Calliope River however there are extensive in-stream freshwater pools in the river and larger tributaries such as Mount Larcom Creek. An assessment of habitat and fisheries resources in the freshwater and estuarine reaches of the Calliope River has been undertaken. A total of 27 fish species were recorded in freshwater and 16 of these were diadromous (Long, 1994). No exotic species were recorded during that assessment.

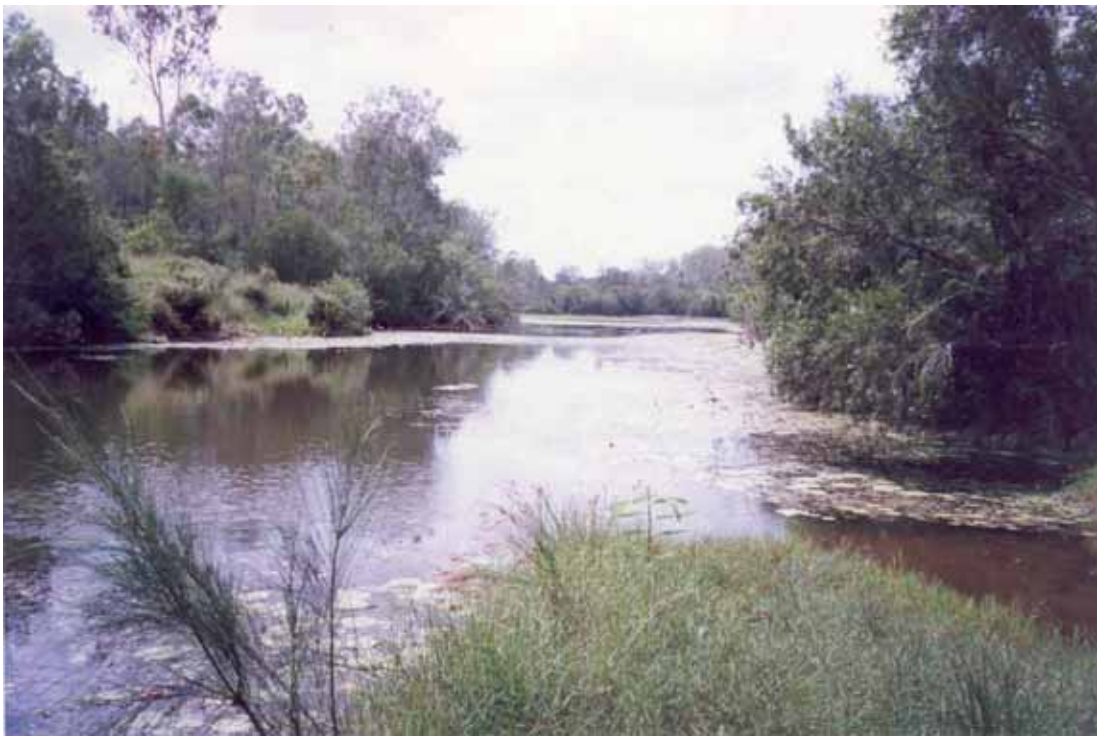

Figure 73: In-stream freshwater wetland on the Calliope River

Wilmott Lagoon is a relatively small lagoon about 1km long that connects to Mount Larcom Creek in the East End area and has connectivity to the creek during floods. Some riparian vegetation remains at the northern end of lagoon but the southern end has been cleared. It has been stocked with barramundi in recent years. Wilmott Lagoon is used for water supply for the Queensland Cement Limited (QCL) limestone mine at East End. A gully connecting the lagoon to Mount Larcom Creek is partially blocked by an earthen wall.

Risks or threats to Calliope River are:

1. Water extraction for adjacent development.
2. Damming for future water supply to Gladstone industrial and urban development (this option was considered but rejected when it was decided to upgrade the capacity of Lake Awoonga however future development may renew consideration of this option).

Risks or threats to Wilmott Lagoon are:

1. Water extraction for the QCL limestone mine at East End.
2. Partial blocking by earthen wall of connecting gutter to Mount Larcom Creek.
3. Loss of riparian vegetation.

11.5. Lake Callemondah – Gladstone

Figure 74: Water overflowing the wall on Lake Callemondah at Gladstone

Lake Callemondah is an artificial lake in Gladstone at the upper tidal limit of Auckland Creek (*figure 74*). It is in an area that has been largely modified by industrial development with significant changes in the saltwater reaches of Auckland Creek. The lake is filled by freshwater runoff from urban areas of Gladstone.

The lake has been stocked with barramundi. The catchment is small and although fish can migrate downstream, upstream migration is effectively prevented by a wall about two metres high separating the freshwater from the saltwater. Stocked fish tagged in Lake Callemondah have been recaptured in all local creeks and rivers running into Gladstone Harbour (Suntag, 2004). No fish tagged below the barrier have been recaptured above the weir wall.

Downstream of the barrier, the mangroves appear stressed with reduced and yellow coloured leaves and some trees are dead (*pers obs* Veitch).

Lake Callemondah is locally important as it raises awareness of the importance of healthy wetlands and could be used in future education programs. While the lake sustains fish, it could not be considered to be high quality habitat due to the impact of adjacent industrial and upstream residential development and poor to non-existent riparian vegetation in many areas.

11.5.1. Boyne River

The Boyne River, to the south of Gladstone, has a low earthen wall called Mann's Weir at the tidal limit that separates saltwater from freshwater. Approximately five kilometres above Mann's Weir is Awoonga Dam that effectively blocks fish passage. Lake Awoonga provides the water supply for Gladstone and the wall was extended in 2002 to increase its capacity. Prior to this there was no flow downstream from the lake except in major flooding. Following the raising of the wall there is now a capacity to allow environmental flows down the river and the first such flow occurred in late January 2004 (*pers comm.* K Cowden). This environmental flow is through a pipe in the dam wall and water can be taken from a range of depths from above the wall. The environmental flows have washed away Mann's Weir but it will be rebuilt once flows cease. The impact of this on fish below the weir and those in the dam is not yet known but will be assessed as part of monitoring the environmental flow by DPI&F and local recreational fishers.

Lake Awoonga has been stocked by a range of fish species over the past few years including sooty grunter, golden perch, silver perch, barramundi, yellowfin bream, sea mullet and more recently mangrove jack.

11.5.2. Rodds Bay creeks

A number of small creeks drain into Rodds Bay south of Gladstone. These creeks include Iveragh Creek, 7 Mile Creek, Sandy Creek, Jeyne Creek, Oaky Creek and Worthington Creek. All these creeks are less than 20 km in length and are mostly estuarine with small permanent in-stream freshwater pools above the tidal limit. None of the creeks have any significant off-stream freshwater wetlands. The catchments of these creeks are generally used for grazing. They have only been lightly to moderately cleared and riparian vegetation along the creeks is generally good although in some cleared areas it is confined to within the creek banks. Most creeks have natural connectivity to their estuaries and water quality is acceptable.

Sandy Creek is typical of these creeks and monitoring of fish has occurred immediately downstream of the tidal limit where an old road causeway provides a limited barrier to upstream fish movement (*figure 75*). A total of 29 species

have been recorded at this site (Sawynok, 2002). Barramundi have been noted in the freshwater pools of this creek about 1km above the causeway. Barramundi and mangrove jack have been tagged in the freshwater pools of the other creeks (Suntag, 2004; *pers comm*. P Stoneley).

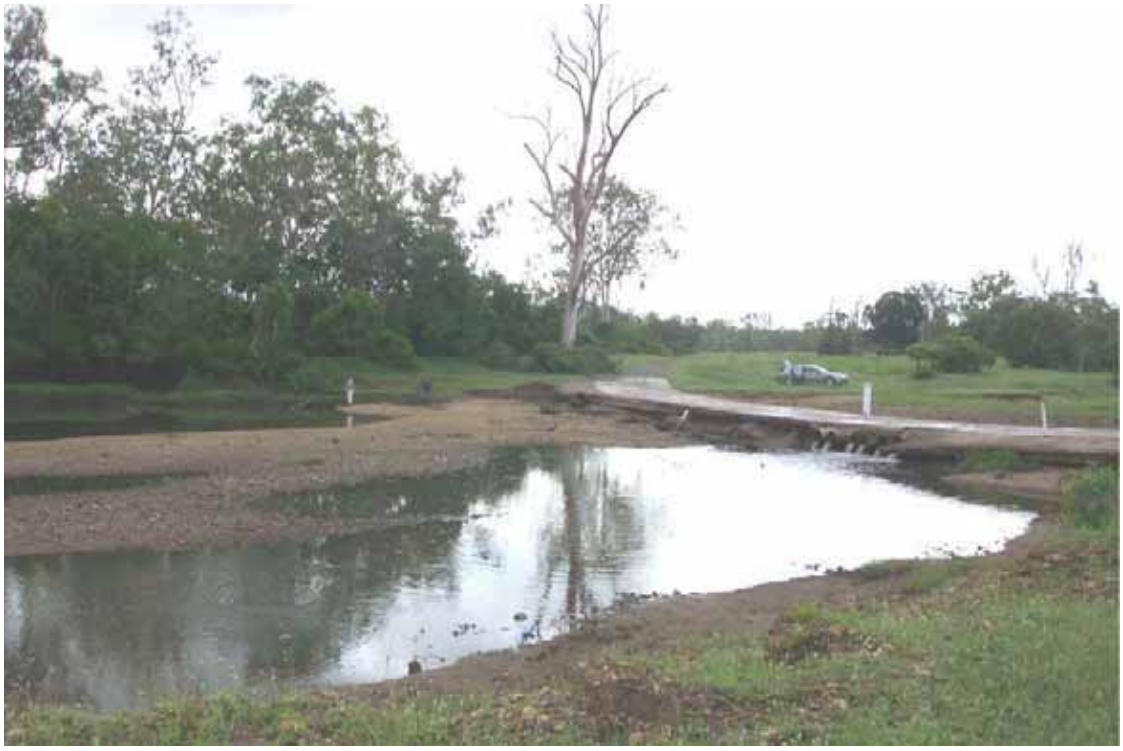

Figure 75: Old causeway over Sandy Creek about 1km downstream from tidal limit

11.5. Bundaberg Region

The Bundaberg Region, for the purpose of this report, is from Bustard Head in the north to Hervey Bay in the south.

11.5.1. Bustard Head to Agnes Waters

From Bustard Head to Agnes Waters there are a number of small tidal creeks. These are Pancake Creek, Jenny Lind Creek, Middle Creek, Eurimbula Creek and Round Hill Creek. Pancake Creek, Jenny Lind Creek and Middle Creek have little or no permanent freshwater wetlands of value to fish. Eurimbula Creek and Round Hill Creek (*figure 76*) have areas of wallum wetlands; however, the extent and value of these to fish is unknown. As both these areas are within the Eurimbula National Park threats are considered to be minimal. Barramundi and mangrove jack have been caught in the freshwater pools of Eurimbula Creek (*pers comm.* P Stoneley).

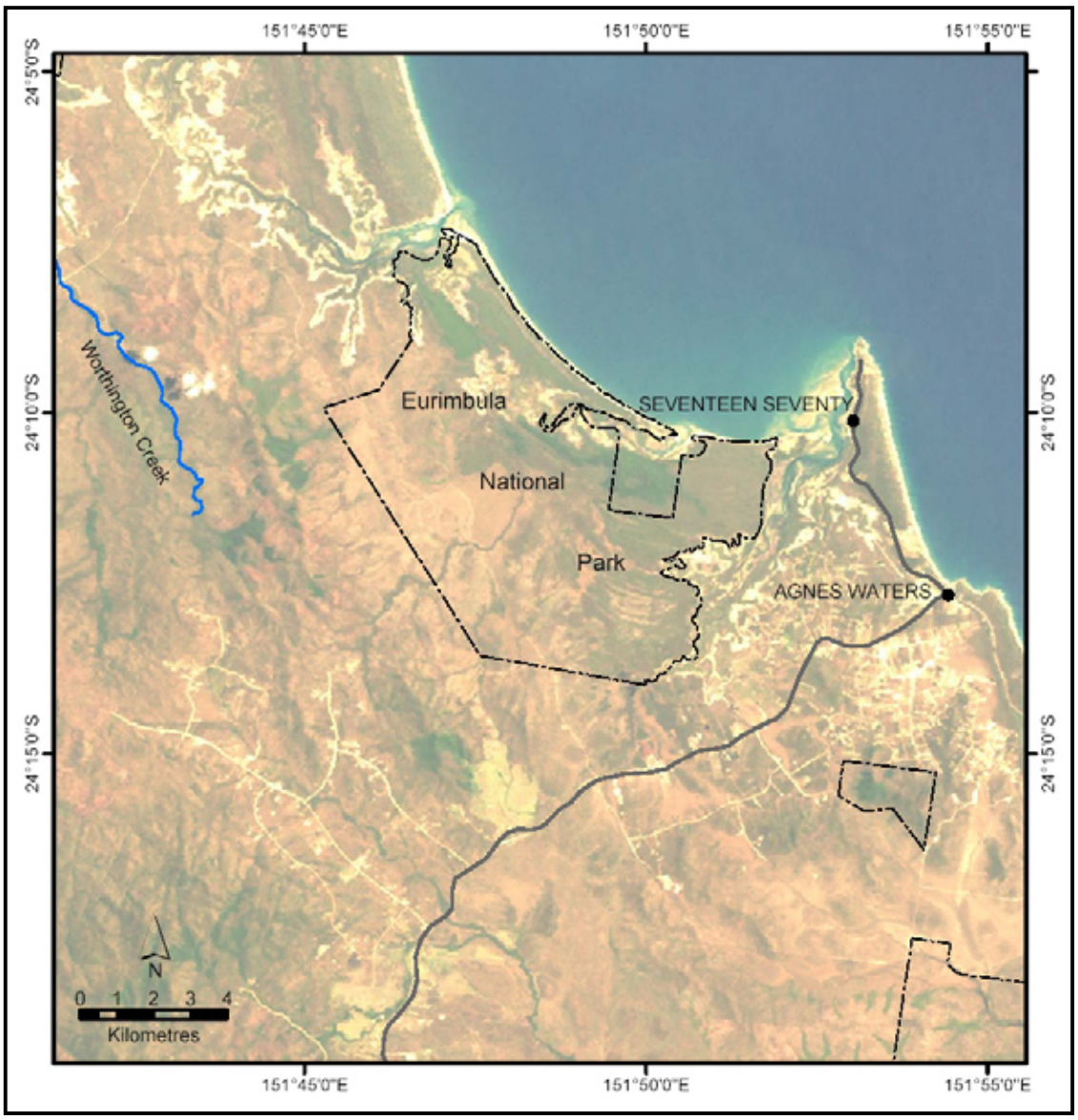

Figure 76: Creeks and adjacent wetlands from Bustard Bay to Agnes Waters

11.5.2. Agnes Waters to Hervey Bay

Deepwater Creek, south of Agnes Waters, has an extensive area of wallum wetland its upper freshwater reaches however there are only small semi-permanent pools of water in the channel of Deepwater Creek. There is a tidal barrage on Deepwater Creek that prevents normal fish movement from saltwater to the freshwater. Impounded freshwater is used for irrigation of an adjacent macadamia farm. The fisheries values of the freshwater to marine fish is likely to be low as the barrage can only be bypassed in major floods.

Baffle Creek (*figure 77*) is the most important waterway in this district as it remains relatively intact with no barriers that prevent fish movement from

saltwater to freshwater. The creek has a number of off-stream wetlands in the lower reaches adjacent to the estuary but most have been converted to production use such as farm water supply, ponded pastures or for irrigation and their fishery values are unknown. An assessment of habitat quality and the fisheries resources of the freshwater and estuarine parts of Baffle Creek has been undertaken including one off-stream lagoon on Granite Creek (Lupton and Heidenreich, 1996). Of the 25 fish species sampled in freshwater seven were diadromous. The freshwater reaches of Baffle Creek have also been sampled for mangrove jack with one fish tagged in the freshwater being recaptured in the Kolan River to the south (Russell *et al*, 2003).

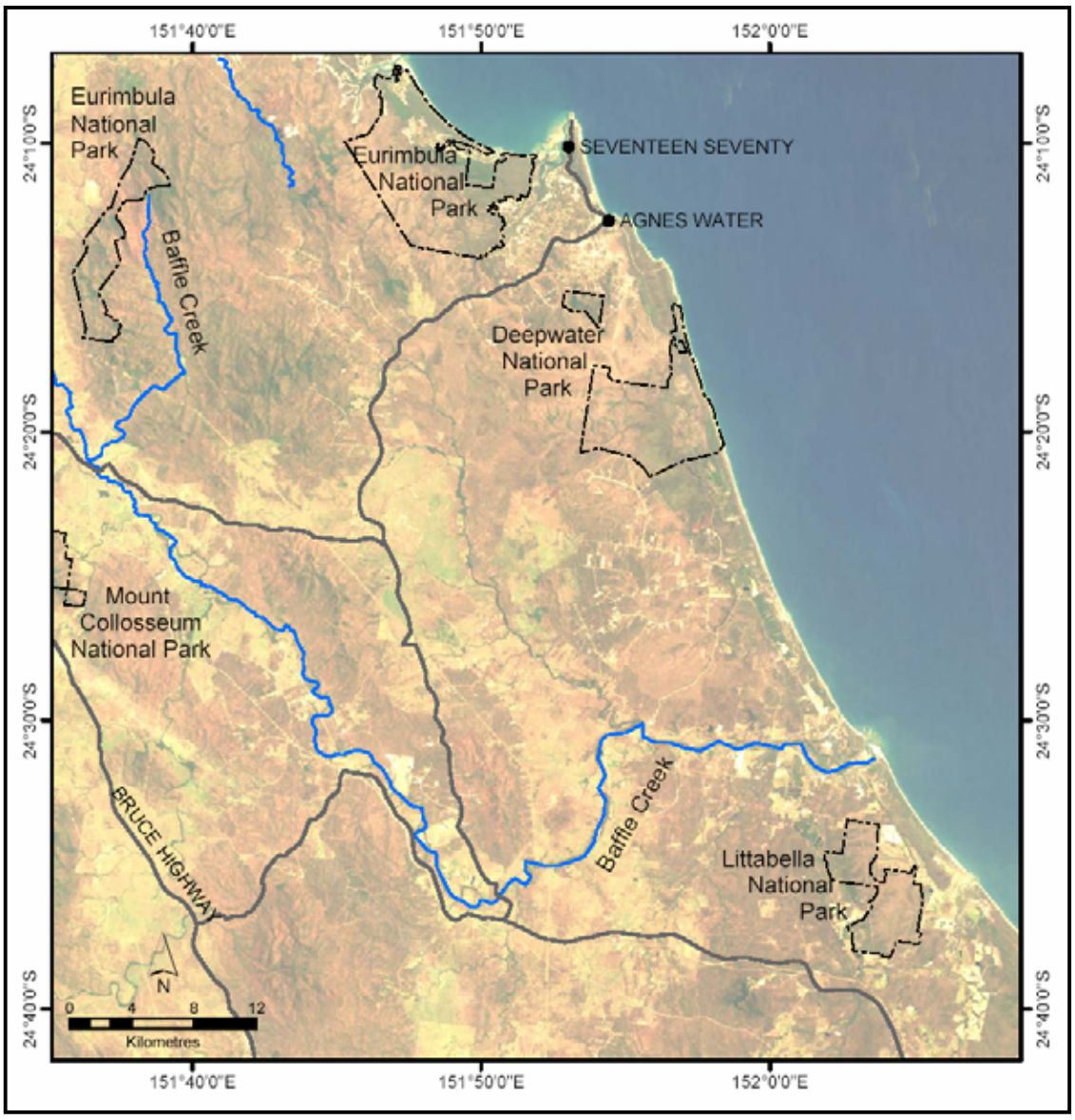

Figure 77: Baffle Creek north of Bundaberg

Littlabella Creek lies to the south of Baffle Creek. There are a number of weirs on feeder creeks and a tidal barrage on Walsh Creek that impound water for use in farm production associated with sugar cane and grazing. There is an off-stream freshwater lagoon on the northern side of Littabella Creek but its fishery values are unknown.

The Kolan River is to the north of Bundaberg and has a tidal barrage that separates freshwater from saltwater. The barrage has a fishway that was upgraded to a vertical slot design in 1998. Monitoring of the fishway has identified use by 22 species including 12 diadromous species (Broadfoot *et al*, 2000). Upstream of the barrage on the Bucca Weir and the Fred Haig Dam prevent any further upstream migration of fish. Lake Monduran above the dam has been stocked with barramundi. Yandaran Creek is a tributary of the tidal reaches of the Kolan River and there is also a tidal barrage on this creek.

The largest river in this region, the Burnett River, has been dammed extensively upstream from the Burnett River barrage in Bundaberg right throughout its catchment. It is likely to be the most extensively dammed river in Queensland. There is a fishway on the Burnett River barrage in Bundaberg and 34 species, of which 18 were diadromous or estuarine species, were recorded moving through the fishway (Stuart and Berghuis, 1999). Walla Weir is 50km upstream from the Burnett River barrage and has a fishlock on it to allow fish passage. A total of 33 species were recording using the fish lock of which only 8 were diadromous species. Significantly fewer diadromous species were recorded at Walla Weir compared with those at the barrage (Stuart and Berghuis, 1999).

There are no off-stream freshwater wetlands on the coastal plain adjacent to the Kolan River and Burnett River that are considered to be significant to fisheries resources.

12. Fish movement between Marine and Freshwater Habitats

Data on fish movement between marine and freshwater habitats in the GBR Catchment is generally limited, although some areas on a local scale are well documented. This section provides an overview of some of the available data.

Seventy-nine fish species have been identified that use a number of habitats from freshwater wetlands to offshore coral reefs. Mangrove jack and eels were identified as using all habitats. The complex matrix of species using different habitats supports the need for fish to have the benefit of a “chain of habitats” (Cappo *et al*, 1998) from freshwater to the outer reef and beyond.

Evidence of marine fish movement between estuaries and freshwater wetlands was obtained from the Suntag database of ANSA Qld. Since 1984 barramundi have been tagged in both estuarine and freshwater habitats. Some other species have also been tagged in freshwater but the numbers have been very low. Barramundi tagged in wetlands areas are listed in *Appendix 2*. Most tagging has occurred in Central Queensland and to a lesser extent in the Townsville and Burdekin areas.

The 12 Mile Creek at Marmor has had 4,658 fish tagged since 1984 showing a continuous usage of this site by barramundi (Sawynok, 2002, 2003). Tagging at other sites has been sporadic and dependent on angler availability, ease of angler access and climatic conditions. Over the last decade there has been below average rainfall in many of these coastal areas limiting fish access to these wetlands and use by barramundi.

Fish movement determined from the tagging data was dependent on the level of connectivity. The majority of fish movements were from freshwater to marine habitats (346) with fewer movements recorded from marine habitats to freshwater (30). This may be due in part to the greater fishing effort in estuaries or may be related to the low numbers of migration opportunities, especially in the last decade when drought conditions have prevailed along much of the coast. It may also be related to downstream migration where swimming with the current is much easier than upstream migration against the current.

A good example of downstream migration occurred in February 2003 following moderate flooding in the Fitzroy River. Four barramundi tagged in the Dawson River above Moura Weir were recaptured in the Fitzroy River estuary following the flooding. These fish had about a week to cover the 420 km down the length of the river while flows allowed them to bypass five weirs to get to the estuary. Four barramundi tagged in Serpentine Lagoon were also recaptured in the estuary. These fish covered around 130 km at about the same time but only had to bypass the barrage. No fish tagged below the barrage have been recaptured upstream following that flooding, however this may be a result of less fishing effort above the barrage.

In 1959, Dunstan reported barramundi in the Dawson River, indicating that a similar migration upstream to Moura was possible before the erection of barriers. The only time barramundi tagged below the barrage have been recaptured above the barrage was following the major flood in 1991 when 7 fish were recaptured up to 200km upstream. This is the only time when natural migration was possible upstream where the barriers were not able to prevent

migration. No fish tagged below the barrage have been recaptured upstream since that time.

Apart from these fish in the Fitzroy River there have been no records of fish tagged below barriers subsequently recaptured above the barriers. All records of upstream movements were in systems where natural connectivity remains.

13. Summary

Table 2 summarises the risks and threats to wetlands identified in this study as important to marine fishery resources. Whilst the risks are mostly potential or in the future, the threats are actual and in many cases have already been realised.

It was difficult to separate off-stream wetlands from other parts of the freshwater component of waterways when dealing with fisheries values as no specific studies have been undertaken to establish differences between in-stream and off-stream wetlands. The extent to which freshwater wetlands are used by marine fish results from a combination of their connectivity to the marine system and the water and habitat quality in the variety of habitats in which the fish must live until they can again access more open systems at the next flood event.

There is only one small catchment along the GBR coast where freshwater wetlands of significance to fisheries are in almost pristine condition (Ella Bay) and the fishery values of this area have not been assessed. The specific values of off-stream wetlands have not been documented. In most regions in-stream wetlands are in much better condition than off-stream wetlands, especially in those systems with barriers to fish migration or where the development in the catchment is intensive, regardless of the land use. In reviewed studies, diversity was higher in lentic systems with their associated less frequent and less intense flows compared to lotic systems where larger species were more dominant.

From the areas considered in this study, catchments used primarily for grazing, especially smaller systems, were generally in better condition than those used for agriculture in relation to connectivity, water quality and habitat quality. Many off-stream freshwater wetlands have been converted to ponded pastures and tidal waterways disconnected from the marine system to prevent tidal inundation. These ponded pastures have been particularly detrimental to fisheries values of these areas. Although the impact of ponded pastures on fish has been recognised since 1991, there is still no policy to prevent or mitigate the impacts.

Threats and Risks	Riparian Zone Reduction	Increase in in-stream weeds and algae	Increased terrestrial weeds	Poor culvert design	Increased sedimentation	Increased nutrients	Pesticides and herbicides	Land degradation from feral animals	Lack of knowledge of use by fish	Inappropriate Fire Management	Agricultural expansion/intensification	Residential development	Tourism development	Industrial development	Drainage works	Reduced water quality (on-site)	Reduced connectivity due to downstream water	Water extraction reducing connectivity	Irrigation impacts	Ponded pasture impacts	Mining impacts (potential or actual)	Reduced water flow from dams etc.	Introduced noxious fish	Disturbance of ASS on-site or downstream
Daintree River	Y	Y	Y	Y	Y	Y	Y	Y				Y	Y			Y								
Ella Bay Swamp			Y					Y	Y															
Wetlands of the Tully-Murray floodplain	Y	Y	Y		Y	Y	Y	Y			Y				Y	Y		Y						Y
Edmund Kennedy National Park wetlands			Y		Y	Y	Y	Y	Y							Y								
Barratta Creek wetlands	Y	Y	Y		Y	Y	Y				Y					Y	Y		Y				Y	
Gorganga Plains wetlands	Y	Y				Y	Y		Y											Y				Y
Herbert Creek in Broad Sound																				Y	Y			
Gavial Creek lagoons at Rockhampton	Y		Y		Y	Y	Y					Y				Y								
Raglan Creek	Y		Y	Y		Y	Y				Y							Y	Y					
Baffle Creek	Y		Y				Y					Y	Y							Y				
Eubenangee Swamp		Y	Y	Y	Y	Y	Y	Y	Y						Y	Y	Y							
Hull River/Mt Coom Wetlands	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y		Y	Y								Y
Barramundi Creek and Red Hill wetlands			Y		Y	Y			Y											Y			?	
Cattle Creek wetlands	Y	Y			Y	Y	Y				Y				Y	Y	Y	Y	Y					Y
Rocky Dam Creek wetlands at Koumala		Y	Y					Y	Y		Y						Y	Y		Y				Y
12 Mile Creek at Marmor	Y		Y		Y	Y								Y		Y								

Table 2: Summary Table of Threats And Risks To Wetlands Of Importance To Fishery Resources

Catchments primarily used for agriculture, where sugar cane production is generally the dominant form of agriculture, and catchments in urban areas were the most modified with reduced connectivity, poorer water quality and poorer habitat. Many wetlands have been reclaimed or drained for other purposes such as residential or agricultural development. A general observation is that there are fewer fish and fewer species in such degraded freshwater wetlands compared with those in good condition. These waterways and wetlands are also those that have the greatest level of introduced noxious fish species and have the highest reported incidence of fish kills.

While small wetlands were considered to be individually not significant in overall terms to the fish stocks of the GBR lagoon these small wetlands are considered to be important both locally and collectively due to the overall loss of wetlands, the large number of these small wetlands remaining and their water quality and hydrological functions.

A number of marine fish species were identified that used freshwater wetlands along the entire length of the GBR coast. These are barramundi, fork-tail catfish, mullet and bony bream and to a lesser extent mangrove jack. Jungle perch is likely to be another species although their range is mainly in the Wet Tropics with isolated small populations as far south as Yeppoon. Barramundi are now regularly stocked in freshwater wetlands where they would otherwise be locally extinct through loss of connectivity.

Connectivity and access for biota is considered to be a key factor in use of freshwater wetlands by marine species. Water quality is another critical factor but this cannot be viewed separately from habitat quality as the two are closely related: good water and habitat quality ensure the maximum use of an area by fish with the widest range of fish species, poor water and habitat quality limits both fish abundance and species diversity. Sub-lethal impacts may include reduced breeding capacity or total denial of habitat as is evidenced in other areas. Numerous reports found that there was a correlation between poor wetland quality and the presence of noxious species; it is generally less desirable or noxious species that can tolerate degraded conditions and therefore further impact on native fish populations. Conversely good wetland qualities were associated with robust populations of native species although not always at the exclusion of noxious species.

14. High Value Wetlands

Whilst all wetlands are important for their hydrological and biological functions and therefore warrant protection, a number of wetlands were identified in this

study as being of high value to fishery productivity along the coast adjacent to the GBR. These are based on the known or likely use of these wetlands by marine fish as well as freshwater species. Wetlands considered to be high value are those where connectivity with the marine system remains near natural, water and habitat quality within and downstream of the wetland are good and use by fish is ongoing although perhaps seasonal. These waterways and wetlands should be given priority in any programs implemented to maintain and improve the value and extent of wetlands.

In the highly developed areas of the GBR coast high value wetlands and especially off-stream wetlands have been impacted by catchment management.

Waterways and wetlands considered to be high value to fishery resources are listed from north to south:

1. Daintree River
2. Ella Bay Swamp
3. Wetlands of the Tully-Murray floodplain
4. Edmund Kennedy National Park wetlands
5. Barratta Creek wetlands
6. Gorganga Plains wetlands
7. Herbert Creek in Broadsound
8. Gavial Creek lagoons at Rockhampton
9. Raglan Creek
10. Baffle Creek

Wetlands that could be important, but there is insufficient information on their use by fish:

1. Eubenangee Swamp
2. Hull River/Mt Coom wetlands
3. Barramundi Creek and Red Hill Coastal wetlands

Important wetlands where some work is required to restore their fishery values:

1. Cattle Creek wetlands
2. Rocky Dam Creek wetlands at Koumala
3. 12 Mile Creek at Marmor

15. Conclusions

There has been a significant loss of wetlands along the GBR coast and those that remain have varying values as fish habitats. The impact of this on fish stocks of the GBR lagoon is unknown but is considered to be substantial.

Our scientific understanding of the importance of freshwater wetlands is expanding rapidly and there are many research papers and technical reports that deal with the status of wetlands. In broad terms the use of wetlands by fish is accepted in terms of connectivity, water quality and habitat quality. The importance of wetlands to marine species is less well documented and the range of marine species using wetlands is likely to be greater than those 79 species identified in this report.

Land management practices that impact on wetlands have been slow to respond to the knowledge of the value of wetlands and many decision makers continue to compromise these values for short-term economic gain without factoring in the potential long-term economic losses to fishery productivity. As an example the issue of the effect of ponded pastures on fish was originally raised in 1991 but to date there is no effective policy on how to deal with this issue.

Catchment management policy and direction has traditionally come from government; however, with the establishment of regional strategy and catchment management groups there has been a gradual shift to a more community-based management approach. Many catchment management groups are developing regional strategies and catchment investment plans with clear targets for environmental improvement. Many groups have included the improvement of wetlands as part of their targets.

This report includes examples of many instances of community groups undertaking projects to improve wetlands, and of research and monitoring being undertaken or proposed, for continual improvement of our knowledge of wetland status and function in the GBR Catchment. That aside, there is an urgent need for holistic management of wetlands from a fishery perspective. Maintenance of fish stocks requires a combination of connectivity and access for the biota, habitat quality/diversity, a suitable food chain and suitable water quality. Remove any one of these factors and productivity is impacted or even completely stopped.

It is likely that, in some regions, the decline in wetland degradation is slowing and may have halted, while in other regions, wetland loss continues. Whilst some gains have been made on the Tully-Murray flood plain and the benefit to fisheries has been realised rapidly, these are isolated cases. There is little other evidence of wetlands where an improvement could be identified, especially in relation to wetlands for use by fish. Remedial action through aquatic weed harvesting in the Burdekin is improving wetlands but without action to improve connectivity to and from the marine environment through addressing both water quality and physical barriers, the benefits to marine fish will be limited.