

**Monitoring of the Health and Fish Passage Issues of Healey's  
Lagoon Following Removal of an Extensive Mat of Floating  
Aquatic Weeds**

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## 1.0 INTRODUCTION

Healey's Lagoon is one of the more valuable wetlands in the Burdekin-Haughton floodplain. Because its health was considered to be seriously compromised by the presence of extensive mats of floating exotic aquatic weeds, funding was obtained from the Burdekin Dry Tropics Board and the Great Barrier Reef Coastal Wetlands Protection Pilot Program (GBRCWPP) to remove those weeds. As part of that process, the Australian Centre for Tropical Freshwater Research (ACTFR) at James Cook University in Townsville, was commissioned to assess the changes in water quality and fish communities that resulted from the removal of the weed mats in Jan-Feb 2005. This report presents the results of that assessment.

The fish communities of the weed-covered lagoon were already known from a survey done by ACTFR in August 2004 (reported in Burrows and Perna 2004). That data can be compared to post weed-clearing surveys conducted during 2005 and 2006 and reported here. Opportune removal via a flood event, of much of the floating weed mats occurred prior to any opportunity for assessing water quality before weed-clearing, thus only post-weed clearing water quality data is presented here. ACTFR hold sufficient data for other lagoons in the region that are, or have been, covered by similar floating weed mats to have a fair idea of what the water quality of Healey's Lagoon would have been prior to weed mat removal. In late 2004, ACTFR undertook temporally-limited but spatially-intensive water quality studies at 20 sites throughout the Burdekin catchment, including several sites on the Burdekin-Haughton floodplain. Those results are reported in Loong *et al.* (2004). The methods for water quality assessment of Healey's Lagoon presented in this report mirror those of that study, resulting in Healey's Lagoon effectively being considered a 21<sup>st</sup> site (N021) of that larger catchment-wide study. This approach provides an opportunity for consistency and comparability between these sites and studies.

### 1.1 Site Description

Healey's Lagoon is located ~40km SE of Townsville and is part of the Haughton River catchment which is generally considered to be part of the Burdekin-Haughton Catchment. The Ironbark Creek/Healey's Lagoon system form an old palaeochannel of the Haughton River and act as a distributary channel for flood waters, when water overflows from the Haughton River, down Ironbark Creek, through Healey's Lagoon and into the Reed Beds coastal wetland system, approximately 1km downstream of Healey's Lagoon. Together, these form one of the more valuable and better condition, creek/wetland systems in the region. This system is also part of the Burdekin Haughton Water Supply Scheme (BHWSS) which supplies irrigation water to farms along Healey's Lagoon and further downstream. Irrigation water from the Burdekin Falls Dam is pumped across to the Haughton River, which is heavily supplemented. Some of this water is then pumped from the Haughton River down Ironbark Creek and thence into Healey's Lagoon, thus changing the lagoons' seasonal hydrology to one of persistent full water level. A pump at the downstream end of Healey's Lagoon, adjacent to the Bruce Highway, distributes

water to farms on the north side of the Bruce Highway, via an underground pipe. Although Burdekin Dam water is persistently turbid, the water is relatively clear by the time it reaches Healey's Lagoon.

Healey's Lagoon is a linear lagoon (Figure 1) retained entirely within an old river channel. It is approximately 5km long and runs in an essentially north-south direction. A survey of the riparian vegetation in December 2004 (Dowe 2004) showed that Healey's Lagoon retains a narrow but relatively good condition strip of dense riparian vegetation, one of the best remaining within the developed Burdekin-Haughton floodplain. Ironbark Creek retains a similarly good condition riparian zone. Paragrass is prevalent along the waters edge, especially in areas where riparian shading is restricted. The persistently high waters levels and mostly intact riparian strip have helped to reduce the invasiveness of paragrass along Healey's Lagoon, compared to many other waterbodies in the Burdekin-Haughton floodplain.

Since at least 1998, the water surface of Healey's Lagoon has been largely covered by floating exotic weeds. Initially, this was mostly salvinia (*Salvinia molesta*) and water lettuce (*Pistia stratiotes*), but in recent years, water hyacinth (*Eichhornia crassipes*) has become dominant and the surface of the floating weed mat has been secondarily colonized in many places by a variety of grasses, vines and sedges.

Funding was obtained from the Burdekin Dry Tropics Board and the Great Barrier Reef Coastal Wetlands Protection Program to clear these floating weeds from the lagoon using the Burdekin Shire Council's floating aquatic weed harvester. However, in late-January 2005, the weekend before the weed harvester was due to start work, a localized flood event washed away most of the weeds, with the remainder being cleared up by the weed harvester in the subsequent weeks.

## 1.2 Condition Status

Other floodplain wetlands in the region that are covered by floating aquatic weeds (eg, Sheep Station Creek – Perna 2003, Perna and Burrows 2005) typically experience severely hypoxic and often anoxic conditions throughout their entire water column. No data exist for Healey's Lagoon when it was covered by these weeds, but it is likely that the parts of this lagoon that were covered by floating weeds, would also have suffered severe hypoxia and be incapable of supporting many of the aquatic species it would otherwise be expected to support. Lagoons studied in Sheep Station Creek showed rapid recovery of their dissolved oxygen status after harvesting of water hyacinth mats (Perna 2003, Perna and Burrows 2005). The data presented in this report show that Healey's Lagoon, 10 months after removal of its floating weed mats (mostly water hyacinth), is now in a position to support a range of benthic (bottom-dwelling) and limnetic (living in the water column) aquatic species of varying oxygen dependency.

### 1.3 Fish Communities of Healey's Lagoon

Because of its size, proximity to estuarine environments and general reasonable riparian condition, Healey's Lagoon has long been considered one of the more important fish habitats on the Burdekin-Haughton floodplain. However, fish survey there has been limited. Burrows and Tait (1998) provided some observations of the fish fauna from the lagoon in 1998. This was a quick visual survey using a spotlight at night. At that time, there was an artificial irrigation water delivery channel that ran from Healey's Lagoon to Reed Beds Lagoon via another lagoon loosely known as 'middle' lagoon. Fish could swim upstream up this channel but a check structure at Healey's Lagoon itself prevented their access to the lagoon, other than in flood times. At the time of the spotlight survey by Burrows and Tait (1998), Healey's Lagoon was covered by floating weeds and the only clear water was in a small pool only a few meters wide, at this check structure at the bottom end of the lagoon, where many fish species had been trapped. Despite the limited location and short time of this spotlight survey (<30 mins), 15 fish species were observed. Of particular interest was the presence of jungle perch, a species that breeds in estuaries and thus relies on good fish passage to return to its freshwater habitats. This species is also in significant decline throughout many rivers systems in Queensland due to habitat modification. Since that time, the irrigation delivery channel surveyed by Burrows and Tait (1998) has been filled in and replaced by a buried pipe, thus preventing fish passage up that channel. At that time, although no survey of the lagoon itself had ever been conducted, it was thought that fish passage could occur via the natural flood-flow path across the paddock between Healey's and Reed Beds lagoons.

The next fish survey of Healey's Lagoon was conducted by boat-based electrofishing in 2004 and reported in Burrows and Perna (2004). Though their productivity must have been reduced, the fish diversity found in that survey (13 species) was not indicative of widespread massive hypoxia, as has been noted for other lagoons in the region that are covered by water hyacinth, which may have only 6-7 species present (eg, Perna 2003, 2004, Perna and Burrows 2005). During that survey however, no jungle perch and only three large barramundi (another species that breed in estuaries and rely on fish passage to return to freshwaters) were located. It was at that time, that it was realized that fish passage to Healey's Lagoon was obviously limited, with the last access possibly being in the significant floods of 1991. This was considered to be an unnaturally low frequency of fish passage. The survey of Burrows and Perna (2004) was conducted when the lagoon was still mostly covered by floating weeds and it was uncertain if the restricted fish community was caused by this factor or poor fish passage.

The removal of the floating weeds from the lagoon by a flood event in early 2005 provided the opportunity to assess improvements in the fish community and in fish passage. Two surveys were conducted under the GBRCWPP monitoring, in March and August 2005. In these surveys, extensive effort was put into surveying for key species such as jungle perch and barramundi. The results from all four fish surveys are provided in Table 1. A total of 17 native fish species have been recorded from Healey's Lagoon to date, plus one exotic – mosquitofish, which are common in many lagoons on the Burdekin-Haughton floodplain.

**Table 1.** Results of Four Fish Surveys in Healey's Lagoon

Species	Common Name	Burrows and Tait 1998 <sup>1</sup>	Burrows and Perna 2004	GBRCWPP Mar-2005	GBRCWPP Aug-2005
<i>Ambassis agrammus</i>	Glass perch	*	1	34	>10
<i>Amniataba percoides</i>	Barred grunter	*	1		2
<i>Anguilla reinhardtii</i>	Long-finned eel	*	9	10	>50
<i>Craterocephalus stercusmuscarum</i>	Fly-specked hardyhead	*	231	382	>100
<i>Gambusia holbrooki</i>	Mosquitofish - exotic			120	
<i>Giurus margaritacea</i>	Snakehead gudgeon	*			2
<i>Glossamia aprion</i>	Mouth almighty	*	5	2	>50
<i>Hypseleotris klunzingeri</i>	Western carp gudgeon	*	6		
<i>Kuhlia rupestris</i>	Jungle perch	*			
<i>Lates calcarifer</i>	Barramundi	*	3	2	1
<i>Leiopotherapon unicolor</i>	Spangled perch	*		37	5
<i>Megalops cyprinoides</i>	Tarpon	*	58	9	>50
<i>Melanotaenia splendida</i>	Eastern rainbowfish	*	57	337	>100
<i>Nematolosa erebi</i>	Bony bream	*	21	3	>200
<i>Neosilurus ater</i>	Black catfish	*	5	1	1
<i>Neosilurus hyrtl</i>	Hyrtl's tandan		2		
<i>Oxyeleotris lineolatus</i>	Sleepy cod	*	6	10	>50
<i>Redigobius bikolanus</i>	Speckled goby				1
Total No. Native Species		15	13	11	14

<sup>1</sup>Note that there have been some name changes and clarification of identification since the surveys of Burrows and Tait (1998) where *G. margaritacea* was listed as *Aporos aporos* (which was its accepted name at that time), *H. compressa* from that survey was probably *H. klunzingeri* and *A. agassizi* from that survey was probably *A. agrammus*.

The survey of Burrows and Perna (2004) was meant to provide a quantitative baseline fish dataset for the lagoon and thus consisted of 10 x 5 minutes electrofishing shots. For each shot, the boat was very slowly manoeuvred along a section of stream for 5 minutes, with the electrical current being applied in short bursts as needed during that time. Stunned fish were captured with a large dip net and placed into aerated nally bins until the end of the 5-minute shot, at which time they were identified and had their length measured before being released. The March 2005 survey followed the same methodology, but included 14 x 5 minutes shots. However, for the August 2005 survey, the purpose was to specifically undertaken an extensive search for evidence of the presence of estuarine-breeding species such as jungle perch and barramundi. Thus the total effort was much greater (electrofishing on-time = 180 minutes) and it was focused on finding evidence of their presence. Thus, other species observed were noted but not captured. The number of fish observed for each species in this last survey is estimated in general terms only.

Ironically, the brief spotlight survey of Burrows and Tait (1998) recorded more fish species than either of the more intensive electrofishing surveys that have followed, although it must be remembered that the spotlight survey mostly occurred at an artificial passage barrier that the fish were backed up against and technically, that survey was of fish that had not yet entered the lagoon. Since, that time, the three electrofishing surveys have not caught any jungle perch and only 6 adult barramundi. Despite applying more than three times the amount of electrofishing effort than other surveys, the August 2005

survey found only one extra species – speckled goby, plus two snakehead gudgeons, with the latter considered likely to have entered the lagoon during the flood event earlier in the year. Though this provides some evidence of fish passage, gudgeons are renowned for their tolerance of poor water quality and ability to migrate to new habitats with limited physical connectivity. The failure of jungle perch, and more particularly barramundi, to recruit to Healey's Lagoon during the 2005 flood event remains a concern. Surveys of Reed Beds Lagoon, about 1km downstream, during 2004 (Burrows and Perna 2004) revealed it to be a major barramundi nursery habitat. The area between Healey's Lagoon and Reed Beds Lagoon (Figure 2) was once a sedge and *Melaleuca* dominated swamp (Jim Tait pers. comm.). This swamp would have ponded water for several months after each wet season, allowing for the passage of migrating fish. The destruction of this swamp structure and alteration of the regions natural flood hydrology for agricultural and other developments, would have reduced opportunities for fish passage.

A total of 17 native fish species have now been found in Healey's Lagoon. Whilst, we would expect this total to be at least 20 species if full fish passage was present, this is still a reasonable result. To put it into context, ACTFR (1994) undertook fish survey at 16 sites in the Burdekin irrigation area. Most sites were creek or river channels, although one lagoon, Didgeridoo Lagoon, was sampled. Only 17 fish species were found in that entire study across all sites. Hogan and Graham (1994a) sampled 11 sites on the Herbert River floodplain, including 7 lagoons in sugar cane areas. None of these lagoons had more than 14 fish species present. Hogan and Graham (1994b) sampled 14 sites in the Tully-Murray floodplain, including 11 floodplain lagoons. Only 3 of the floodplain lagoons had 14 or more fish species and none had more than 17 species present. Kennard (1995) sampled six lagoons on the Normanby floodplain within Lakefield National Park on two occasions each. He found a total of 21 fish species across the six lagoons, though no more than 17 species were found in any individual lagoon. Thus, the fish diversity of the fish fauna of Healey's Lagoon is comparable to that of many of the major rivers in this region and to floodplain lagoons in more diverse regions such as the Herbert and Tully-Murray floodplains and lagoons on the undeveloped Normanby floodplain. However, like the Burdekin-Haughton floodplain, many of the lagoons in the Herbert and Tully-Murray floodplains are not in the best of condition either and we should be aiming for a better fish diversity for floodplain lagoons in all of these catchments.

#### **1.4 Water Quality-Mediated Fish Passage Issues for Healey's Lagoon**

It was hoped that with the relatively large size of the January 2005 flood event and the removal of the floating weed mats during that event, that evidence of fish passage, especially of barramundi would be found. However, it was not, even though quite clearly, it has occurred in the past. The most likely cause for this is either physical inability to negotiate the road culverts under the Bruce Highway, immediately downstream of Healey's Lagoon (Figure 3), or poor water quality during flow events turning fish away from swimming upstream. Examination of the culverts during several flood events, and their construction in general, leads us to think they are not the likely cause. They are of the recommended box culvert design for improved fish passage, are

not particularly long and there are several of them. In addition, in flood events such as the 2005 event, flood water overtops the highway, as evidenced by floating weeds on the road guideposts, and fish passage would be possible over the road for a limited time.

The opportunity during a moderate-sized flood event over the last few days of January and the first few days of February 2006 was taken to examine water quality during high flow periods. Water quality was focused on dissolved oxygen (DO) as this is the most likely cause of fish avoidance of the flowing water. Water quality measurements were taken with a YSI-556 multiprobe meter, and visual observations made, on 27 and 30 Jan and 2 Feb 2006, between 1130 and 1430 hrs each time. On each occasion, measurements were made at three sites – the downstream end of Healey's Lagoon (~50m upstream of the Bruce highway)(Figure 4), the downstream side of the Bruce Highway culverts (~50m downstream from Healey's Lagoon outlet but through a shallow, weeded channel)(Figure 5) and at the inlet to Reed Beds Lagoon which is approximately 1km across a well-grassed cattle paddock (Figure 8). Flow rates and levels appeared suitable for physically allowing fish passage both across the cattle paddock and through the highway culverts.

Sampling on 27 Jan followed heavy rainfall on 26 Jan and the run-off was on the early part of the tail of the hydrograph. The water looked turbid but no turbidity measurements were taken (Figures 5 and 6). Fish species identified at and above the highway crossing included *Ambassis agrammus*, *Craterocephalus stercusmuscarum*, *Hypseleotris klunzingeri*, *Melanotaenia splendida* and an eel, probably *Anguilla reinhardtii*. Generally, water quality was suitable for all native fish species at all locations, although DO dropped from ~65% sat. at the outlet of Healey's Lagoon to 42.5% sat. at the inlet to Reed Beds Lagoon. There was no smell of H<sub>2</sub>S at either location.

Sampling on 30 Jan followed a period of warm, sunny to overcast days with low rainfall that did not add to flow events measurably. The hydrograph was slowing and flow rates were greatly reduced compared with 27 Jan. Water quality at Healey's Lagoon outlet was still acceptable with DO at ~42% sat. There was no smell of H<sub>2</sub>S at the outlet to Healey's Lagoon and fish fingerlings were visible at a number of places immediately upstream and downstream from the highway. At the inlet to Reed Beds DO was 4.2% sat. and the smell of H<sub>2</sub>S was strong. The water was visibly clearer than at the outlet to Healey's Lagoon and was an opaque dark grey colour (Figure 8). There was no visible sign of fish at this site. The low DO reading is likely to severely stress most native fish species and the impact of H<sub>2</sub>S is still unknown but is indicative of unfavourable conditions.

Sampling on 2 Feb followed continued warm, sunny to overcast days. Run-off continued to slow and most of the run-off was the result of slow drainage of shallow ground water and ponded surface water. The outlet to Healey's Lagoon was an effective barrier to small fish schooling below in the pool that extends under the road culvert (Figure 4). There was no smell of H<sub>2</sub>S. Water was still flowing at the entrance to Reed Beds Lagoon. The water was opaque black and still smelt of H<sub>2</sub>S although the strength had diminished since 30 Jan. There was no visible sign of fish although large tadpoles

(presumably cane toads) could be seen. All water quality measurements from all dates are presented in Table 2.

**Table 2** Water Quality Data from Healey's and Reed Beds lagoons, 27 & 30 Jan and 2 Feb. 2006.

**Site 1** = Healey's Lagoon outlet upstream side of the Bruce Highway

**Site 2** = Healey's Lagoon outlet downstream side of the Bruce Highway

**Site 3** = Inlet to Reed Beds Lagoon

Date	January 27 2006 – 1130hrs			January 30 2006 - 1430hrs			February 2 2006 – 1300hrs		
	1	2	3	1	2	3	1	2	3
Temperature (°C)	24.24	24.27	24.71	27.34	29.26	32.17	28.83	29.26	33.67
Conductivity (µs/cm)	70	69	68	104	106	217	126	137	210
DO (mg/L)	5.36	5.45	3.5	3.00	3.56	0.35	11.79	9.05	0.08
DO (% sat.)	64	66	42.5	37.7	47.1	4.2	149.5	119	1.1
pH	8.9	8.4	8.25	6.45	6.52	6.3	8.10	8.19	6.21
Depth (m) (approx.)	1.0+	1.0+	0.2	0.2	0.9	0.1	0.1	0.1	0.1

Because DO levels change with the rate of photosynthesis and respiration, they vary constantly over the course of a day. Thus, DO is generally best monitored by taking readings over the course of 24-hour periods, as has occurred in the detailed limnological study included with this report. However, because of budgetary and time constraints, and the risk of losing equipment to flood flows, this was not possible during the flow event monitored here. Although diel DO logging would provide more information, because we are comparing between three locations at the same time of day and during the time of day when DO is normally expected to be at a maximum, the current sampling program provides the indicative information we require at this stage.

For fish to move into Healey's Lagoon, they have to move upstream from Reed Beds Lagoon and across the cattle paddock for a distance of ~1km, move through the highway culverts and then into Healey's Lagoon. From the water quality data and field observations during the 2006 flow event, it appears that the water entering Reed Beds lagoon has such a low DO content, that the fish would appear unlikely to swim up that flow path. This result is borne out by the lack of migrating fish observed in this flow path and the lack of appreciable recruitment to Healey's Lagoon. Thus, the low DO levels of flow water entering Reed Beds Lagoon would need to improve to encourage fish passage.

On all three sampling dates, water quality at the two upstream sites were similar to each other and appeared suitable for enabling fish passage. However, the water quality, especially the DO level was much lower at the inlet to Reed Beds Lagoon. This decline in water quality across the paddock between Healey's and Reed Beds Lagoons, was least on the first sampling day and greatest on the last sampling day. It is possible that the

water exiting Healey's Lagoon has a high Biochemical Oxygen Demand, thus reducing the DO levels as the water slowly moves downstream across the paddock. However, it is far more likely that the water is becoming deoxygenated as it moves across the cattle paddock (Figure 2) due to the very high oxygen demand exerted by soil. With a shallow flow path, the amount of contact between soil and water is great and the soil exerts a strong influence on the overlying water column. When the flow is stronger (on the first sampling day), the effect is less than when the flow rate declines (2<sup>nd</sup> and 3<sup>rd</sup> sampling days). Thus, water leaving Healey's Lagoon has sufficient oxygen content (at least during the daytime) but the effect of being in contact with oxygen-demanding soil deoxygenates the water by the time it reaches Reed Beds Lagoon. This type of scenario is not uncommon.

The supersaturated DO levels (up to 149% sat.) recorded in water exiting Healey's Lagoon on 2 Feb indicate during the late stage of the flow event, oxygen cycling is high. Levels this high are suggestive of very high productivity and can be expected to result in very low overnight DO levels. Logging of DO data over a 24-hour period in Figure 7 of the attached limnological study shows that DO can range from 200% (supersaturation) during the afternoon down to almost zero overnight. This in itself suggests that water quality within Healey's Lagoon at this time is likely to be poor for at least part of the day (eg, overnight). Very early in the morning is often the most stressful time of day for fish living in hypoxic waters. The oxygen content of water exiting Healey's Lagoon was not measured during night-time, but was clearly sufficient for fish passage during the daytime at least.

Water quality changes at the Reed Beds inlet sites are not just restricted to DO. On 27 Jan, for all parameters, there is not much difference between all three sites, however, as the flow rate decreases, the pH of Reed Beds inlet is noticeably reduced, but temperature and conductivity noticeably increased. Increased temperature could be expected as the flow rate slows and the water heats up as it travels more slowly across the shallow and sun-exposed paddock. pH could be expected to decrease slightly under the same conditions as organic acids produced from decaying grass vegetation and aquatic weeds in the flow channel across the paddock reduce pH levels, but this is likely to be a minor effect (see attached limnology to see that this is a site that supports significant diel pH cycling (eg, 10-7) and the field sampling program here would confound diel variation with other changes so data between time should be treated with caution. The increase in conductivity is unlikely to be fully explained by evapotranspiration, indicating that there may be some sub-surface throughflow from soils entering the flow path when moving across the paddock. The area is known to have high groundwater levels and these may have increased during the flow event.

A single water quality sample for nutrient analysis was also collected on the 27<sup>th</sup> January 2006, the day of maximum discharge during that flow event, from water exiting Healey's Lagoon at its most downstream end. This sample was analysed for nutrients and total suspended sediments at the laboratories of the Australian Centre for Tropical Freshwater Research at James Cook University. Results from this sample are presented in Table 3.

**Table 3.** Results for nutrients and TSS collected from water exiting Healey's Lagoon during a flow event at Healey's Lagoon 27 January 2006

Parameter	Analytical Result
Total Nitrogen ( $\mu\text{g N/L}$ )	4630
Total Filterable Nitrogen ( $\mu\text{g N/L}$ )	3040
Nitrate ( $\mu\text{g N/L}$ )	1410
Nitrite ( $\mu\text{g N/L}$ )	129
Total Phosphorus ( $\mu\text{g P/L}$ )	704
Total Filterable Phosphorus ( $\mu\text{g P/L}$ )	332
Filterable Reactive Phosphorus ( $\mu\text{g P/L}$ )	299
Total Suspended Solids (mg/L)	62

Because the sample was only collected opportunistically and not as part of a pre-planned program, the sample was not filtered on site and thus the key parameter, ammonia could not be analysed for. Apart from that, the results appear typical of flow events in this area.

## 1.5 Conclusions and Recommendations

The results of several fish surveys show that Healey's Lagoon has some fish passage issues and that its fish diversity and productivity is less than what would be expected of a major floodplain lagoon of its size, location and condition. There do not appear to be any physical barriers preventing fish passage. Although only a cursory examination of one flow event, it is clear that the quality of water entering Reed Beds Lagoon, specifically the dissolved oxygen content, appears to be too poor to encourage fish to migrate up this flow path into Healey's Lagoon. The DO content of the water is sufficient when it leaves Healey's Lagoon but insufficient by the time it arrives at Reed Beds Lagoon, the source of potential fish recruits. The most likely cause of the decline in DO content is oxygen demand from the soil, which consumes the oxygen in the overlying water. Where the overlying water is deep or flowing fast, the effect is lessened, but when shallow and/or flowing slower, it is heightened. During strong flows from large flood events, the residence time of water on the paddock is reduced and fish may have the opportunity to move upstream, but this only occurs for brief periods of strong flow on rare occasions. Restoration of good fish passage requires that pathways for fish passage remain viable more frequently and for longer periods. One means of achieving this in the current situation would be to construct a channel across the paddock between Healey's and Reed Beds Lagoons (Figure 9). Having a channel would allow greater separation between the water column and the soil, thus reducing the effect of the soils oxygen demand on the quality of the overlying water and making conditions for fish passage more favourable. The finding by Burrows and Tait (1998) of many fish species, including jungle perch, at the Healey's Lagoon end of the old irrigation channel that went across this paddock until 1998, shows that fish can move across this paddock under the right conditions. Anecdotally, barramundi are reported by locals to have formerly used this channel to migrate upstream (Burrows and Tait 1998).

Investigation of the channel would require consideration of the location, depth, shape and configuration (eg, presence of vegetation, installation of aeration structures) of the channel and the potential for acid sulphate soils to be disturbed as a result of the channel excavation. Consideration should also be given to the provision of snags (for fish to rest behind and hide in the water column while accessing water surface layers for oxygen intake) and riparian vegetation.

Further investigation of water quality characteristics through other flow events is also recommended. Future investigations should remain focused on DO but should be more detailed, covering various times of the day, including more sites, and investigating the cause of the low DO. Additionally, fish sampling needs to be undertaken at various sites in the flow path, including the upstream end of Reed Beds Lagoon.

## **2.0 REFERENCES**

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Figure 1: Middle section of Healey's Lagoon (Photo: Jim Tait)

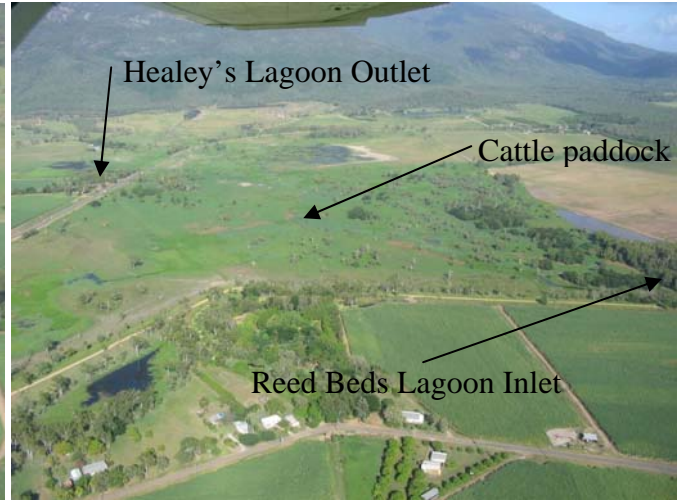


Figure 2: Cattle paddock between Healey's and Reed Beds Lagoons (Photo: Jim Tait)



Figure 3: Highway culvert downstream from Healey's Lagoon



Figure 4: Outlet to Healey's Lagoon showing restricted fish passage on low flows



Figure 5: Turbid water flowing downstream from Healey's Lagoon on 27/1/06



Figure 6: Water flooding into Reed Beds Lagoon across a wide area on 27/1/06



*Figure 7: Reduced water flow across cattle paddock downstream from Healey's Lagoon on 30/1/06*



*Figure 8: Water draining from cattle paddock into Reed Beds Lagoon on 30/1/06*



*Figure 9: Approximate proposed course of channel across cattle paddock (Photo: Jim Tait)*