSIRO (Fitzpatrick *et al*, 1999).

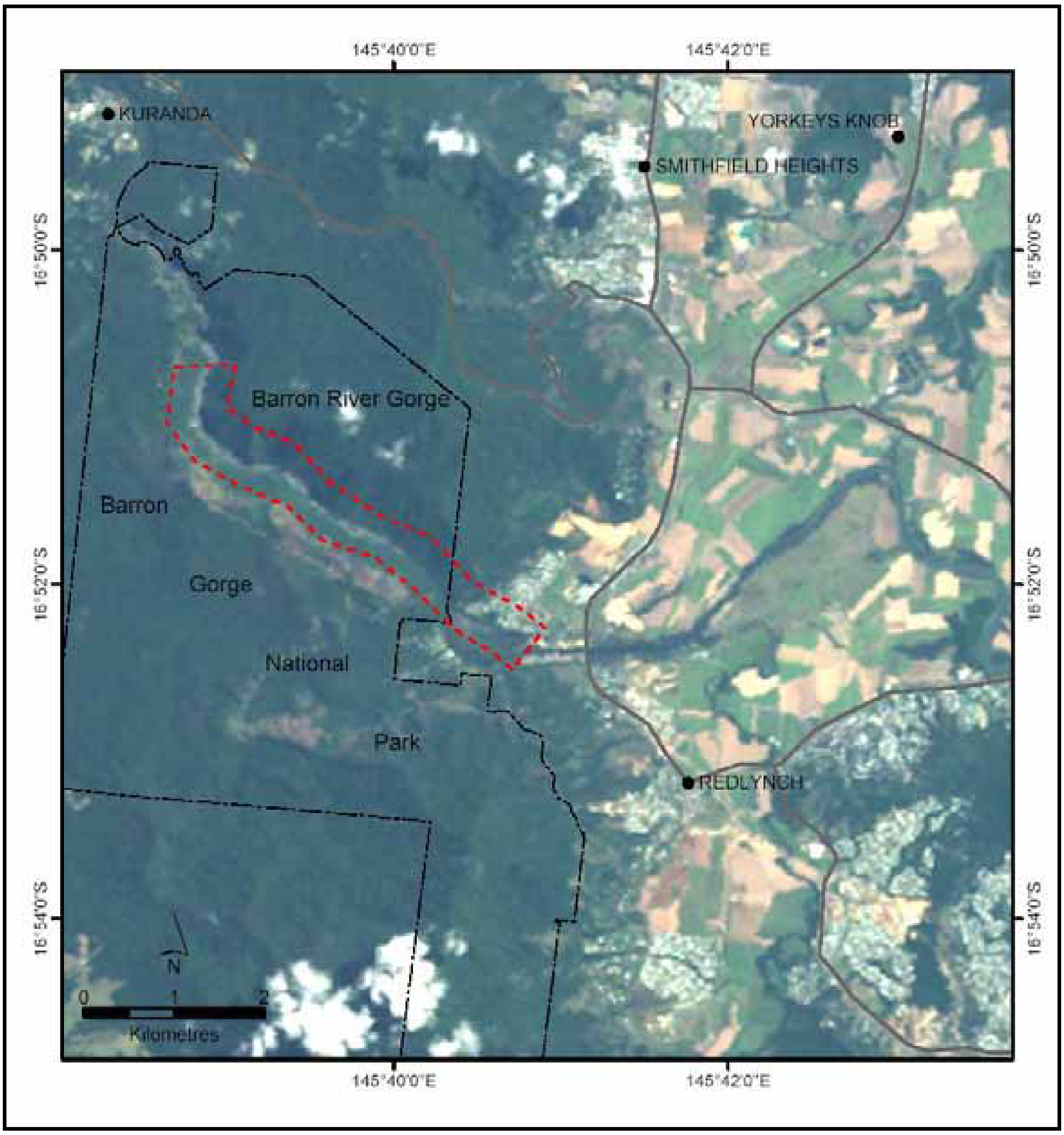


Figure 8: Wetland area on the Barron River

Despite extensive studies on land degradation and other environmental impacts, very limited studies have been undertaken in tropical areas on impacts affecting fishery resources despite acknowledgement that acid production at East Trinity was two orders of magnitude higher than for estimated rates in Northern NSW (Fitzpatrick *et al*, 1999). Unlike seawater, freshwater has limited buffering capacity to neutralise acid production but impacts in North Queensland have not been documented.

Figure 9: Outflow from Lake Placid into the Barron River

Figure 10: Middle reaches of Freshwater Creek in Cairns choked by para grass

Risks or threats to The Barron River wetland areas:

1. Residential development further reducing riparian vegetation.
2. Residential and industrial development in the lower reaches.

3. Disturbance and/or drainage of ASS.
4. Invasive weeds, particularly para grass.
5. Nutrient contamination from catchment run-off.
6. Sedimentation from upstream erosion.
7. Pesticide, herbicide and/or industrial pollution.

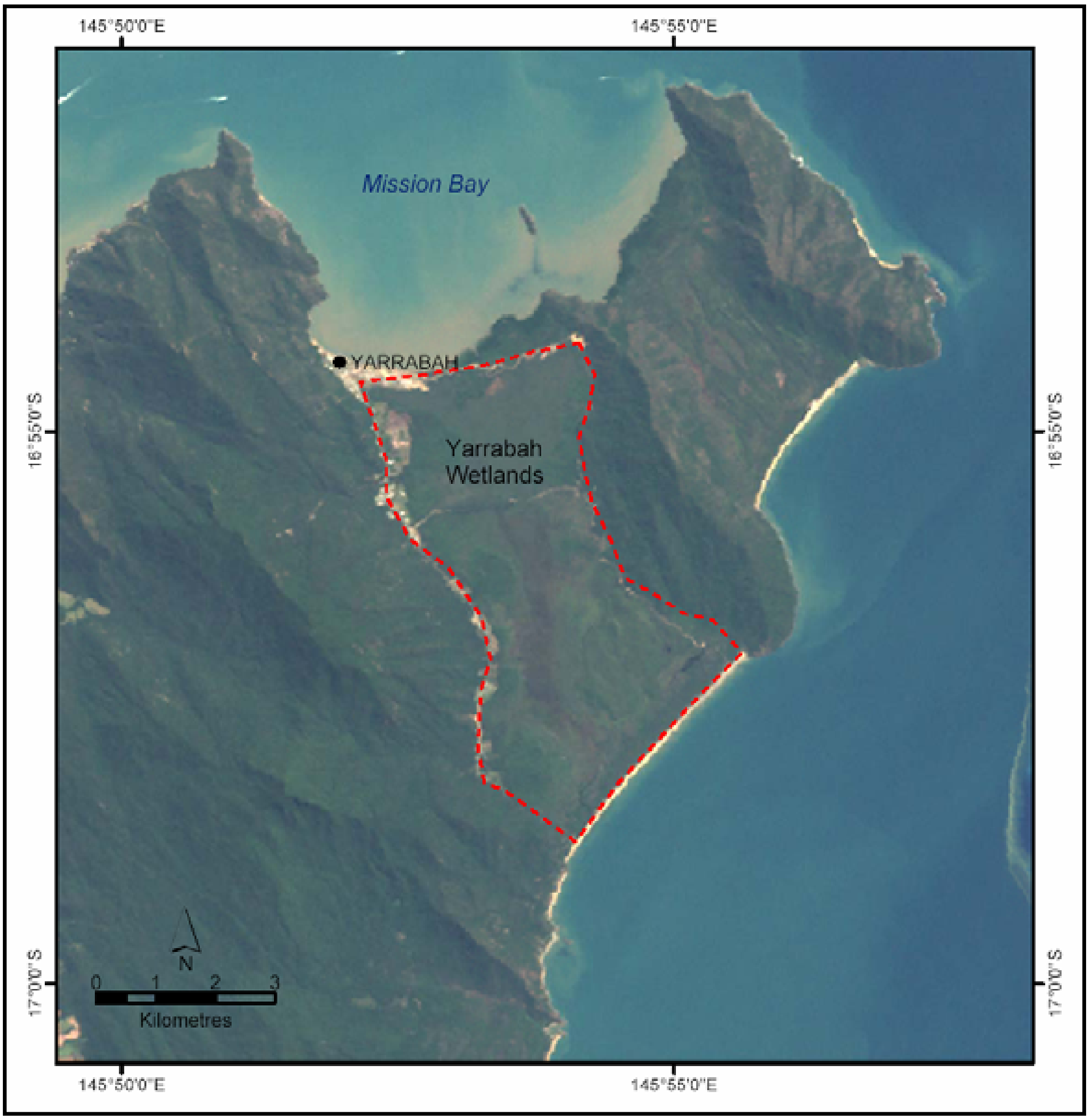


Figure 11: Yarrabah wetlands

The wetlands in the Yarrabah area (*figure 11*) are almost pristine with the only impacts arising from increased access by mostly traditional owners using modern transport. Impacts from development in the catchment are considered to be negligible. The main threats to these wetland areas are the natural threats that apply to most wetlands such as fire, introduced weeds and feral animals such as pigs. No study of the use of these wetlands by fish species has been undertaken.

### 11.1.3. Russell and Mulgrave Rivers


Figure 12: Mulgrave River lagoons

Unlike the Barron River, the Russell and Mulgrave River catchments are dominated by rural land uses although there is an increasing expansion of residential development from the Cairns City area. Both the Russell and Mulgrave Rivers have had extensive development of intensive agriculture, particularly sugar cane, in their middle and lower reaches while the upper reaches are well protected by world heritage listing of wet tropical rainforests. Both rivers maintain natural connectivity but some in-stream habitat values have been lost due to reduced riparian vegetation and intensive land use such as grazing and cropping that result in sedimentation and changes to the natural habitat (Rayment and Bohl, 2002).

Despite the regular heavy rainfall experienced in the area, the lower floodplain areas have been extensively drained and cleared. Where the area was once dominated by lowland rainforest and wetlands, there is little remnant habitat remaining. There are three deepwater off-stream wetlands, referred to as the lower Mulgrave lagoons (*figure 12*), remaining on the Mulgrave River immediately adjacent to the present course of the river upstream of Deeral Landing. Above Gordonvale, there are numerous in-stream ponds of varying depth that continue to have high fishery values.

Figure 13: Part of the wetlands in Eubanangee Swamp

The Russell River has similar impacts to the Mulgrave River and they join together before entering the GBR Lagoon at Mutchero Inlet. There is less likelihood of large-scale residential development on the Russell River in the foreseeable future. The Russell River has lost some important wetland areas such as Babinda Swamp.

Eubenangee Swamp (*figure 13*) joins the Russell River through the Alice River and numerous agricultural drains. Water quality in the Alice River after early season rain was particularly turbid. Eubenangee Swamp has undergone significant hydrological and drainage changes as a result of adjacent development of intensive agriculture. There are numerous farm drains that result in faster run-off into the swamp and then drain the area more quickly than was the case before development. Eubenangee Swamp has an artificially lowered water level that results in reduced surface area during dry periods and reduced water quality. Drainage from adjacent upstream land use is likely to have resulted in increased sediment and nutrient loads flowing into this wetland. Eubenangee also suffers from terrestrial and water weed infestations.

Eubenangee Swamp is likely to have maintained its fishery values although no specific assessment of fish use of the area has been undertaken. Due to the loss of similar habitat in the catchment, the importance of Eubenangee to fishery values is significant. Eubenangee Swamp is protected from any further on-site impacts due to its declaration as a national park.

The fish resources of the Russell-Mulgrave Rivers were assessed by Queensland DPI in 1996. A total of 94 species were recorded of which 56 were found in the estuary, 29 in the freshwater tidal areas and 33 on the floodplain (Russell *et al,* 1996b).

Risks or threats to remaining wetlands on the Russell and Mulgrave Rivers:

1. Increased residential development.
2. Sediment and nutrient inputs from adjacent and upstream land use.
3. Continued reduction on the riparian zone from encroaching land use.

Risks or threats to Eubenangee Swamp:

1. Lack of knowledge of the use of this area by fish;
2. Invasive terrestrial and aquatic weeds;
3. Nutrient enrichment from adjacent farms;
4. Introduced noxious fish species;
5. Lowering of water levels by drainage works on adjacent properties;
6. Poor water quality affecting both the wetland and the Alice River below it.

#### 11.1.4. Wyvuri and Ella Bay Swamps

Wyvuri and Ella Bay swamps (*figure 14*) are significant areas because there are only a small number of similar wetlands within the Wet Tropics area of the GBR. Wyvuri Swamp is a small catchment that is bounded by the Graham Range and drains into the GBR Lagoon through a small coastal estuary. It does not feed a large riverine ecosystem and the range of habitats available to fish between the shallow melaleuca wetland areas and the estuarine areas is significantly less than in other adjacent areas such as the Russell-Mulgrave floodplain.

Despite its relative isolation, Wyvuri Swamp has been significantly degraded. At its southern end (*figure 15*), access to the swamp is along sealed roads that lead to the Brampston Beach community. Wyvuri Swamp has been grazed extensively and suffers from invasion by para grass and other common weeds associated with grazing. It has been mined for sand in places and partly drained for horticulture. At its southern end, Wyvuri has been burned apparently igniting the underlying peat and risking stability of the surface area. Most of Wyvuri Swamp is privately owned with approximately 20% of the area in national park at the northern end. There has been no assessment of fish use of Wyvuri Swamp.


Figure 14: Eubenangee Swamp, Wyvuri Swamp and Ella Bay wetlands

Risks or threats to Wyvuri Swamp:

1. Lack of knowledge of the use of this area by fish.
2. Disturbance of ASS.
3. A potential tourist development in the area adjacent to Brampston Beach.