swamps and it is likely that, in its natural state, there were dozens of wetlands that were significant to fishery resources.

The Ingham District (*figure 27*) has been extensively developed for intensive agriculture, primarily sugar cane, resulting in extensive draining and clearing of floodplain wetlands and riparian vegetation (Hogan and Graham, 1994; Johnson, 1997). There is significant and valuable in-stream habitat in the Herbert River that has been only lightly impacted, however the river rarely stops flowing and has permanent connectivity with the GBR Lagoon and does not have the same values as an off-stream wetland.

There are few off-stream freshwater wetlands remaining that could be considered significant. Areas not mentioned are considered to be significantly degraded and unlikely to be able to be restored to a condition that would allow a diverse range of native fish to survive for more than a few months after the wet season.

11.1.10.1 Mandam Wetlands

Figure 28: Part of Mungulla wetlands on the Herbert River floodplain showing lack of riparian vegetation

The Mandam wetlands are at the bottom of the Herbert River floodplain, immediately above to tidal waters (*figure 28*). The district now has a recent history of chronic water quality problems that resulted in numerous fish kills (Veitch, 1999). It is now likely that fish are adopting "avoidance behaviour" where they sense reduced water quality and move to other areas as has been observed with numerous sub-tropical species (Kroon *et al*, 2004).

The Mandam wetlands are impacted with artificial flow paths cut through the mangroves that resulted in disturbance of ASS; tide gates increase the impacts of this disturbance (Sammutt et al, 1994, 1996; White et al, 1996) (*figure 29*). While some areas close to the coast remain in good condition (Blackman et al, 1999) they are connected to tidal areas through farm drains that are potential barriers due to water quality issues.

Figure 29: Floodgates preventing tidal intrusion on Mandam wetlands

While works are being undertaken on this catchment through the SIIP, restoration of these wetlands to improve fishery productivity would be costly and should be considered lower priority in this district compared to less affected wetlands.

Risks or threats to Mandam wetlands:

1. Further reduction of connectivity between wetlands and estuaries through installation of tide gates.
2. Ongoing water quality impacts resulting in avoidance behaviour by fish and potential fish kills.
3. Wetlands areas are highly impacted and restoration costs will be high.

11.1.10.2 Seymour River and Ripple Creek Sump

The Seymour River and middle reaches of Ripple Creek are on an old flow path of the Herbert River (*figure 30*). The drainage system has been substantially modified and the only connectivity that the Seymour now has with Ripple Creek

is in major flood events. Ripple Creek drains into the Herbert River along a deep narrow canal by the same name in low flows but overflows into the Seymour River in flood events.

Figure 30: Ripple Creek sump

Figure 31: Ripple Creek sump at top right and farm detention area at middle left after moderate rainfall.

Ripple Creek Sump (*figures 30 and 31*) is still a valuable and significant wetland but floodgates approximately 100 metres upstream from its present junction with the Herbert River reduce its value to fish. In addition, recent works by an adjacent landholder appear to have intersected a shallow aquifer that in the past has leached fine sediments into the sump. Recent sampling of Ripple Creek Sump has shown improved water quality but this may not be representative due to the recent drought and further monitoring needs to be undertaken during and following wet periods to assess the impacts of these works.

Ripple Creek is a known habitat of jungle perch in its upper reaches (*pers obs* Veitch). According to local anecdotal reports, jungle perch are now rare in the Herbert Valley except in pristine creeks (*pers comm*. V Vitale 2004). Ripple Creek's connectivity to the Seymour River is particularly important as fish passage is denied by the flood gates where it drains into the Herbert River.

Risks or threats to the Ripple Creek Sump are:

1. Loss of connectivity to the Seymour River.
2. Sedimentation, nutrient enrichment and further degradation of water quality.
3. Invasion by aquatic weeds and pasture grass species, particularly hymenacne.
4. Riparian zone destruction.
5. Further change to natural surface and ground water levels from drainage works on adjacent land.

11.1.10.3 Lagoon Creek and Palm Creek

Lagoon Creek is an old distributary channel of the Herbert River (*figure 27*) that suffers from the cumulative impacts of farm run-off from trash blanketing, inappropriate storage of mill mud, fertiliser application and sugar mill effluent that has reduced dissolved oxygen to chronically low levels for long periods (EPA, 1998) which has resulted in numerous fish kills (Veitch, 1999). Many adjacent landholders have undertaken riparian vegetation projects in recent years but Lagoon Creek is likely to need dredging of its contaminated sediments and rotting weeds. These have sunk to the bed of the creek and will continue to recycle their contaminants and prolong water quality impacts. The removal, and ongoing management, of invasive plants and changes to adjacent land management practices to reduce nutrient run-off, and increases in natural vegetation, is needed if fishery and water quality values are to be restored.

Recent agricultural development on the south bank of the lower reaches of Palm Creek adjacent to Mungulla has resulted in significant loss of riparian

vegetation, disturbance of PASS and increased sediment and nutrient loss into this system. In addition, tidal barriers in the lower reaches are likely to restrict fish movement at critical times and may be contributing to impacts from PASS (Sammutt *et al*, 1994, 1996; White *et al*, 1996). When combined with other impacts on Palm Creek including weirs, storm water, farm run-off and a sewage treatment plant outlet, restoration of this system would be a major task.

Palm Creek is now significantly degraded from a fishery perspective. It has major weed infestation, chronic low dissolved oxygen levels (Hogan and Valance, 1999), barriers to migration in low flows, riparian vegetation has been almost completely removed and it suffers from major nutrient inputs from upstream land uses. While fish may still be able to move into Palm Creek during larger floods, fish survival during dry periods may not be possible due to the degraded state.

Risks or threats to the Lagoon and Palm Creek wetlands are:

1. Loss of connectivity to downstream tidal waters.
2. Sedimentation, nutrient enrichment and further degradation of water quality.
3. Invasion by aquatic weeds and pasture grass species, particularly hymenacne.
4. Riparian zone destruction.
5. Further change to natural surface and ground water levels from drainage works on adjacent land.
6. Drainage/disturbance of ASS.

Due to their degraded state, both Palm and Lagoon Creeks are considered to be lower priority for restoration works compared to other wetlands in the Herbert district. In the longer term, issues in these wetlands need to be addressed if ongoing impacts on water quality and fishery resources in the district are to be mitigated.

11.1.10.4 Cattle Creek

Cattle Creek is an old channel of the Herbert River. Prior to development there were extensive areas of wetlands from Trebonne in the north to Bambaroo in the south across an almost flat floodplain (*figure 32*).

Cattle Creek was the most important wetland complex remaining on the Herbert River floodplain until it was developed in the early 1990's but over the last 12 years has become increasingly degraded. In the early 1990's, Cattle Creek held large numbers of native fish and was used by many marine species. Barramundi, tarpon, mangrove jack and other marine species as well as freshwater species

have previously made extensive use of the Cattle Creek wetland (*pers obs* Veitch). One of many barramundi tagged in the fresh water sections of Cattle Creek in the mid 1990's was later recaptured near Forrest Beach.

Figure 32: Cattle Creek wetlands

The development of the Pomona area in the early 1990's has substantially impacted on the fishery values of Cattle Creek. Since then, sediment and nutrient runoff, irrigation from adjacent aquifers and levy construction for flood mitigation have impacted heavily on both the habitat quality and water quality. The fish habitat values of wetlands are significantly impacted by hydrological changes (Johnson *et al*, 1997) in this area.

A small range of fish species still survive in low numbers but Cattle Creek is no longer considered significant to fishery resources. Sampling of water quality undertaken for assessment for fish stocking showed Cattle Creek to have chronic oxygen depletion (Hogan and Vallance, 1999). Invasive weeds, particularly water hyacinth and hymenacne, have choked the wetland in recent years significantly reducing its value as a fishery resource. Ironically, the preferred method of weed control in the Herbert Valley (herbicide spraying) (*pers comm*. V Vitale) may be compounding the problem by leaving the dead weeds in situ as well as providing another threat to fish through poisoning.

Risks or threats to the Cattle Creek wetlands:

1. Continued development of the catchment for agriculture.
2. Increased sedimentation and reduction in depth.

3. Invasive weeds, particularly water hyacinth and hymenacne.
4. Spraying for weeds.
5. Modified hydrology due to adjacent and upstream levies.
6. Water extraction during dry periods.

11.2. Townsville Region

The Townsville region, for the purpose of this report, extends from Rollingstone in the north to Upstart Bay in the south.

11.2.1. Rollingstone to Yabulu

The area from Rollingstone to Yabulu, just to the north of Townsville, has a series of small creeks that run off the Paluma Range. The coastal plain is narrow being less than 10km wide in most places and no more than 20km wide in any area resulting in very short intermittently flowing creeks. This section of the coastal plain has little or no off-stream wetlands associated with these creeks.

11.2.2. Bohle River

The Bohle River has some small deepwater perennial ponds and natural riparian vegetation in its middle reaches (*figure 34*). Schools of mullet and tarpon have been observed and the area is used by juvenile barramundi. Further upstream, fish become stranded in the pools during prolonged dry periods and fish rescues by Sunfish have included the above species as well as mangrove jack and some freshwater species including rainbow fish, flyspecked hardyhead and empire gudgeons. Upstream impacts include improved drainage and past inputs from a secondary treated sewage treatment plant that has recently been upgraded to tertiary treatment. In-stream impacts include nutrient run-off from both the sewage treatment plant and residential areas, invasive aquatic weeds such as pistia, water hyacinth and para grass. The water quality remains acceptable for fish and the area is important remnant in-stream habitat within the district (Lukacs, 1996). Tilapia are known to inhabit some section of the river (*pers obs* Veitch).

Risks or threats to the Bohle River:

1. Urban development as Thuringowa City expands.
2. Changes to river hydrology from urban and industrial development.
3. Invasive aquatic weeds including pistia, water hyacinth and para grass.
4. Tilapia and potentially other non-native fish species.

11.2.3. Town Common and Louisa Creek

Louisa Creek (*figure 33*) and the Town Common have recently had artificial wetlands built in the catchment, but it is unlikely that these will achieve their full

potential without further major works to address water quality and connectivity issues in the remainder of the catchment. The upper reaches of Louisa Creek have heavy infestations of introduced weeds, particularly singapore daisy and chinee apple (*pers comm.* S McDermott). Nutrient runoff from adjacent residential properties exacerbates the weed growth and leads to exotic aquatic plant outbreaks and algal blooms (Lukacs, 1996). As a result, the upper reaches suffer from chronic depletion of dissolved oxygen in the water (*pers comm.* D Reid). Further downstream, para grass and other invasive weeds choke the waterway at a number of sites and provide effective barriers to fish migration.

Figure 33: Wetlands on waterways in the vicinity of Townsville

Louisa Creek, like all waterways in the Townsville District, has a significant infestation of tilapia and gambusia. Many of the introduced species identified in Ross River (see 11.11.2 below) are shared with Louisa Creek (Webb, 2004). While major restorations have improved the visual aspect in the middle reaches of Louisa Creek (*figure 34*), works are necessary downstream if native fish are to be able to migrate in anything other than major floods. Louisa Creek and the Town Common are capable of sustaining healthy and significant fish populations however their current status limits their use by fish.

Risks or threats to Louisa Creek and the Town Common:

1. Litter and contaminants from upstream urban areas.
2. Reduced water quality from urban and industrial runoff.
3. Invasive weeds such as para grass, Singapore daisy and pistia.
4. Introduced noxious fish species such as tilapia and gambusia.
5. Lack of riparian vegetation.

Figure 34: Middle reaches of Louisa Creek

11.2.4. Cleveland Bay Wetlands

The main freshwater habitat remaining on the Ross River floodplain is in-stream above Aplins Weir and the two other upstream weirs plus Ross River Dam that all reduce the connectivity within this system. There are no fishways on the weirs to allow fish migration. Monitoring of the in-stream freshwater habitat shows the area used by 15 exotic species and 23 native species, including eight

translocated native species, some of which are not native to the Ross River (Webb, 2004). Townsville has the somewhat dubious reputation of having the most diverse range of introduced fish species of any freshwater system anywhere in Australia. The only marine species are barramundi and mangrove jack and these fish are stocked.

Of creeks that drain into Cleveland Bay, Stuart Creek (*figure 33*) has the only remaining freshwater wetland habitat with connectivity for native fish. Of the other systems, only Ross River and Alligator Creek have significant freshwater reaches but access to these areas is blocked by weirs.

Stuart Creek is a distributary system on the floodplain. Below the Bruce Highway it becomes indistinct and has numerous flow paths. There is a network of small freshwater wetlands (*figure 35*) above the tidal limit with some including Stuart Creek above the highway maintaining permanent deep water areas that are refuges for many species.

Monitoring in the freshwater wetlands of Stuart Creek has identified 20 fish species of which 10 are known to use both freshwater and marine habitats (Perna, 1998).

Figure 35: In-stream freshwater pool on Stuart Creek

Although most of the catchment is relatively natural, some small areas in the middle reaches of Stuart Creek are heavily impacted. It suffers from an infestation of tilapia, gambusia and possibly other introduced species, has been

used as a dump site for illegal dumping of industrial waste, has a low level private road with pipe culverts in its middle reaches that is a small but significant barrier to migration for native fish and it suffers from weed infestations including chinee apple, rubber vine, para grass and various other introduced species both in the water and along the banks. Despite this, riparian vegetation is being actively re-established and in-stream macrophyte diversity is outstanding including rare species (Perna, 1998). It has good water quality and a high integrity and diverse native fish community including all catadromous species lost from Ross River, and is a functional nursery area for Mangrove Jack and Barramundi.

Stuart Creek is part of the area earmarked by the Queensland Government for future development of heavy noxious industries in the Townsville District (DSD, 2003). It is likely to be subjected to the range of impacts already experienced in Gladstone from similar development.

Risks or threats to Stuart Creek:

1. Invasive plant and fish species.
2. Illegal industrial and domestic waste dumping.
3. The area has been declared for development of heavy noxious industries as part of the Townsville State Development Area. DSD concept plans include infrastructure straddling one of the remaining permanent wetlands in the vicinity of Colinta Holdings homestead.

The freshwater reaches of Alligator Creek have been degraded due to an old weir downstream from the highway that prevents fish migrations for most species in most flow conditions and adjacent development that has reduced riparian vegetation in its middle reaches and increased contaminant inputs. Jungle perch are able to migrate into the upper reaches Alligator Creek during flooding but most other species are unable to bypass the barrier. Alligator Creek has chronic weed and water quality problems in its middle reaches as a result of water extraction, sediment and nutrient runoff and litter that limits its suitability as dry season habitat to native fish species (Lukacs, 1996).

Risks or threats to Alligator Creek:

1. Expanding horticulture and rural residential development.
2. Water extraction.
3. Weir/tidal barrier near tidal limit.
4. Farm litter including plastic weed covering.
5. Loss of riparian vegetation.