Chapter 4

Condition of Proserpine, O’Connell and Andromache rivers

4.1 Introduction

This chapter identifies ecological impacts associated with existing water resource development and land use in addition to those impacts that are not related to flows for the Proserpine and O’Connell river catchments. This assessment is made with reference to the expected natural state.

In addition, key features and values, such as surface and groundwater-dependent ecosystems, ecological refugia, recreational and commercial fisheries, wetlands, conservation, groundwater-recharge areas and estuarine processes are identified.

A photographic record of condition of the study rivers can be found in Appendix 6.

4.2 Hydrology

A comparison of the flow duration curves for the Proserpine (pre-dam), Andromache and O’Connell rivers at their respective gauging stations for the period of overlapping record is shown in Figure 4-1. A comparison of flow rates and volumes between each station is not particularly informative because the positions of the gauging stations within each catchment are not directly comparable. However, the shapes of the flow-duration curves can be compared in a more meaningful way.

The flatter middle and lower parts of the flow-duration curves for the Andromache River and O’Connell River show that low flows and base flows were more persistent compared with the Proserpine River (pre-dam). The base flow of the Andromache River was also higher than the base flow of the O’Connell River. Base flow is derived from groundwater and, although interactions between surface and groundwater for the plan area are generally poorly understood, higher base-flow rates for the O’Connell and Andromache river system probably result from greater hydraulic connectivity between the fractured rock aquifer systems and the surface drainage network.

Figure 4-2 shows base-flow hydrographs for the O’Connell, Andromache and Proserpine rivers, plotted with rainfall, for monthly intervals. Data show that there is approximately a 1- to 1.5-month lag between the maximum rainfall month and the peak base-flow discharge.

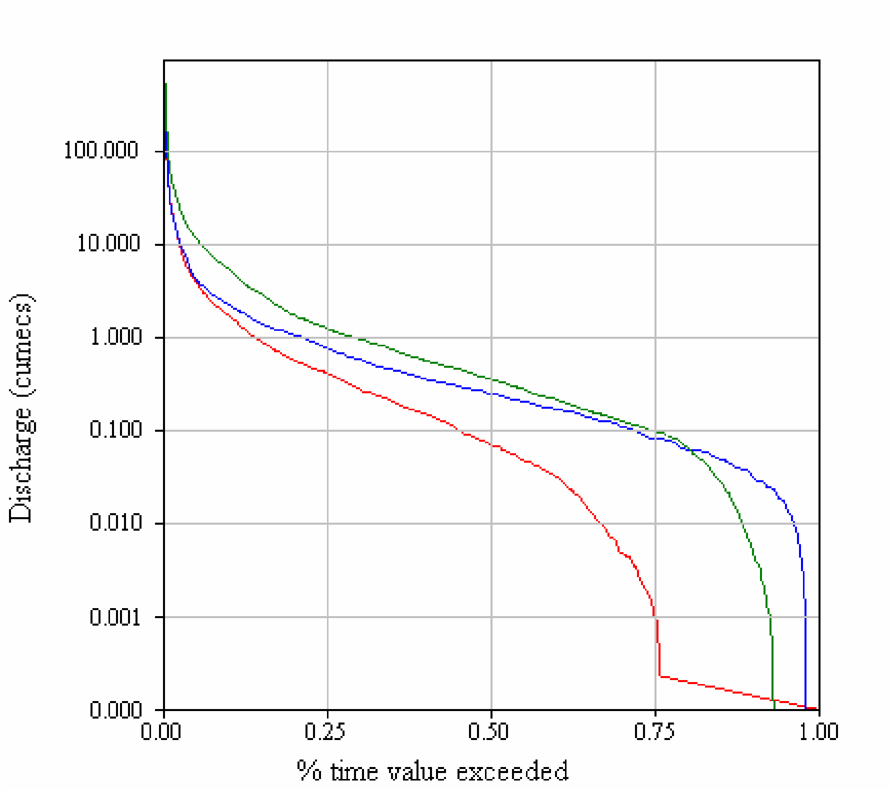


Figure 4-1 Comparison of flow-duration curves for the Proserpine (pre-dam), Andromache and O'Connell rivers

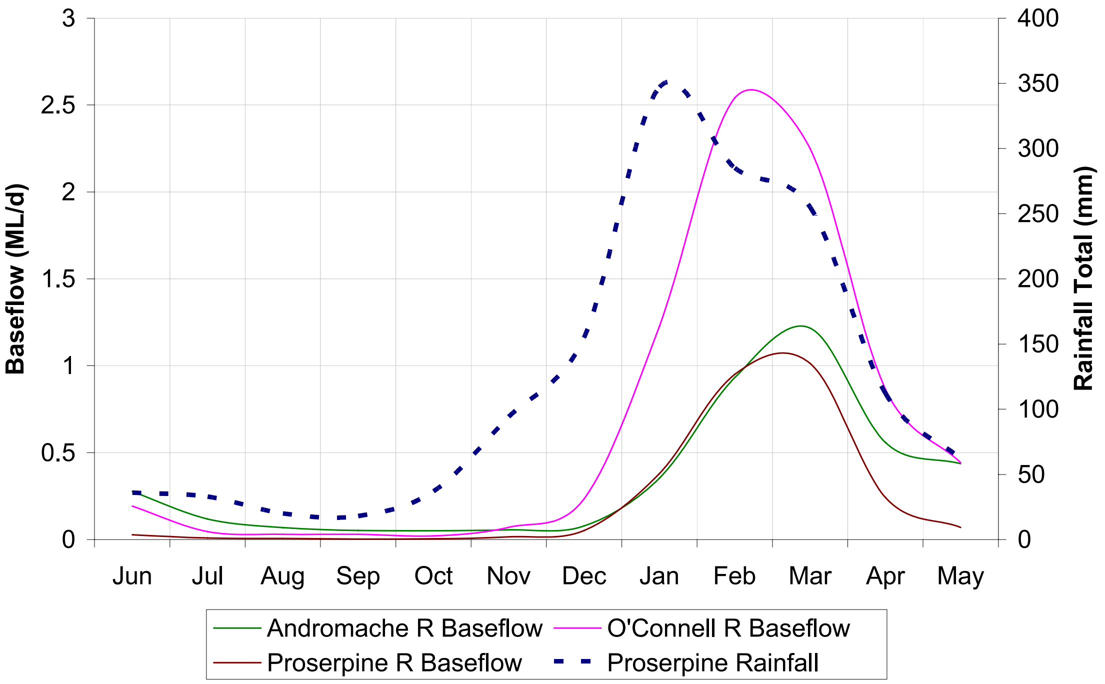


Figure 4-2 Response of base flow to rainfall events

As previously described in Section 2.7, the presence of Peter Faust Dam has had a major effect on the flow characteristics of most of the length of the Proserpine River and the current flow regime bears little resemblance to the natural flow regime (refer Figure 4-3). There has been a loss of flood flows, and an increase in low flows and base flows. The seasonal distribution of flows has also changed (refer to following sections).

Flows in reaches upstream from Peter Faust Dam are unregulated and would be much closer to the expected natural state. Minor changes to the flow regime may have occurred as a result of change to catchment land use, but these are probably not significant with respect to environmental outcomes.

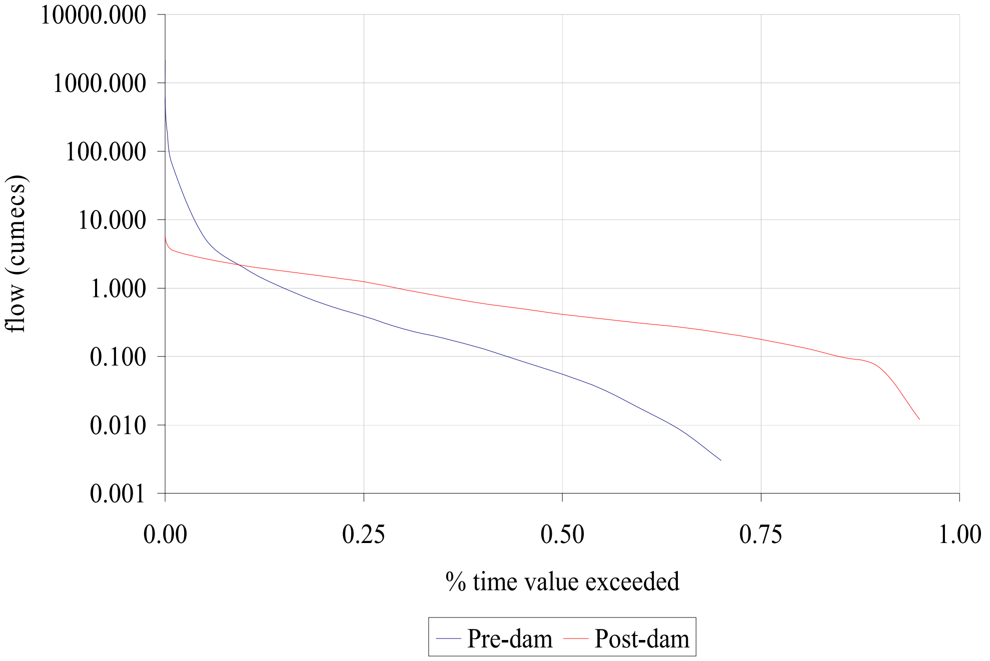


Figure 4-3 Pre- and post-dam flow-duration curves for the Proserpine River

As described in Section 2.7, the O'Connell River flows are also more variable. Compared with the Proserpine (post-dam) and Andromache rivers, it has the greatest flow rate and the greatest seasonal difference in both flood flow and base flow. As previously shown in Figure 2-4, flows have been in decline since about 1990 due to a run of drought years. This is also shown below in Table 4-1, which shows selected flow statistics for the period of record pre- and post-1990 for the O'Connell and Proserpine rivers. For the O'Connell River, data show that the magnitude of mean daily flows, base flows and flood flows were all lower than pre-1990 values, while more recent flows were less variable with longer zero-flow periods. Therefore the flow-related processes by which geomorphic condition and aquatic habitats are maintained are now less 'potent' due to the current climatic situation.

However, for the Proserpine River the effects of flow regulation (Peter Faust Dam) have had a much greater effect than climatic variability. Table 4-1 shows that median flows were higher and much less variable after 1990. There were no flows higher than 10 cubic metres per second (m^3s^{-1}) and both the duration of zero-flow spells and the mean daily base flow were reduced. Further discussion on the effect of Peter Faust Dam is provided below.

Table 4-1 Summary of flow statistics for the O'Connell River and Proserpine River

	O'Connell River		**Proserpine River**	
Period start	1/02/1969	1/01/1991	1/02/1969	1/01/1991
Period end	31/12/1990	30/06/2002	31/12/1990	30/06/2002
Median daily flow (cumecs)	0.4	0.2	0.08	0.4
Coefficient of variation of daily flows	7.1	5.9	9.5	1.1
For high flows (above 10 cumecs)				
Longest period of high flow (days)	66	22	44	0
Mean magnitude (cumecs)	176	104	128	-
Mean duration (days)	6.7	4.8	3.8	-
Mean duration of zero flow spells (days)	26	32	29	4.2
Mean daily base flow	0.74	0.68	0.30	0.20

4.2.1 *Overland flow capture*

A large number of farm dams and overland flow storages were noted during the catchment flyover. The impact of these features on catchment water balance processes has not been determined, but may be important at a local scale during low to intermediate flood events.

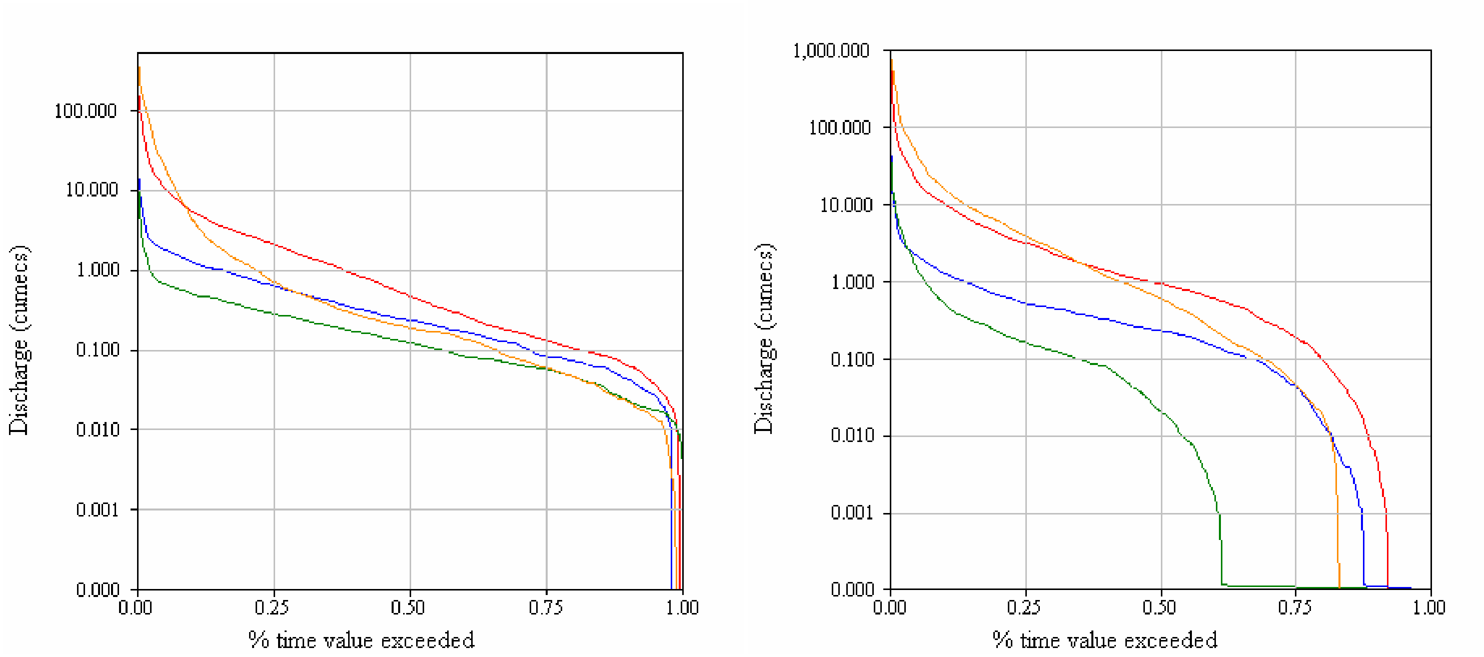
4.2.2 *Seasonal variability*

In addition to long-term cycles, seasonal variability is also an important consideration for water resource planning. presents seasonal flow-duration curves for the Andromache River and O'Connell River. Seasons were described as follows:

- Spring: September to December
- Summer: December to March
- Autumn: March to June
- Winter: June to September

The seasonal distribution of flows showed that autumn flows were highest. Summer and autumn flows were characterised by a greater proportion of floods, but lower flows in those seasons were similar to winter low flows. Spring was the driest period for both rivers.

Figure 4-4 Seasonal flow duration curves for the Andromache River (left) and O'Connell River (right)



Andromache River O'Connell River

4.2.3 *The effect of Peter Faust Dam on the Proserpine River*

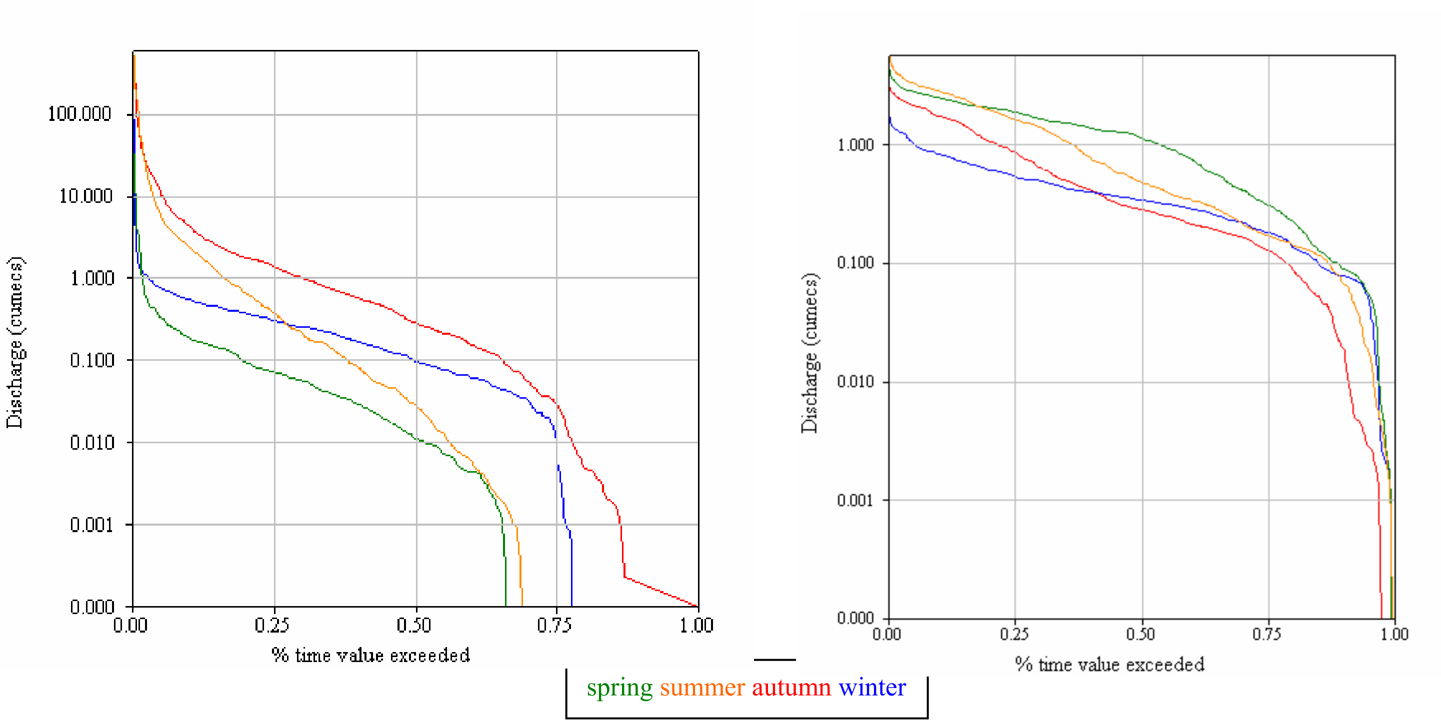
Peter Faust Dam was completed in December 1990 and has a significant effect on downstream flows in the Proserpine River. At the time of writing the spillway had never overtopped while dam operating staff indicated that voluntary environmental releases could be made up to a value of approximately 20 megalitres per day (MLd^{-1} which is the equivalent of an elevated base flow). Hydrologic modelling by SunWater Engineering Services (SunWater 2001) indicated that the attenuation capacity of the dam was very significant. Under PMP (probable maximum precipitation) conditions, the dam spillway outflow was predicted to be less than 1400 m^{3}s^{-1} for all duration events considered, while for the 100-year ARI event the maximum predicted outflow was 265 m^{3}s^{-1} for the 72-hour design storm, which equates to approximately the two to three-year ARI flood for pre-dam conditions.

Erskine (in FSI 1999) undertook detailed analyses of flow and rainfall data and demonstrated a significant reduction in annual, monthly, mean daily and flood-peak flows since 1990. Due to limited unregulated tributary inflow below the dam, these effects extend to the estuary. Erskine also noted the following had occurred:

- the duration of zero flows significantly reduced
- a significant change to the ephemeral flow regime
- truncation of flows significant for sediment transport and channel maintenance (nominally specified at > 100 m^{3}s^{-1})
- reduction in flow variability

- significant change in seasonality of flows
- increased duration of low to medium flows.

Figure 4-5 shows seasonal pre- and post-dam flow-duration curves for the Proserpine River. Apart from the obvious loss of flood flows for all seasons, the plots show that before the dam summer and autumn flows were characterised by high flow events. Winter flows were characterised by higher base flows. Autumn was the wettest period. For the post-dam case the seasonality changed dramatically. Spring flows were elevated and autumn flows were comparatively low. The shape of the flow-duration curves was similar for all seasons for the post-dam case.



Pre Dam

Post Dam

Figure 4-5 Proserpine River seasonal flow duration curves pre-dam (left) and post-dam (right)

4.2.4 Flow statistics

A more detailed assessment of the seasonal flow characteristics was undertaken using the River Analysis Package (RAP) distributed by the Cooperative Research Centre (CRC) for Catchment Hydrology. This computer program calculates key statistics for a sequence of daily-flow or gauge-height data. The RAP program was run using data for the four key gauging stations described previously, with the period of available data overlap for the gauging sites on the three rivers. The period of overlapping data is highlighted by the box in Figure 4-6. The purpose of using only the overlapping data was to ensure that comparisons between the three rivers were valid and based on the same period of data.

The results of the analyses are presented on a number of bar charts below. The period of data overlap for the Proserpine, O’Connell and Andromache river gauging stations was from 1976 to 1989 (Figure 4-6, the post-dam period for the Proserpine River was 1991 to

2002).

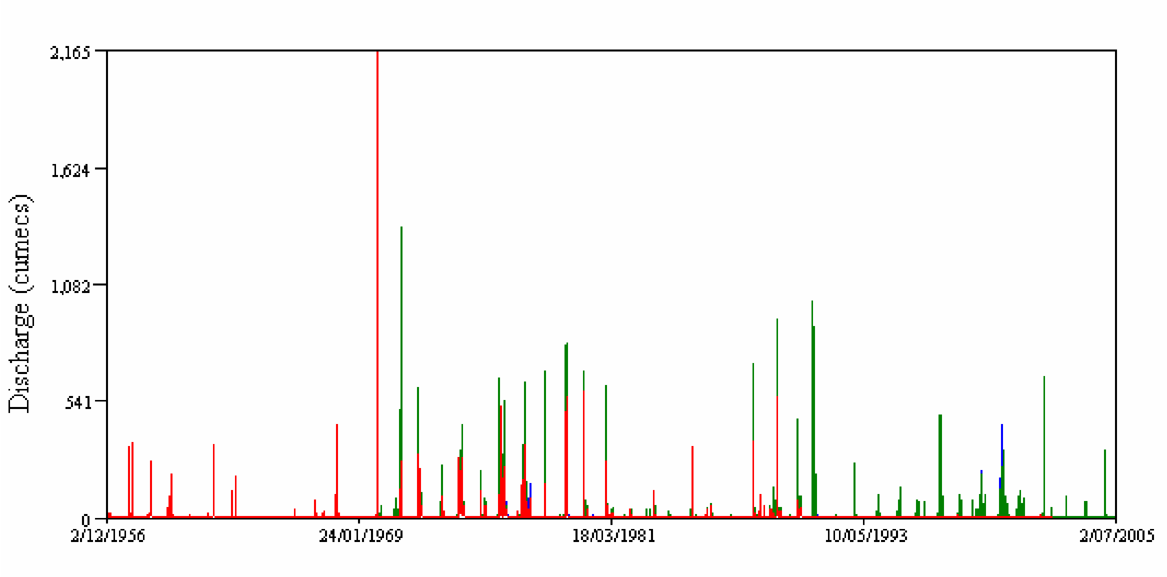


Figure 4-6 Period of available overlap for the flow record

As previously discussed, when comparing the flow statistics, it should be remembered that the location of the stations within each catchment was different (although the catchment areas of the gauging stations were generally similar) and the flow characteristics would be expected to differ slightly for upper, middle and lower catchment locations. However, the relative positions of the stations within the rivers' catchments were considered similar enough for the purposes of broad-brush comparisons between the rivers.

For Figure 4-7 through to Figure 4-12, seasonal statistics were calculated as the arithmetic mean of the annual values for the particular statistic in question.

4.2.5 Mean and median flows

Figure 4-7 and Figure 4-8 show the seasonal mean values for the mean daily flows and median daily flows respectively. The data clearly show the effect of Peter Faust Dam on the Proserpine River flows. Winter and spring flows were higher for the post-dam scenario compared with the pre-dam scenario, whereas summer and autumn flows were lower. For the Andromache and O'Connell rivers the data showed the strong seasonality of flows, with much higher flows occurring in summer and autumn, and higher flow in the O'Connell River compared with the Andromache River. Summer and autumn would, therefore, be the most important times of the year for sediment transport, flushing and filling of waterholes, wetting of benches and terraces, and floodplain recharge events.

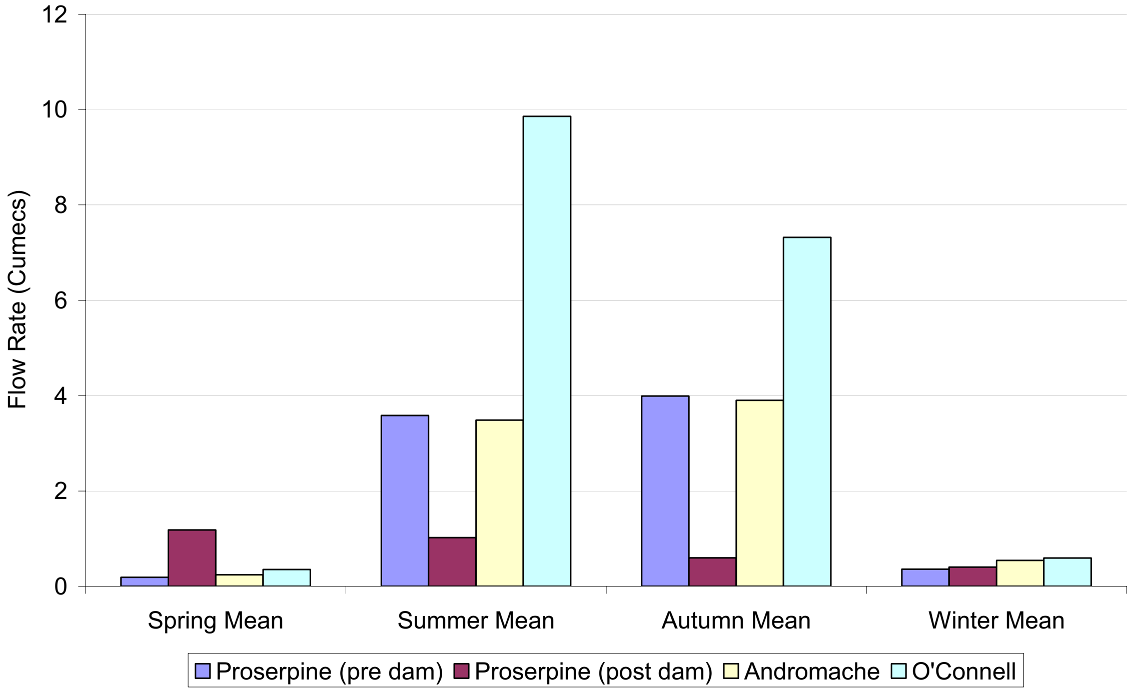


Figure 4-7 Mean seasonal flow levels

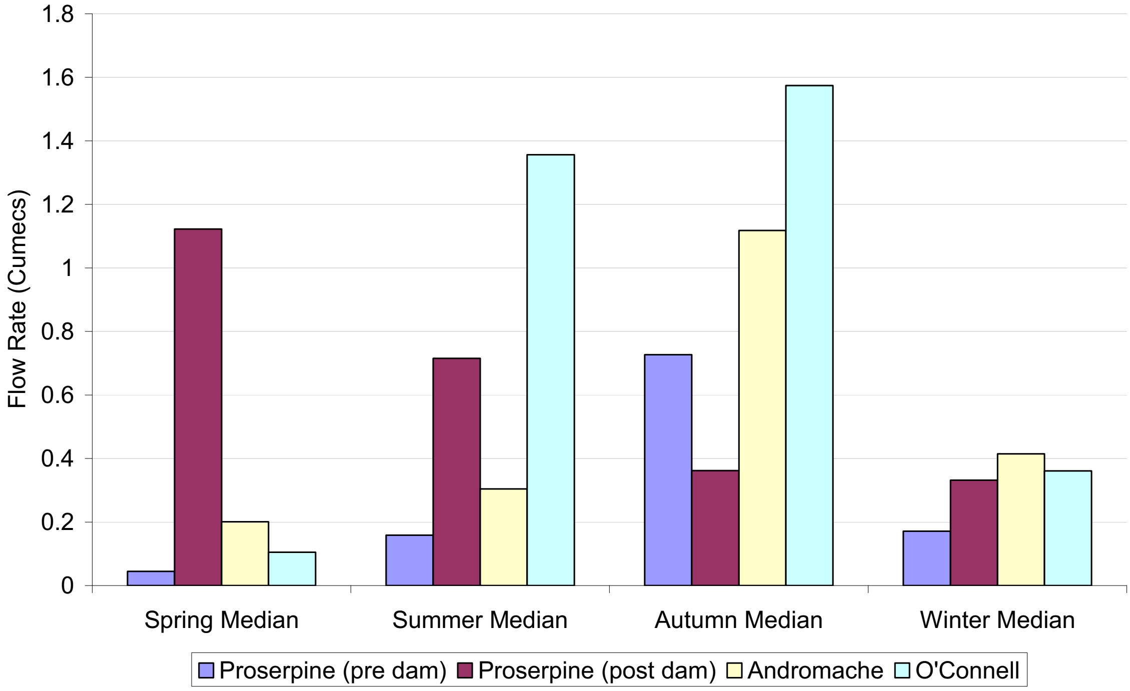


Figure 4-8 Median seasonal flow levels

4.2.6 Base flow

Base flows are important for maintaining micro-habitat, for water exchange in pools and providing a transport processes for fine material, nutrients and small organisms. Figure 4-9 shows the seasonal base-flow patterns for the study rivers. Summer and autumn base flows were notably higher for all rivers (this was somewhat dependent on the period of record used, as analysis of the full period of record for the O'Connell and Andromache rivers, as opposed to the period of overlapping record, showed highest base flows in summer months). The O'Connell River had the highest base-flow levels of the plan area rivers, with summer and autumn levels markedly higher. The O'Connell River also showed the greatest seasonal difference of base flows. Base flow for the Proserpine River was higher for the post-dam case compared with the pre-dam case, except for autumn, due to elevated pre-dam base-flow levels during autumn compared with the rest of the year. This seasonal difference will need to be considered for possible future water allocations from base flows due to the importance of maintaining base flows during dry periods.

Figure 4-10 shows statistics for the base-flow index, which is defined as the proportion of the total flow that is base flow. For this statistic, the Andromache River and Proserpine River were quite similar, with approximately 20 per cent to 30 per cent of the total flow being base flow for spring, autumn and winter seasons. During summer the base flow was a much smaller component of total flow, which was dominated by higher flood flows.

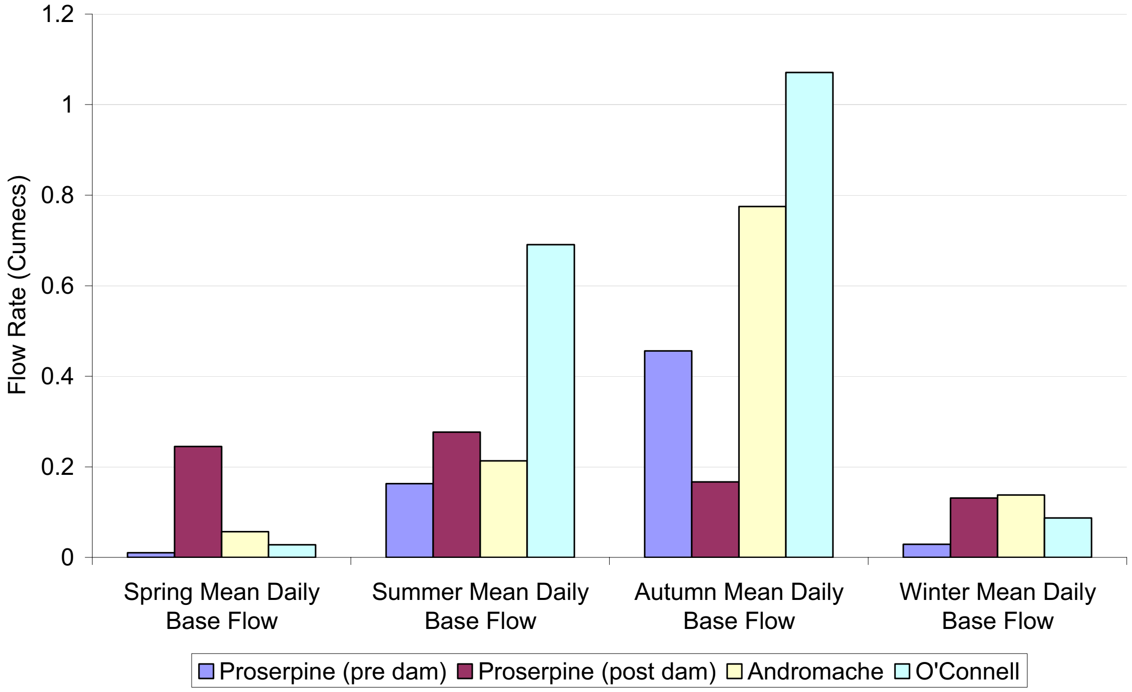


Figure 4-9 Seasonal base-flow statistics

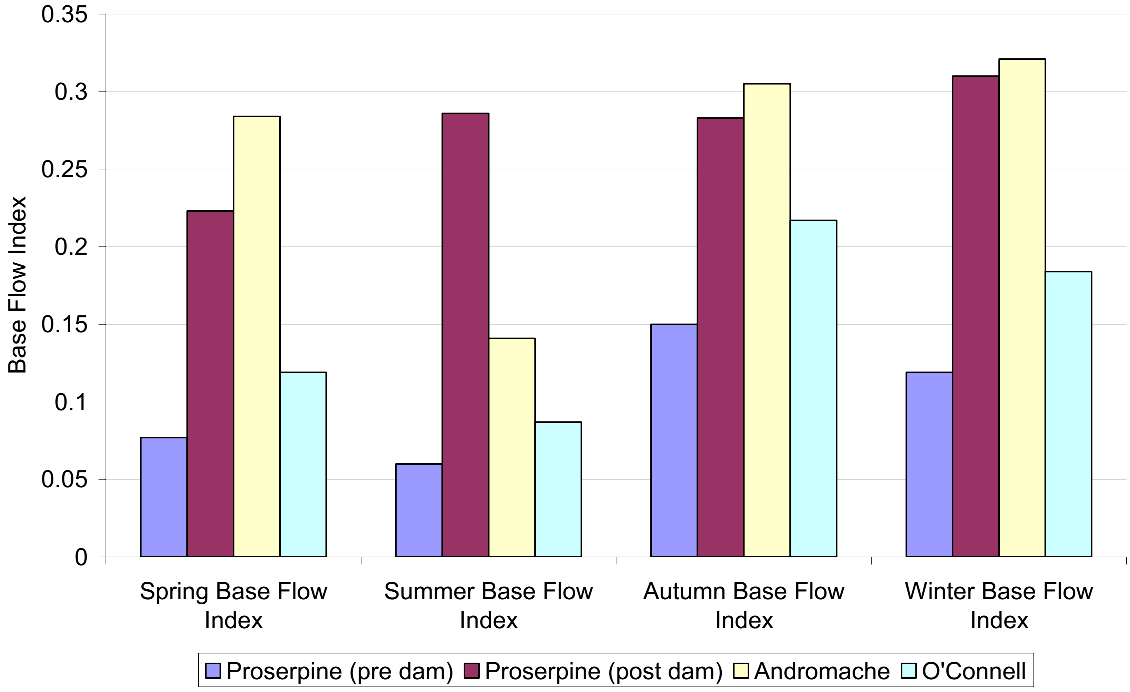


Figure 4-10 Season base-flow index

4.2.7 Zero flows

Figure 4-11 shows data for zero flow spells (consecutive days when the flow was zero). For the Proserpine River, the number of zero flow spells was less for the post-dam period compared with the pre-dam period. The greatest difference occurred for spring and summer periods. Data for the Andromache River showed a low frequency of zero flow spells for all seasons (none for the spring season), indicating that the base flow was reliable. However, zero flow spells were much more frequent for the O’Connell River, during spring and summer.

Figure 4-12 shows the mean number of zero flow days (as distinct from continuous spells) for each Gauging Station. The greatest number of zero flow days (compared with the other study rivers) occurred for the Proserpine River before Peter Faust Dam but this pattern changed dramatically for the post-dam period. Figure 4-11 and Figure 4-12 show that there were fewer zero flow spells for the Proserpine River for the post-dam period. For the O’Connell River, the number of zero flow days was much higher for the spring and summer periods compared with autumn and winter. There was a relatively low rate of zero flow days for the Andromache River.

These results highlight the importance of zero flow events and the dramatically altered frequency of these events for the Proserpine River. For water resource management purposes, it will be important to maintain zero flow events and the ecological values these events support. However, extended zero flow events could also be detrimental and therefore the management of water abstraction during low flow periods will clearly be important.

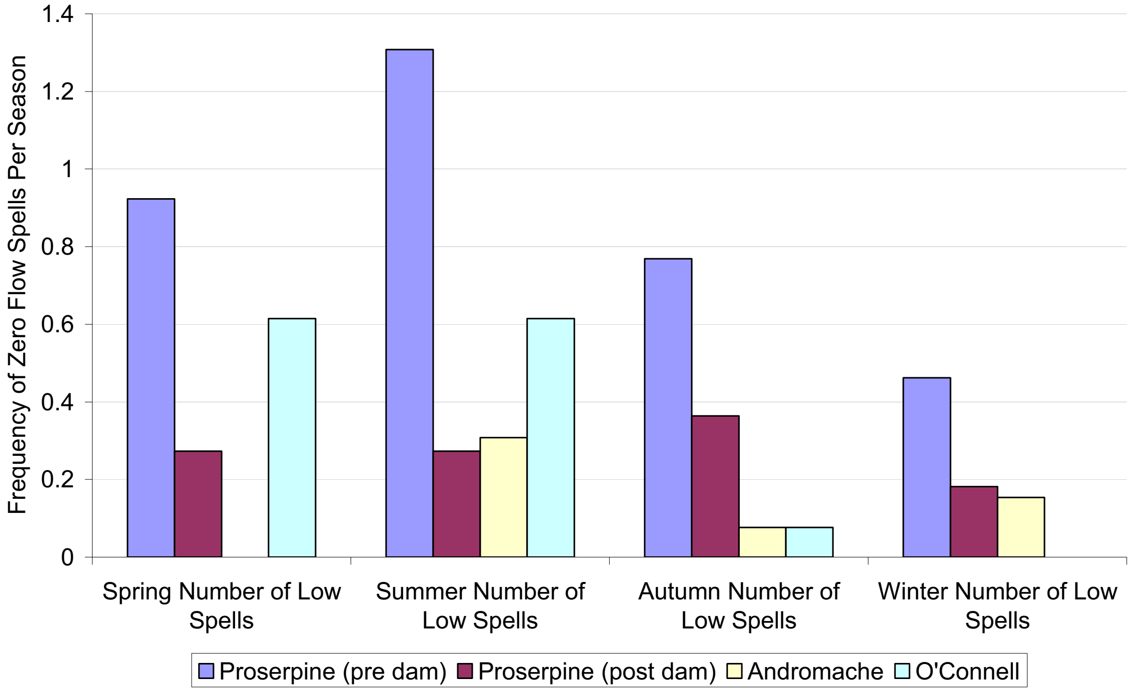


Figure 4-11 Seasonal frequency of zero flow spells

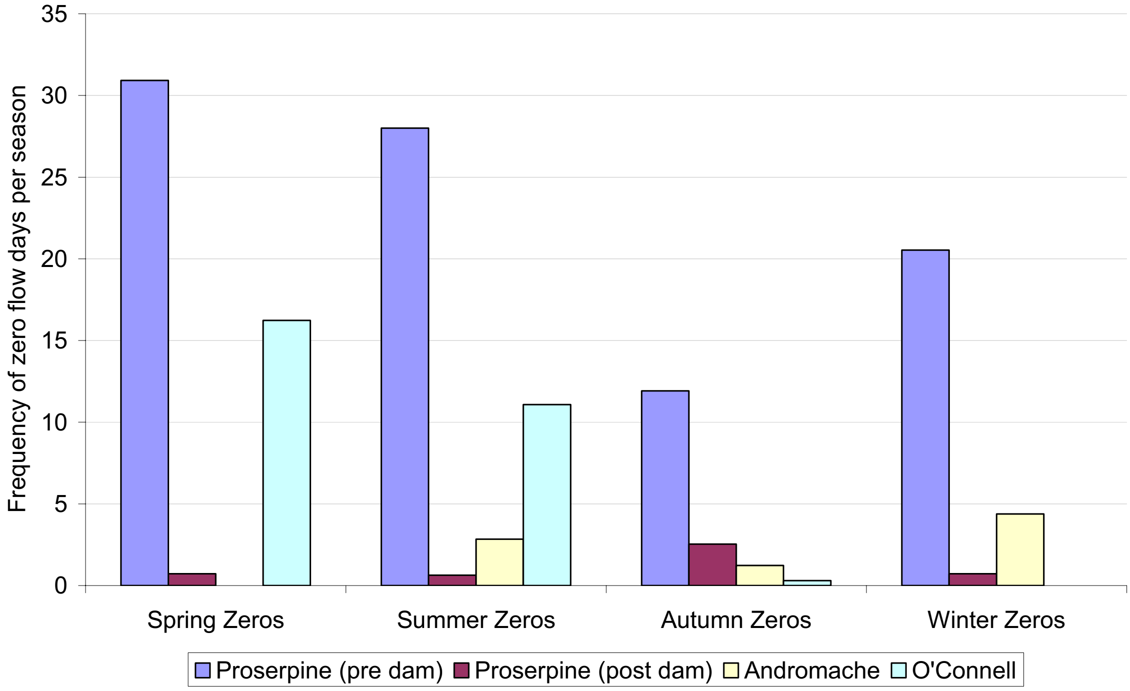


Figure 4-12 Seasonal frequency of zero-flow days

4.3 Groundwater

Since commencement of operation of Peter Faust Dam on the Proserpine River maintenance releases have resulted in a managed balance between extraction and recharge from the recent alluvium aquifers, presumably with less fluctuation in groundwater levels as a consequence. Potential salinisation due to irrigation-induced groundwater rise has been recognised in the Kelsey Creek and Lethe Brook areas, where baseline total dissolved solids within the Tertiary terrace aquifers is typically 2000 to 3000 ppm and application rates are controlled with reference to monitoring bores.

Groundwater level and quality data has been collected over the extent of the irrigation licence areas for some time. Groundwater level, yield and quality data has not been systematically analysed to assess the effects of changes in the river flow regime or usage of agricultural chemicals.

Outside of the irrigation licence areas groundwater extraction from Tertiary terrace or fractured bedrock aquifers is unregulated, but it is understood that some monitoring information has been collected. No systematic analysis of monitoring data has been undertaken to assess the effects of extraction. No information has been identified in relation to groundwater occurrence or use within coastal sediments, or of interactions between such groundwater and stream channels or water levels in recent alluvium adjacent to streams.

Within the Proserpine River channel and Recent alluvium extending to about 200 metres away from the channel banks there is direct communication between surface water and groundwater. For Six Mile Creek, Myrtle Creek, Kelsey Creek, Lethe Brook, Goorganga Creek and Thompson Creek there are groundwater windows supplied by Tertiary terrace aquifers but the interactions between surface and groundwater are not currently understood.

For most of the subcatchments of the O’Connell and Andromache rivers, groundwater resources are expected to be of restricted extent because any Tertiary terrace cover over the older bedrock is limited. Very little is known about the yield and quality of groundwater because existing development is unregulated. The bases of most stream channels are formed in older bedrock. Within the upper catchment reaches, fresh groundwater windows provide the greatest contribution to baseline flows and development of pools within stream channels. Within the middle reaches the interactions of groundwater and surface water have not been systematically studied, so the degree to which groundwater extraction would influence pool levels in streams is unknown. The lower reach of the O’Connell River is tidally influenced and no information has been accessed regarding the extent of saline intrusion into Recent alluvium. Based on the broad understanding of the groundwater regimes as outlined in Section 2.6 above, significant increases in groundwater extraction from the middle or lower reaches are considered very likely to reduce pool levels or increase saline intrusion as the case may be.

4.4 Fluvial geomorphology

4.4.1 Proserpine River

A review of the fluvial geomorphology of the Proserpine River below Peter Faust Dam was undertaken by Markham and Erskine (in FSI 1999). In summary, there had been channel contraction, the formation of in-channel benches, and vegetation encroachment across the flood channel (refer Plate 4-1, Plate 4-5). Incision of the low-flow channel had also occurred, as demonstrated by cross-section overlay plots from NRW datasets. Due to the truncation of larger flows, the processes that were responsible for the geomorphic features of the channel had largely been removed.

Changes to channel geomorphology had also occurred due to the in-stream sand and gravel extraction operations.

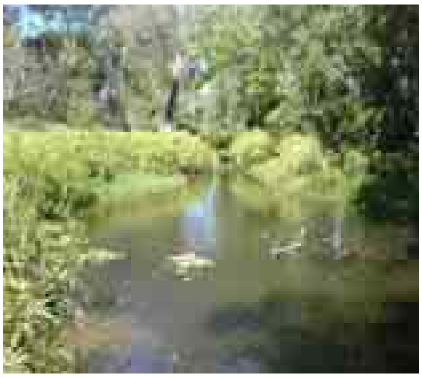
Desktop reviews and calculations of bed material transport rates for the Proserpine and O'Connell rivers were made by Markham (in FSI 1999) and Brown & Root (2001). Broadly speaking, estimates of bed material transport capacity made by a range of desk-based calculation procedures varied between about 18 000 and 60 000 tonnes per year ($t\ y^{-1}$) for the Proserpine River (pre-dam). Markham (in FSI 1999) calculated that the bed-material transport capacity for the post-dam flow record was approximately 1000 $t\ y^{-1}$. It is also noteworthy that the mean and peak rates of sediment extraction may both have exceeded the true rate of bed material transport (causing a net sediment deficit) until approximately 1998, when extractions were halted on the Proserpine River and dramatically reduced on the O'Connell River. The bed material transport capacity of the O'Connell River was estimated to be approximately 60 000 $t\ y^{-1}$.

Plate 4-1 Proserpine River near Proserpine showing contracted low flow channel in alluvial tract (left) and abandoned gravel extraction pool (right).

Flow-related geomorphic processes were better maintained on unregulated tributaries such as upper Lethe Brook, Kelsey Creek, Thompson Creek and Brandy Creek. However, generally the stream channels were set within a narrow riparian corridor. Examples of severe land degradation were noted.

Goorganga Creek (near Bruce Highway)

Thompson Creek upstream from Bruce Highway



Kelsey Creek (dam release water)

Plate 4-2 Selected tributaries of the Proserpine River (and Thompson Creek)

Upper Andromache River showing discontinuous riparian corridor, vegetated sand bed and pools

Confluence of the Andromache and O'Connell Rivers, showing sand deposits, rock outcropping and sand and gravel operations

Bank erosion works, O'Connell River Estuary

Boundary Creek

Plate 4-3 Geomorphic character of the Andromache and O'Connell rivers and tributaries

4.4.2 O’Connell and Andromache rivers

For much of its length, the O’Connell River is a wide sand-bed stream discontinuously flanked by locally extensive in-channel benches. The benches are often dissected by secondary channels or chutes and become progressively vegetated after flood events. (Erskine in FSI 1999). Field-trip observations indicated that the Andromache River also contained extensive in-stream sand deposits, and both rivers showed frequent bed and bank rock outcropping in contrast to the Proserpine River. The Andromache River was flanked by a variable but generally narrow band of riparian vegetation and was incised in places, with severe bank erosion noted in erodible soils and in the absence of bank vegetation.

A number of previous studies considered the nature of geomorphic processes on the Andromache and O’Connell rivers. Lobegeiger and Otto (1999) studied aerial photographs from 1970, 1989, and 1993 as part of a study for the Whitsunday Rivers Integrated Catchment Management Association. They concluded that the Andromache River had been relatively stable in its middle and lower reaches, with some ongoing erosion of banks. They further stated that the majority of sand-bed load was derived from general erosion of areas developed for grazing and cane, transported by concentrated overland flow in uncleared areas. Their erosion analysis indicated that for the Andromache River undercutting of the sand soil banks was the most common type of erosion and that the severity increased in a downstream direction. The effect of the increased incidence of in-stream vegetation (due to drought conditions) that diverted flow to cause bank erosion was also noted. For the O’Connell River, Lobegeiger and Otto (1999) noted that the overall erosion severity was low due to the rocky structure of the bed and banks. The majority of erosion occurred in downstream reaches, and was facilitated by lack of riparian vegetation and the downstream migration of large sandbars deflecting flows towards the banks.

In broad terms it is likely that the volumes of sand in the Andromache and O’Connell rivers are elevated compared with natural conditions (due to accelerated land disturbance since European settlement), and that the these sandbars can cause a variety of bank erosion processes due to both downstream migration during wet phases and colonisation and flow deflection during drier periods (although the scouring effects caused by sandbars can often be beneficial for maintaining and creating in-stream habitat). The rate of downstream transport of the increased sand load would have been relatively low during the low flow years of the last two decades and it is also likely that the current rate of land erosion is low for the same reason.

4.4.3 Sediment transport in the O’Connell and Proserpine river catchments

As previously described, maintenance of sediment transport in the O’Connell River will be important for maintaining coastal geomorphic processes in the absence of a significant supply from the Proserpine River. In order to assess the flow range that, in the long run, is most important for maintaining sand transport to Repulse Bay, both the magnitude and frequency of flow transporting events must be considered. This involves computing the bed material transport capacity for different flow bands, and then calculating the frequency over time, when each flow band occurs. The product of the frequency and magnitude of sediment-transporting flows yield the ‘dominant discharge’, or the flow band, that over time transports most sediment.

This calculation was performed on data for the O'Connell and Proserpine rivers (Figure 4-13). Results show that the dominant discharge band for the range of flows considered was approximately 250 to 600 m^3s^{-1} for the O'Connell River, and approximately 100 to 400 m^3s^{-1} for the Proserpine River (pre-dam). These values correspond to approximately the two-year to five-year ARI flow events in each case, reflecting the importance of regular and seasonal flooding. Therefore, for the purposes of water resource planning in the plan area, it will be important to maintain the natural frequency of O'Connell River flows in this range. For the Proserpine River no flows in the dominant discharge band have been recorded since the construction of Peter Faust Dam.

Figure 4-14 shows a cross-section of the O'Connell River at Caping Siding, with mean base-flow level and the dominant discharge band shown.

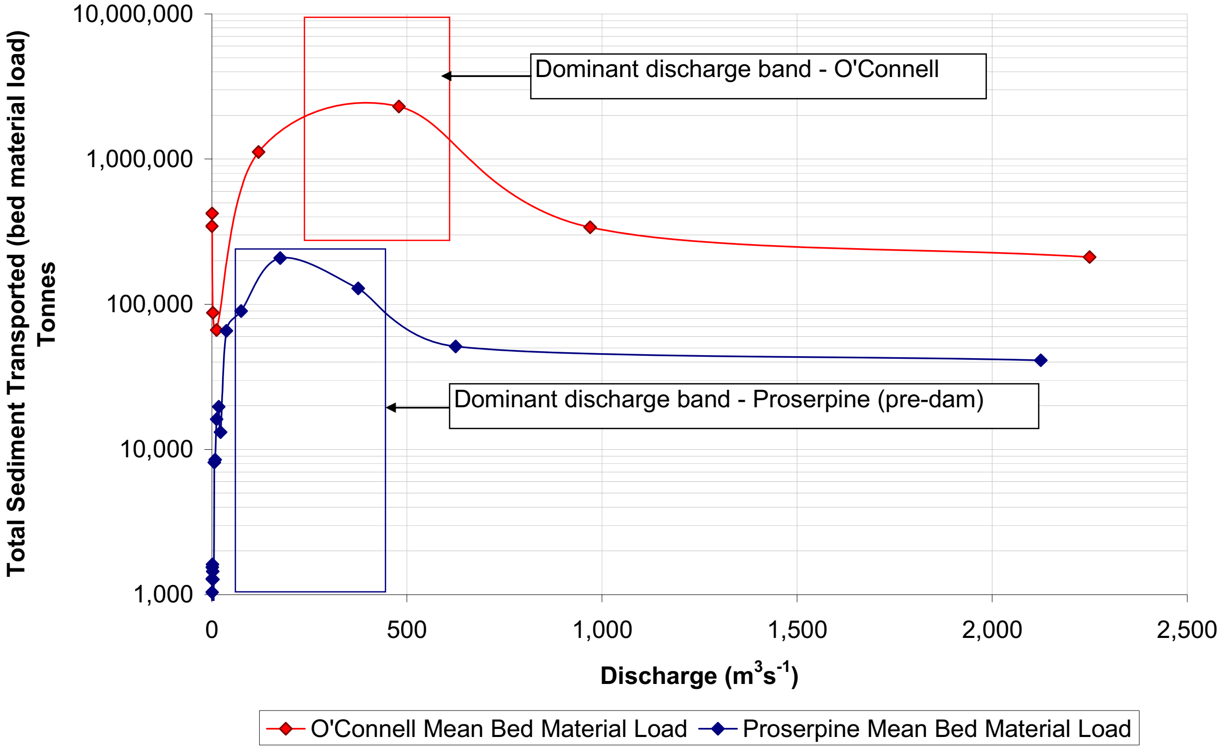


Figure 4-13 Dominant discharge for the O'Connell River and Proserpine River

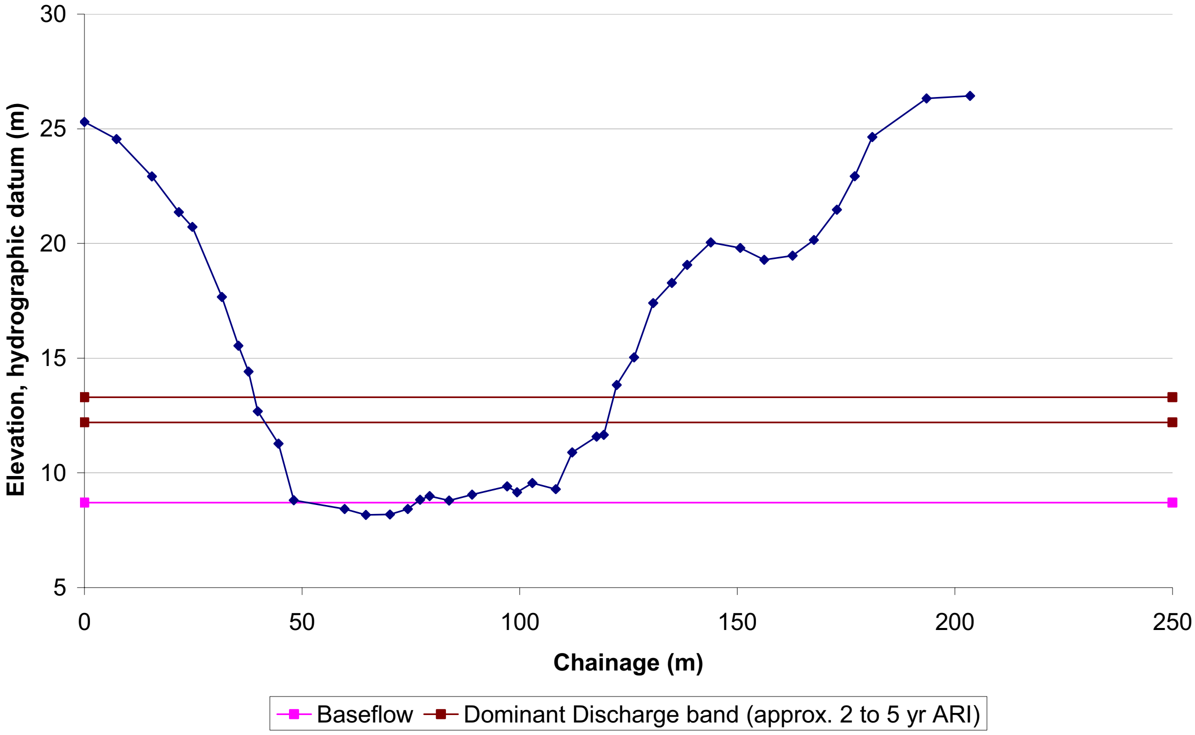


Figure 4-14 Cross-section of the O'Connell River at Caping Siding showing selected flow levels

4.5 Water quality

4.5.1 Proserpine River catchment

Clayton and Skull (1994) reported on water quality in Kelsey Creek, Happy Valley Creek and Lake Proserpine before the development of the Kelsey Creek irrigation scheme. They found that generally the waters had high but not excessive total nitrogen and phosphorous concentrations, and otherwise good water quality. The phosphorous finding is in contrast to the later study by ACTFR (2003) discussed below. Despite sufficient nutrients to stimulate plant growth in both areas, the Kelsey Creek catchment had low abundance of phytoplankton, algae and macrophytes at the time.

ACTFR (2003) summarised the available water quality information for the Whitsunday rivers catchments for the Whitsunday Rivers Integrated Catchment Management Association, based primarily on their monitoring data for the period 2000 to mid 2002. They also compared their data with the NRW and EPA water quality database values for the preceding 15 year period. They noted a decline in water quality in the Proserpine River downstream of the Proserpine Sewage Treatment Plant (STP) and Proserpine Sugar Mill, notably in terms of elevated nutrients, particularly total nitrogen and phosphorous, oxidised nitrogen and ammonia, detectable in the estuary. This was also reflected in elevated chlorophyll-a in the estuary. Elevated nitrogen concentrations were also found at the site below the Peter Faust dam, particularly during the warmer months. This was attributed to the discharge of water from beneath the thermocline in the dam, where accumulation of nitrogenous compounds can be expected to naturally occur when the lake stratifies. Note that this effect is likely to be reversed by oxygenation of the water in surface stream flows, at least upstream of the additional nutrient inputs from the STP noted above, but that ACTFR (2003) did not have sufficient sites along the river to discern this.

The Myrtle Creek catchment was also characterised by high nutrient concentrations, which tended to be associated mostly with wet season flows or pooled conditions after flow ceased. In Lethe Brook (Site 9), which was at the top of the Goorganga Plain wetland, there were notably elevated nutrient concentrations, particularly nitrogen compounds. This was associated with elevated chlorophyll-a concentrations. Of interest was the observation by TAP members that Lethe Brook, which receives flows from Kelsey Creek, had visibly more macrophyte and algal scum growth than the nearby Goorganga Creek, which does not receive regulated flows or have irrigated agriculture in its upper catchment. In both the Kelsey Creek and Lethe Brook catchments dissolved oxygen concentrations tended to be low except during flow events, which was indicative of poor water quality.

Note that no diurnal dissolved oxygen profiles were recorded as part of that study, so the full extent of oxygen cycling could not be assessed, and comparisons made between times of day were complicated by the fact that measurements at different times of day were not made on the same day at each site. Generally, dissolved oxygen concentrations were adequate at the Proserpine River sites although the potential for critical declines during diurnal or seasonal conditions could not be discounted and may be expected given the extent of submerged and emergent macrophyte growth present in some reaches.

An oddity in the ACTFR (2003) review was the finding of elevated phosphorous throughout the plan area, particularly filterable reactive phosphorous. The results for the ACTFR (2003) sampling did not match the results for the NRW and EPA monitoring, and although attributed by ACTFR (2003) to catchment characteristics, do not fit with the known geology of the region (see Section 2.3). This finding seems anomalous.

Apart from the phosphorous results, a review of the water quality monitoring data of NRMW collected for this review was generally consistent with the findings of ACTFR (2003). As the focus of this review was on the catchment-wide characteristics, and consideration of water quality was primarily focused on assessing pre-existing ecological stress from water quality as an underlying impact for consideration of potential for water resource use issues, the approach taken was to use hazard quotients to screen for potential water quality stress. Hazard quotients were calculated for each sample and for each parameter by dividing the measured parameter concentration by the default water quality trigger value for central Queensland, or northern Australia from the draft Queensland Water Quality Guidelines (EPA 2004), or the national guidelines for fresh and marine water quality (ANZECC/ARMCANZ 2000), as appropriate for each parameter. A hazard quotient of greater than one is indicative of potentially ecologically stressful water quality, while values of one or less are indicative of probable adequate water quality. The median hazard quotient was calculated for each parameter at each site for the period from 1999 to the end of data records, and the sum of the hazard quotients across parameters for each sample at each site and the median of that value also found. These values were then mapped, and the resulting figures are provided in Appendix 3.

Generally, the highest total hazard quotient scores for the Proserpine River catchment were found for the Proserpine River below Proserpine. Note that some parameters were not reliably measured by the NRW monitoring to concentrations as low as the ANZECC/ARMCANZ (2000) water quality trigger values, as appears to have been the case for some metals such as copper and zinc (although these parameters only had median hazard quotients above one for Dryander Creek in the Gregory River catchment and the Proserpine River below Proserpine for copper).

From these results higher levels of conductivity were most evident for Kelsey Creek, Lethe Brook at Hadlow Road, and the Proserpine River at Proserpine. The high hazard quotients for Kelsey Creek and Lethe Brook reflect the finding of an elevated groundwater salinity zone in this area (Section 4.3). Median pH hazard quotients were not above one for any Proserpine catchment site.

Median hazard quotients above one were found for total phosphorous and filterable reactive phosphorous only for Lethe Brook at Hadlow Road, and the Proserpine River below Peter Faust Dam (tailwater) and below Proserpine (below the STP). This is in contrast with the ACTFR (2003) results for phosphorous, but is consistent with inputs from below the thermocline of Peter Faust Dam, from the Proserpine STP, and from irrigated agriculture in the Lethe Brook catchment.

The highest median hazard quotient for nitrates in this catchment were for the Proserpine River below Proserpine for spot measurements, and also for Lethe Brook at Hadlow Road for data logger measurements. This again probably reflects STP inputs at Proserpine and agricultural inputs into the Lethe Brook subcatchment.

The finding of elevated nitrogen concentrations in both the Proserpine and O’Connell catchments (see below) is consistent with the finding of Moss et al. (1992) that the Pioneer–O’Connell has the third and the Proserpine River has the fifth highest estimated exports of nitrogen and phosphorous per unit area of all eastern coastal catchments in Queensland.

ACTFR (2004) utilised available water quality data for the catchment at the time and derived a series of stream-condition scores with reliability scoring (see Appendix 2). This was based largely on the datasets described above, but did include some reference to SEDNET and ANNEX modelling of overall sediment and nutrient exports from the Proserpine and O’Connell basins (Brodie et al. 2003 in ACTFR 2004, see Table 4-2). Note that these models were based on the input data of ACTFR (2003), which may have had elevated phosphorous readings as discussed above. Nonetheless, the model results clearly indicated an approximate order of magnitude increase for natural exports of sediment, nitrogen, and phosphorous for the Proserpine River basin, which is supportive of the finding of Moss et al. (1992). The overall scores for the Proserpine River segments considered indicated generally good condition in the headwater streams (a score of B+ with medium reliability), but more impacted health in the lower reaches and estuary (scores of D and C respectively with medium reliability). The poorer scores in the lowlands were attributed to altered flow regime, elevated nutrient concentrations, low dissolved oxygen, fish kills and poor riparian vegetation condition, and to elevated nutrient concentrations, high turbidity and flow disruption in the estuary. The Goorganga Plain wetlands were given an overall score of B, but with low reliability. Lake Proserpine was given an overall score of B+, but with low reliability. It was noted that the *Mimosa pigra* infestation and long water-retention times were potentially detrimental factors. It was also noted that the development of stratified conditions during warmer months was associated with geochemically driven increases in ammonia, iron, and manganese concentrations below the thermocline. As noted above, these influence the quality of the tailwater from the dam but are reversed by oxygenation in surface waters.

Table 4-2 Modelled current and suspended sediment and nutrient exports for the Proserpine and O'Connell river basins (from ACTFR 2004).

	Proserpine River		**O'Connell River**	
Export to the coast	Current	Natural	Current	Natural
SS[3] (kt.y^{-1})	353	45	793	99
DIN (t.y^{-1})	253	-	418	-
DON(t.y^{-1})	189	-	281	-
PN (t.y^{-1})	653	-	1310	-
Total N (t.y^{-1})	1095	204	2009	295
DOP (t.y^{-1})	12	-	20	-
FRP (t.y^{-1})	5	-	6	-
PP (t.y^{-1})	197	-	457	-
Total P (t.y^{-1})	214	32	483	48

Overall, the surface-water quality of the Proserpine River catchment is apparently impacted by point-source nutrient loadings from the Proserpine STP and below-thermocline waters from Peter Faust Dam, and by more diffuse impacts of nutrient and salinity inputs into the Kelsey Creek and Lethe Brook subcatchments, with at times high nutrient loading in Myrtle Creek. The heavy use of water for irrigation and industrial purposes in the catchment, and the lack of natural flushing flows, have undoubtedly contributed to this pattern of lowered water quality in the catchment. Because most of the stream surface waters are now shallow, the observed elevated nutrient concentrations have not led to general dissolved oxygen suppression at the sampling sites, except in lower Lethe Brook and Myrtle Creek, but the sampling data available are not comprehensive and may well miss reaches and times with suppressed oxygen concentrations.

A difficulty with detailed interpretation of the water quality data available is that the data are patchily distributed both geographically and temporally. In particular, sites are lacking in some key tributaries, such as Thompson Creek and Goorganga Creek, and very limited in extent in most catchments. There are sufficient data post 1999 to at least make some overall characterisation at the hazard quotient level across the Proserpine catchment, but can be assessed in more detail only for some sites that have longer time series of data. The best available such summary of site water quality characteristics is that of ACTFR (2003), with the possible exception of the phosphorous measurements in that dataset.

4.5.2 O'Connell and Andromache river catchments

The following section is based on the results of ACTFR (2003, 2004) and data provided by NRW as referenced in the text. ACTFR (2003) was the main data source, while ACTFR (2004) referred to those data and provided additional interpretation.

ACTFR (2003) reported that for the O'Connell and Andromache catchment there were few water quality sampling points, with one site on the Andromache River, one site on Boundary Creek and three sites on the O'Connell River. Comparisons with the ANZECC/ARMCANZ (2000) default water quality trigger values showed that only nitrate, total phosphorous, and filterable reactive phosphorous were recorded above the trigger values, but the anomalous nature of the reported phosphorous concentrations in this study

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[3] All abbreviations as per ACTFR (2004)

noted above is also applicable for these sites. Water quality for the O'Connell River subcatchment sites was generally within the ANZECC/ARMCANZ (2000) trigger values, except for the anomalous ubiquitous elevated phosphorous concentrations and a median total nitrogen concentration for Boundary Creek that was just above the trigger value (11 μgL^{-1} versus 10 μgL^{-1}). There was also a trend of steadily increasing conductivity noted for the Boundary Creek site over the nearly two years of the study. It is difficult to determine whether this trend was caused by prevailing dry conditions during the study or due to catchment effects on water quality, but it is worth noting that this subcatchment has had extensive clearing of lands with sodic soils in recent times, and this may have led to increased salt loading of the surface waters.

The median hazard quotient values for the Andromache and O'Connell catchment sites in the dataset obtained from NRW are mapped in Appendix 3.

Generally, the highest total hazard quotient scores in the plan area were found for sites in the O'Connell and Andromache catchments. This will have been influenced by generally fewer samples taken at some sites in the O'Connell and Andromache catchments than the Proserpine River catchment, and the occurrence of no flow or pooled conditions in these unregulated catchments.

Conductivity hazard quotients were not above one for the Andromache and O'Connell catchments. Median pH hazard quotients above one were found only for Mares Nest Creek and the O'Connell River at Cathu, Bloomsbury, and Caping Siding from data logger measurements, probably reflecting occasional pH fluctuations during low or zero flow conditions.

Median hazard quotients above one were not found for total phosphorous or filterable reactive phosphorous for this catchment. This is in contrast with the ACTFR (2003) results for phosphorous. The situation for nitrates was quite different, with median hazard quotients well above one at Mares Nest Creek and the O'Connell River sites for both spot measurements and data logger measurements. In the absence of notable STP inputs, the elevated nitrogen concentrations in this catchment are probably related to agricultural and stock watering inputs.

The finding of elevated nitrogen concentrations in both the Proserpine and O'Connell catchments is consistent with the finding of Moss et al. (1992) that the Pioneer–O'Connell has the third and the Proserpine River has the fifth highest estimated exports of nitrogen and phosphorous per unit area of all eastern coastal catchments in Queensland.

ACTFR (2004) also derived stream condition scores for the O'Connell River basin (see Appendix 2). The overall scores indicated generally good condition in the headwater stream and coastal plain reaches (scores of B+ with medium reliability for both), but noted that poor riparian vegetation condition in many lower reaches, and elevated nutrient concentrations in base flows and storm flows in the coastal plain reaches were potentially negative factors. The O'Connell estuary was given a score of B with low reliability.

The sediment and nutrient model results indicated an approximate order of magnitude increase over natural exports of sediment, nitrogen, and phosphorous for the O'Connell River basin (see Table 4-2), which was also supportive of the finding of Moss et al. (1992).

Overall, the water quality in the Andromache and O'Connell catchment is characterised by common occurrence of high nitrogen concentrations and increasing conductivity in Boundary Creek at least between 2000 and 2002. Visual observations by the TAP within the O'Connell and Andromache catchments support the findings of elevated nutrient availability. Algal scums indicative of high nutrient availability were observed in flowing reaches of the upper Mares Nest Creek subcatchment (see Appendix 3) and in middle reaches of the O'Connell affected by low flow. To what extent the latter simply reflected normal late dry season water quality conditions could not be ascertained without specific water quality sampling. An algal bloom that spanned two perennial pools in the middle reaches of the Andromache River adjacent to agricultural areas also appeared indicative of elevated nutrient levels (see Appendix 3).

However, a difficulty with detailed interpretation of the water quality data available is that the data are patchily distributed both geographically and temporally. In particular, sites were limited in the Andromache River subcatchment, with no site in the Andromache River monitored by NRW since 1999 and only one site in that river monitored by ACTFR (2003). Temporal patchiness of data is common for intermittent waters, but a number of sites in this subcatchment have only been monitored during macroinvertebrate spot sampling events, at most twice per year. So, while there are sufficient data for a broad overview of water quality as required for this study, few sites have sufficient regularity of time period of sampling to permit detailed assessment of water quality trends and patterns.

4.6 Aquatic ecosystems

4.6.1 Macroinvertebrates in the Proserpine River catchment

Macroinvertebrate data were sourced from the NRW monitoring data, and included

- records for edge habitats for seven sites,
- riffle habitats for six,
- macrophyte habitats for three and
- sandy pool-bed habitats for four sites in the Proserpine River catchment over the period 1994 to present.

These data were also utilised by ACTFR (2004), but no details of that analysis were provided in the report. For this study, when considering the condition of the macroinvertebrate assemblages across the catchment, the modal score for the full time period of sampling at each site for each metric was used, and these results are illustrated in Appendix 4. Scoring for the Family and PET[4] taxa richness was based on the overall richness percentiles for the full dataset, with a value below the first quartile rated as poor, between the first and second quartile as moderate, between the median and third quartile as good and above the third quartile as very good.

For edge habitats, which had the greatest overall site coverage, good to very good taxa richness was found to be typical for the Proserpine River sites, but poor to moderate scores were typical for Lethe Brook and Saltwater and Cedar creeks in the Conway Ranges. Good PET[4] taxa richness was found for the Proserpine River above and below Peter Faust Dam, middle Lethe Brook and Lethe Brook at Hadlow Road, but moderate scores were typically

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[4] 'PET taxa richness' refers to the number of families of Plecoptera, Ephemeroptera and Trichoptera, or stoneflies, mayflies and caddisflies, which are generally regarded as pollution- and habitat-sensitive taxa.

found for Cedar and Saltwater creeks and lower Lethe Brook, and poor scores for the Proserpine River at Proserpine. The latter results may reflect the STP inputs above this site (see Section 4.5), as these taxa tend to be intolerant of eutrophication. In terms of AusRivAS modelling of expected macroinvertebrate assemblage composition, all sites were typically either in the A band (good representation of the expected taxa) or X band (more taxa found than expected, for the upper Proserpine River only). SIGNAL 2 scores were generally in quadrant 2 (high family richness but low SIGNAL scores) for the Proserpine River above and below the dam (potentially indicative of nutrient or salinity impacts, but can be natural), while scores were generally in quadrant 4 below Proserpine (low family richness and SIGNAL scores, indicative of urban, industrial or agricultural impacts or downstream effects of dams). All three sites in Lethe Brook typically had scores in quadrant 3 (low family richness but high SIGNAL scores, indicative of toxicity, harsh physical conditions or inadequate sampling) possibly due to the oxygen stress noted by ACTFR (2003) at least for lower Lethe Brook. Saltwater Creek typically had a score in quadrant 1 (high family richness and SIGNAL score, indicative of favourable habitat and water quality), while Cedar Creek generally had quadrant 3 scores.

For riffle habitats the family richness was very good for Saltwater Creek and good for the upper Proserpine River, but a moderate score was found in the Proserpine River downstream of the dam and poor scores were found for Lethe Brook at Hadlow Road, the Proserpine River below Proserpine and Cedar Creek. This indicates greater impact on the riffle assemblages than the edge assemblages below Proserpine and in lower Lethe Brook. PET taxa richness received a modal good score for Lethe Brook at Hadlow Road, and moderate for Cedar Creek, but was also poor for the Proserpine River at Proserpine. The reduced richness scores for the Proserpine River at Proserpine and Lethe Brook at Hadlow Road resulted in band B AusRivAS scores for those sites, while the very good richness scores for Saltwater Creek resulted in an X band score for that site. The SIGNAL 2 scores for Saltwater Creek and the Upper Proserpine at Hecate were in quadrant 1, indicating good habitat and water quality, while the other Proserpine catchment sites had modal quadrant 3 scores, potentially indicative of harsh conditions or toxicity.

Sand bed habitats were sampled only for two sites in Lethe Brook and two sites in the Proserpine River below Peter Faust Dam. For both streams good or very good family richness and PET taxa richness scores were typical for the upstream sites, but poor scores were recorded for both downstream sites. However, band A AusRivAS scores were typical for all sites except the Proserpine River below Proserpine, which was typically band B. Modal SIGNAL 2 scores in quadrant 3 were found for the two upstream sites, but quadrant 4 scores (indicative of urban, industrial or agricultural pollution or downstream effects of dams) were found for both lower sites.

The only other habitat sampled in this catchment was macrophyte, for which there is no applicable AusRivAS model developed. Samples were taken only for the Proserpine River at Allen's Farm (below Peter Faust Dam) and below Proserpine and middle Lethe Brook. Good or very good family and PET taxa richness scores were typical for all three sites, except for a modal moderate score for family richness for middle Lethe Brook. The SIGNAL 2 scores for the Proserpine River sites were modally in quadrant 2 (often indicative of high salinity or nutrient levels), and were modally in quadrant 4 for middle Lethe Brook.

Overall, the macroinvertebrate sampling results were indicative of generally healthy assemblages in the upper reaches of the Proserpine River and Saltwater Creek, moderate to good health in middle Lethe Brook and the Proserpine River below Peter Faust Dam, but poor health in lower Lethe Brook and the Proserpine River below Proserpine. The overall pattern of taxonomic richness and SIGNAL scores was consistent with nutrient impacts below Proserpine and in lower Lethe Brook, and consistent with the surface water-quality monitoring results discussed above. Typically poor to moderate health was indicated for Cedar Creek, but this may reflect the temporary nature of this creek rather than providing any strong indication of anthropogenic impacts.

There were no sampling data available for some major tributaries, such as Goorganga Creek, Thompson Creek, Kelsey Creek or Myrtle Creek, making assessment of macroinvertebrate health for those streams impossible. Clayton and Skull (1994) did undertake macroinvertebrate sampling in Kelsey Creek before the development of the irrigation scheme, and found that at that time the macroinvertebrate assemblages were diverse, despite low dissolved oxygen at all sites.

4.6.2 Macroinvertebrates in the Andromache and O'Connell river catchment

For the O'Connell and Andromache river catchment, NRW data included records for edge and riffle habitats for nine sites, macrophyte habitats for three, sandy pool-bed habitats for two sites and rocky pool bed habitat for one site (not further discussed) over the period 1994 to present.

Edge habitat richness scores were generally very good, but moderate scores were typical for the Andromache River at Jocheim's and Pandanus Creek at Cathu Forest Station. PET Richness scores were good or very good for all sites in the catchment, and all modal AusRivAS scores were either in the A or X bands. However, the SIGNAL 2 scores were generally in quadrant 2 (often indicative of high salinity or nutrient levels), except for O'Connell River at Argents (quadrant 1, indicative of good water and habitat quality), Pandanus Creek (quadrant 3, indicative of harsh conditions or toxicity) and the Andromache River at Jocheim's (quadrant 4, usually indicative of urban, industrial or agricultural pollution or downstream effects of dams).

For riffle habitats the Family richness scores were good or very good for the sites in Mares Nest, Boundary and Pandanus creeks, and the O'Connell River upstream of Bloomsbury, with moderate scores typical for the two Andromache River sites and modally poor scores for the O'Connell River at Caping Siding. The PET taxa richness scores were similar, except that Boundary Creek at Mt Bullock had modally moderate scores and the Andromache River upstream of the tramway had typically good scores. Again, all sites had modal AusRivAS scores in bands A or X, but the majority of sites had SIGNAL 2 scores in quadrant 1, indicating good habitat and water quality. The SIGNAL 2 scores for the two Andromache River sites were in quadrant 3 (indicating possibly harsh conditions or toxicity), but the modal score for the O'Connell River at Caping Siding was in quadrant 4.

The two sites with samples from sand bed habitat were the O'Connell River at Caping Siding and Bloomsbury. For Bloomsbury the Family and PET taxa richness scores were good, and the AusRivAS score was modally in band A, while the SIGNAL 2 score was in quadrant 3. For Caping Siding the modal scores were similar, but the Family richness score was moderate. Caping Siding, Bloomsbury and the O'Connell River at Cathu were the only sites with samples for macrophyte habitats. Both the Family and PET richness scores were typically moderate for Cathu, while for Bloomsbury the Family richness score was modally good and the PET richness score modally moderate, while the reverse was found for Caping Siding. All three sites had modal SIGNAL 2 scores in quadrant 4.

Overall, the macroinvertebrate sampling results for the Andromache and O'Connell catchment were indicative of generally adequate health, but there were signs of impact, probably from agricultural impacts, in the O'Connell, particularly for the lower reaches, and generally harsh conditions or agricultural impacts at the two Andromache River sites. As for the Proserpine River catchment, coverage of sampling sites was sparse, although there were four sites in the O'Connell River above the Andromache River junction. Of the major tributary systems, only Fish Creek had no sites at all, but most subcatchments were represented by a single site, and these varied between headwaters and middle reaches, making comparisons between streams difficult.

4.6.3 Macrophytes

No sources of macrophyte data for the Proserpine River catchment were obtained for this study, despite searches of the literature and available EPA and NRW databases, apart from direct observations of the TAP during the brief field trip. No quantitative sampling was undertaken, but at each site note was made of macrophytes observed, usually at the genus level, and to species level where possible. Particular note was made of exotic species where they occurred.

A feature of the aquatic macrophyte assemblages of the Proserpine catchment was that generally there was a low incidence of weed species. The only exotic plants growing in aquatic situations were grasses. A total of 14 types of native macrophytes were observed by the TAP during a single day of field site visits (Table 4-3), which greatly under-represents the full diversity, but does indicate substantial diversity.

Table 4-3 Aquatic macrophytes observed by the TAP during brief field inspections on 20 and 21 September 2005 in the Andromache, O'Connell and Proserpine catchments.

Macrophytes	**O'Connell/Andromache**	**Proserpine**
Aponogeton	✓	
Azolla spp.	✓	
Ceratophyllum demersum		✓
Hydrilla verticillata	✓	✓
Ipomoea aquatica		✓
Lemna		✓
Ludwigia peploides	✓	✓
Lugwigia octovalvis		
Marsilea mutica	✓	✓
Monochoria cyanea		✓
Myriophyllum verrucosum	✓	✓
Nymphea		✓
Nymphoides	✓	✓
Ottelia alismoides	✓	
Ottelia ovalifolia	✓	
Persicaria		✓
Phylidrum lanuginosum		✓
Potamogeton	✓	✓
Utricularia aurea		✓

Macrophytes	**O'Connell/Andromache**	**Proserpine**
Vallisneria	✓	
Exotics		
Cyperus involucratus	✓	
Rorippa	✓	
Sedges		
Phragmites australis	✓	

Generally the structure of the macrophyte assemblages appeared healthy (e.g., Plate 4-4) but in sections of the Proserpine River further downstream from the dam there was a tendency for overgrowth of either native or exotic plants (Plate 4-5). This overgrowth is probably related to sustained base flows from controlled releases, the absence of flushing flows and the elevated nutrient levels found downstream of the dam and Proserpine (Section 4.5). The absence of riparian trees to shade the water surface in many sections of the Proserpine River will further encourage the vigorous growth of in-stream vegetation in the presence of stable water levels and plentiful nutrients. Overgrowth was also noted in the adjacent Gregory River where channel width and thinning of riparian trees similarly led to enhanced aquatic plant growth in the presence of nutrient loading.

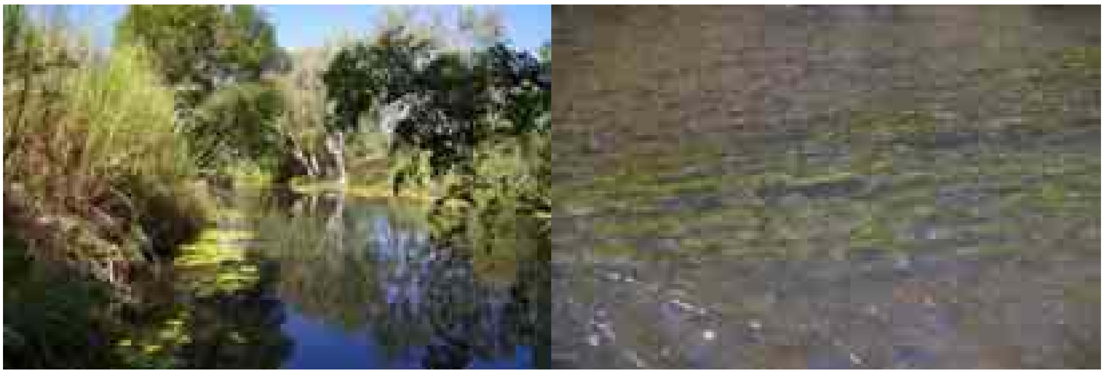


Plate 4-4 Healthy macrophyte assemblages in the Proserpine River below Peter Faust Dam (left) and Kelsey Creek above the gauging weir (right).

Plate 4-5 Overgrowth of largely native macrophytes in the Proserpine River at the Breakaway (left) and of exotic grasses in the Proserpine River at Spur’s Crossing (right).

Clearly there was insufficient data available to draw clear overall conclusions for the status of macrophytes in the Proserpine River catchment, but the field observations did suggest that there existed a good diversity of native macrophyte species in the catchment, a very low abundance of exotic species other than grasses and that generally the assemblage structure was healthy. Overgrowth of aquatic vegetation was evident in some sections of the Proserpine River, and was probably associated with managed stable flows, the absence of flushing flows, elevated nutrient concentrations, and the absence of riparian shading of the stream.

As for the Proserpine catchment, no macrophyte data for the Andromache and O'Connell catchment were able to be obtained for this study other than the observations of the TAP during the brief field trip. The taxa that were observed are listed in Table 4-3.

As for the Proserpine catchment, there was a very low incidence of exotic macrophytes in the Andromache and O'Connell catchment apart from exotic grasses. Patches of water cress, *Rorippa* sp., were noted in the upper O'Connell, while umbrella sedge, *Cyperus involucratus*, was abundant in places such as the Andromache at Jocheim's (Plate 4-6). However, 11 taxa of native macrophytes were observed during a single day spent in the catchment, which will have greatly under-represented the full diversity but does indicate substantial diversity of native macrophytes present in the catchment. Generally the macrophyte assemblage composition appeared healthy (e.g., Plate 4-7), although in some places excessive growth of filamentous algae was noted. Such algal growth can be symptomatic of elevated nutrient concentrations (see Section 4.5), but this can also occur naturally in the later stages of the dry season when light levels, available nutrients and lack of high currents facilitate rapid algal growth.

As for the Proserpine catchment, there were not sufficient data to draw clear overall conclusions regarding the status of the macrophyte communities of the Andromache and O'Connell catchment, but the field observations of good diversity of native macrophytes, low abundance of exotic species and generally good assemblage health would suggest that the aquatic flora of the catchment do have substantial environmental values.

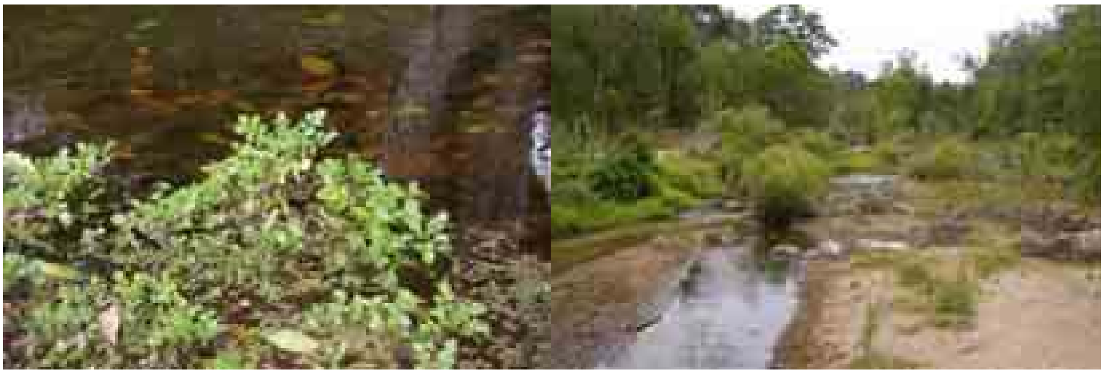


Plate 4-6 Exotic macrophytes noted in the Andromache and O'Connell catchment. Water cress, *Rorippa* sp., in the upper O'Connell (left) and umbrella sedge, *Cyperus involucratus*, in the Andromache River at Jocheim's (right)

Andromache River near Mares Nest Creek

Mares Nest Creek near Andromache junction

O'Connell River near Caping Siding

Plate 4-7 Examples of healthy macrophyte assemblages in the Andromache and O'Connell catchment

4.6.4 Fish

4.6.4.1 Proserpine River catchment

There has also been remarkably little fish sampling in the Proserpine River catchment, particularly for a catchment that is advertised by road signs near the airport as a haven for barramundi fishing. The only documented sampling that was located for this review was that reported by Clayton and Skull (1994). This was very limited in extent, being confined to reaches that were considered potentially impacted by development of the irrigation scheme in the Kelsey Creek subcatchment and extending to sites in Lethe Brook a few kilometres downstream of the Kelsey Creek junction. The sampling was limited to standardised seine netting, supplemented with fish catches in standardised dip netting for macroinvertebrate sampling. Consequently only nine native and two exotic fish species were recorded in this study. Wetlands within Goorganga Creek, which is contiguous with the Proserpine floodplain, were sampled for juvenile barramundi via electro fishing method by Hyland (2002), who recorded a maximum total of seven other species that were not reported.

Apart from Clayton and Skull's study of a small number of sites in the early 1990s, and the Goorganga data of Hyland (2002), the only other data that were obtained were the visual observations of the TAP during the brief fieldwork for this study. Naturally, this will have under-represented cryptic species and should not be regarded as adequate sampling of fishes. However it did add another four native fish species and two translocated fish species to the list of Clayton and Skull (1994).

The known fish species for the Proserpine River catchment from these limited data sources are listed in Table 4-4. The distributions of key species are mapped in Appendix 5. The only exotic fish species found in the plan area were the Guppy, *Poecilia reticulata*, and Gambusia, *Gambusia holbrooki*, which were only found in the Proserpine River and Lethe Brook catchments (including lower Goorganga Creek for Gambusia). Despite more detailed sampling in the Andromache and O'Connell by QDPI as well as TAP visual observations across that catchment, these exotic species were not located in that catchment (see Section 4.6.4.2)

Table 4-4 Fish species known to occur in the plan area (from Clayton & Skull 1994, QDPI Fisheries unpublished data and TAP field observations). Green shading indicates catadromous species, blue shading indicates amphidromous species and striped green shading indicates marine vagrant species.

	Clayton & Skull	DPI				
	Kelsey/Lethe	Bloomsbury	Caping Siding	O'Connell Highway	Andromache Railway	Elaroo
Native FW						
Ambassis agassizii	✓			2		
Ambassis agrammus		1			1	2
Amniataba percoides		31	18			12
Anguilla reinhardtii		✓	1	✓	✓	✓
Arius graffei				3		
Awaous acritosus			1			
Craterocephalus stercusmuscarum	✓	5	13		3	40
Glossamia aprion		30	6		5	21
Glossogobius giurus				1		
Hypseleotris compressa	✓	21	17		32	20
Hypseleotris sp.	✓					5
Lates calcarifer			17	1		
Leiopotherapon unicolor	✓	46	2			10
Melanotaenis splendida splendida	✓	12	30		45	49
Megalops cyprinoides		✓	2		1	15
Mogurnda adspersa	✓					
Nematalosa erebi		15	18		7	1
Neosilurus ater		1	✓			1
Neosilurus hyrtlii		1				
Notesthes robusta		2				2
Phylipnodon grandiceps						
Pseudomugil signifer	✓		1			
Strongylura kreffti				✓		
Tandanus tandanus	✓					
Toxotes chatareus				✓		
Native Marine Vagrant						
Gerres filamentosus			16	11		
Mugil cephalus		4	4	7		3
Selenotoca multifasciata				7		
Lutjanus argentimaculatus				5		
Native Estuarine						
Acanthopagrus australis				18		
Acanthopagrus berda				1		
Monodactylus argenteus				3		
Platycephalus fuscus				11		
Gerres sp.				1		
Gob spp?				1		
Garfish?				1		
Herring??				54		
Nematalosa come				1		
Pomadasys kaakan				2		
Translocated						
Hephaestus fuliginosus						
Oxyeleotris lineolatus						
Exotic						
Gambusia holbrooki	✓					
Poecilia reticulata	✓					

TABLE 4.4	TAP Records								
	Andromache/O'Connell Catchment								
	WPT512	WPT513	WPT514	WPT515	WPT517	WPT518	WPT522	WPT524	WPT526
Native FW									
Ambassis agassizii							✓		
Ambassis agrammus									
Amniataba percoides		✓		✓	✓		✓		
Anguilla reinhardtii									
Arius graffei									
Awaous acritosus									
Craterocephalus stercusmuscarum	✓	✓	✓		✓		✓		✓
Glossamia aprion		✓	✓						
Glossogobius giurus									
Hypseleotris compressa									
Hypseleotris sp.		✓							
Lates calcarifer									
Leiopotherapon unicolor	✓	✓	✓	✓	✓		✓		
Melanotaenis splendida splendida	✓	✓	✓	✓	✓	✓	✓	✓	
Megalops cyprinoides									
Mogurnda adspersa						✓			
Nematalosa erebi									
Neosilurus ater				✓					
Neosilurus hyrtlii									
Notesthes robusta									
Phylipnodon grandiceps		✓							
Pseudomugil signifer	✓	✓	✓			✓	✓		
Strongylura kreffti									
Tandanus tandanus									
Toxotes chatareus									
Native Marine Vagrant									
Gerres filamentosus									
Mugil cephalus				✓					
Selenotoca multifasciata									
Lutjanus argentimaculatus									
Native Estuarine									
Acanthopagrus australis									
Acanthopagrus berda									
Monodactylus argenteus									
Platycephalus fuscus									
Gerres sp.									
Gob spp?									
Garfish?									
Herring??									
Nematalosa come									
Pomadasys kaakan									
Translocated									
Hephaestus fuliginosus		✓							
Oxyeleotris lineolatus									
Exotic									
Gambusia holbrooki									
Poecilia reticulata									

Table 4.4	TAP records							
	Proserpine catchment							
	WPT528	WPT530	WPT537	WPT538	WPT539	WPT540	WPT541	WPT545
Native FW								
Ambassis agassizii								
Ambassis agrammus								
Amniataba percoides							✓	
Anguilla reinhardtii								
Arius graffei								
Awaous acritosus								
Craterocephalus stercusmuscarum				✓	✓	A		
Glossamia aprion								
Glossogobius giurus								
Hypseleotris compressa					✓			
Hypseleotris sp.								
Lates calcarifer		✓				✓		
Leiopotherapon unicolor					✓	✓		
Melanotaenis splendida splendida					✓		✓	
Megalops cyprinoides							✓	✓
Mogurnda adspersa			✓					
Nematalosa erebi						A		
Neosilurus ater								
Neosilurus hyrtlii								
Notesthes robusta								
Phylipnodon grandiceps								
Pseudomugil signifer					✓			
Strongylura kreffti								
Tandanus tandanus								
Toxotes chatareus								
Native Marine Vagrant								
Gerres filamentosus								
Mugil cephalus							✓	
Selenotoca multifasciata								
Lutjanus argentimaculatus								
Native Estuarine								
Acanthopagrus australis								
Acanthopagrus berda								
Monodactylus argenteus								
Platycephalus fuscus								
Gerres sp.								
Gob spp?								
Garfish?								
Herring??								
Nematalosa come								
Pomadasys kaakan								
Translocated								
Hephaestus fuliginosus						A		
Oxyeleotris lineolatus					✓	A	✓	
Exotic								
Gambusia holbrooki	✓	✓		✓				✓
Poecilia reticulata								

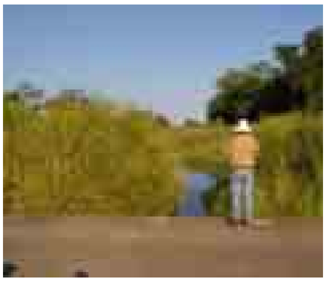
Two translocated species also occur in the Proserpine River catchment. Sooty grunter, *Hephaestus fuliginosus*, and Sleepy cod, *Oxyeleotris lineolatus*, have been stocked into Lake Proserpine. Sooty grunter have not been recorded in the available datasets downstream of the dam in the Proserpine catchment. Sleepy cod are native to some eastern drainages of north Queensland, but their natural distribution on the east coast is uncertain because of numerous deliberate translocations over an extended time period (Pusey et al. 2004). Therefore, while they are known to be native to the Fitzroy catchment, and it is possible that they are native to the lower Burdekin (below the gorge), it is not known whether they may have naturally occurred in the Proserpine area. It is known that they were introduced to the Proserpine River (Pusey et al. 2004), and that they have been stocked into Lake Proserpine (information provided by dam operators during visit to Peter Faust Dam). This species was located in the TAP observations in Kelsey Creek (Plate 4-8).

Plate 4-8 Sleepy cod, *O. lineolatus*, observed below the Kelsey Creek gauging weir.

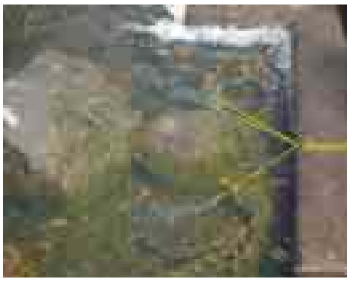
Several migratory species are known to occur in the area, and at least two species were observed just below Peter Faust Dam; sea mullet, *Mugil cephalus*, and oxeye herring, *Megalops cyprinoides*. Presumably they are more widespread than this single point of observation in the catchment by the TAP (Appendix 5). Eels, *Anguilla reinhardtii*, were not observed in the Proserpine River catchment, but this species is rarely recorded in this manner during the day. The distribution of barramundi, *Lates calcarifer*, is anomalous, not only because this species is also not readily observed from the bank, so only one TAP observation point was recorded in the lower catchment, but also because the uppermost point of observation was in Lake Proserpine, where they have been stocked. The extent of natural recruitment of barramundi in the catchment is not known, but is of some importance because of its status as a sports and food fish. Hyland (2002) found the Goorganga Creek and Goorganga wetland barramundi population to be dominated by first-year class juveniles and recorded the greatest daily capture rate for that species relative to all his other central Queensland study sites at Goorganga. Juveniles tagged as part of that study were also subsequently captured in the Proserpine River estuary, highlighting the importance of the site as a barramundi nursery and recruitment source for the Proserpine River basin, and the importance of maintaining the habitat values and hydrological connectivity between this floodplain habitat and the adjoining ecosystems.

A number of fish passage barriers were observed in the catchment, as illustrated in Plate 4-9. While not as extensive as the network of road-crossing barriers observed in the Andromache and O’Connell catchment (Section 4.6.4.2), these will act to limit the dispersal of fishes in the system under many flow levels. A number of Sleepy cod, and also smaller gudgeons (*Hypseleotris* spp.)

and rainbowfish were observed congregating below the Kelsey Creek weir and road crossing during the TAP fieldwork, when a small flow was occurring. These fish were unable to pass the small vertical barriers presented by these obstacles at that time, indicating how small barriers can inhibit natural dispersal during smaller flow events. With the largely artificial flow regime imposed in the supplemented parts of this catchment, the impacts of such small barriers are exacerbated by the reduction in frequency of higher flows.

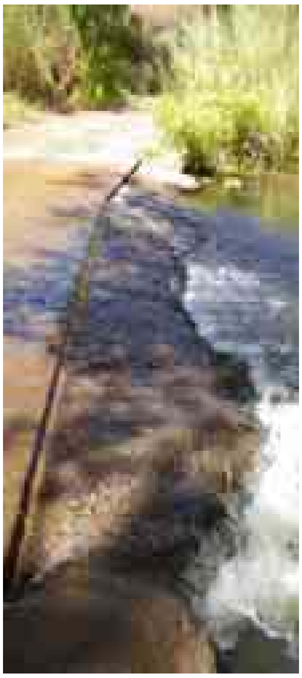

Proserpine River at Spruces Crossing (narrow culvert)


Kelsey Creek weir


Sleepy cod stopped below Kelsey Creek weir


Peter Faust Dam


Gauging weir below Peter Faust Dam


Kelsey Creek road crossing

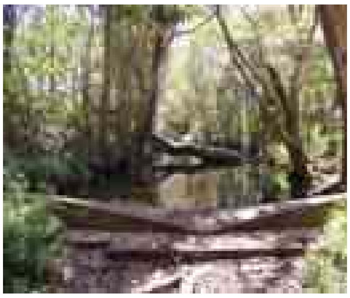

Lethe Brook gauging weir

Plate 4-9 Selected fish passage barriers noted during the TAP fieldwork

Another issue in the Proserpine catchment is the poor habitat condition of some sections, particularly those that have been substantially altered into irrigation channels rather than natural streams (see Section 4.4), or have become overgrown with weeds due to the lack of canopy shading and flushing flows. Some examples of such altered habitat structure are given in Plate 4-5. In the absence of any detailed sampling of fishes in these stream reaches, it is difficult to make any firm statements about the impact of this habitat alteration on the status of fish populations, but it was evident in the TAP field observations that such locations were among the few sites where exotic Gambusia and Guppies tended to numerically dominate the visible fish fauna. Other sites within the regulated reaches of the mid-Proserpine River and Kelsey Creek had apparently high quality perennial fish habitats that are partially created or sustained by the regulated flows within this system. Targeted sampling of these reaches is required to assess the presence or absence of valuable fish populations within these modified reaches, and the merits of targeted management to optimise fish habitat values in regulated stream reaches.

4.6.4.2 Andromache and O'Connell catchment

More fish-sampling data were obtained for the Andromache and O'Connell catchment than for the Proserpine catchment. QDPI Fisheries data were obtained from Tim Marsden, covering two rounds of sampling at four sites in the O'Connell River and one Andromache River site. This has been supplemented with observations made by the TAP at nine sites during a single day of field inspections, anecdotal reports from long-term landholders and NRW water-licensing officers and a follow-up inspection of a number of O'Connell River sites by one of the TAP members (Jim Tait). Again, this cannot be regarded as an adequate dataset, but it does at least include some quantitative sampling with efficient methods by QDPI Fisheries, albeit at a very limited number of sampling sites.

The known fish species from the catchment from these two data sources are listed in Table 4-4. The distributions of key species are listed in Appendix 5. No exotic fish species have been recorded from the Andromache and O'Connell catchment, which is extremely rare for eastern Queensland streams. A single specimen of the translocated Sooty grunter, *Hephaestus fuliginosus*, was observed at a site at Mares Nest Creek, shown in Plate 5-8. This species is only known to have been stocked in the plan area into Lake Proserpine, so this specimen may be an example of between-catchment dispersal from the Proserpine River to the Andromache River, probably in the region of little between-catchment relief in the upper catchment of both rivers (Plate 5-9), or alternatively the result of private stocking activities within the catchment. It is not known how much further in the catchment this species has spread. Sleepy cod, *Oxyeleotris lineolatus*, the other probably translocated species in the plan area, was not observed in this catchment during the TAP field visit, and was not collected by QDPI Fisheries, but may be present.

Plate 4-10 Habitat in a tributary of Mares Nest Creek in which a Sooty grunter, *Hephaestus fuliginosus*, was observed

The migratory species that have been recorded in the catchment include the catadromous longfinned eels, *Anguilla reinhardtii*, barramundi, *Lates calcarifer*, oxeye herring, *Megalops cyprinoides*, and bullrout, *Notesthes robusta*, the amphidromous roman-nosed goby, *Awaous acritosus,* and flathead goby, *Glossogobius giurus,* and the marine vagrant sea mullet, *Mugil cephalus,* threadfin silverbiddy, *Gerres filamentosus,* striped scat, *Selenotoca multifasciata*, and mangrove jack, *Lutjanus argentimaculatus.* Reports from local landholders indicate that jungle perch, *Kuhlia rupestris*, a species that prefers flowing habitat and good riparian vegetation condition also occurred in the system as least as late as the 1970s. Its current status is not known. It was not recorded in the TAP observations or QDPI sampling in the catchment, but small populations or isolated groups may have been missed by that limited sampling effort.

The distributions of these species are illustrated in Appendix 5. Of these migratory species, Flathead gobies, Striped scats, and Mangrove jacks were not collected upstream of the O'Connell River at the Bruce Highway. Although TAP observations noted large populations of juvenile and sub-adult Mangrove Jack as far upstream as Bloomsbury, Barramundi, Roman nosed gobies, and Threadfin silverbiddies were not collected upstream of Caping Siding in the O’Connell, and none were collected in the Andromache River subcatchment. Anecdotal reports from long-term local landholders suggest that barramundi may have historically extended further upstream within the O’Connell system to the vicinity of Elaroo. This may relate to passage barrier problems in this catchment as discussed further below. Bullrouts were collected in the O’Connell as far upstream as Elaroo, but were not collected from any site in the Andromache subcatchment. Longfinned eels and Oxeye herrings were also collected as far as Elaroo in the O’Connell River, but were also collected at the railway crossing on the Andromache. Of all the migratory species, Sea mullet were collected most widely, as far upstream as Elaroo in the O’Connell and as far as Jocheim’s in the Andromache. Note that Jocheim’s and Elaroo were the furthest sites from the estuary that were sampled by QDPI Fisheries, and the visual observations of the TAP would not reliably identify some of these migratory species, particularly cryptic species such as gobies and eels. Taking this into account, the recorded distributions of the migratory species appear correlated with their ability to surmount passage barriers, with the more agile species being recorded further upstream than the less agile species.

Plate 4-11 View from the upper Andromache River catchment to the Proserpine River catchment

Certainly, a number of potential fish passage barriers were noted in the catchment, as illustrated in Plate 4-12. Many of these would be flooded out at high flows, but at low to intermediate flows these would inhibit fish dispersal. In a period of lower than normal rainfall, such inhibition of fish dispersal by low-level barriers is exacerbated, and this is likely to have affected the observed fish distributions in the dataset compiled for this study.

With such limited sampling data available, and only a brief inspection of potential fish passage barriers in one day, it is not possible to fully assess the extent of such barriers in the catchment nor the impact they have on fish distributions; but clearly there is the potential for alteration of the flow regime to adversely affect the ability of fish to bypass the barriers that exist, and that this would be particularly exacerbated at low to intermediate flow levels.

Road crossing, Mares Nest Creek

Weir on Andromache River at Jocheim's

Road crossing, O'Connell River near Kamo

Road crossing, O'Connell River above Caping Siding

Well-constructed box-culvert crossing on Boundary Creek

Plate 4-12 Examples of fish passage barriers and one example of a well constructed box-culvert crossing observed during the TAP field visit

4.7 Riparian and freshwater wetland ecosystems

Regional ecosystems (RE) were selected as the basis for identifying flow-dependent riparian ecosystems within the plan area, as:

- RE mapping identified the vegetation that was protected under the *Vegetation Management Act* and, therefore, warranted efforts to protect.
- Recent RE mapping provided the most complete vegetation mapping available for the plan area and represented the most up-to-date and accurate ecosystem mapping available for the area.
- RE mapping, incorporated into a GIS database, provides a basis for planning and implementing monitoring programs of flow dependent ecosystems.

Nonetheless, other data sources, such as Hardy (2004) and Lobegeiger and Otto (1999) were used to inform discussion of the current condition of vegetation in the plan area.

Flow dependent ecosystems were considered to be all regional ecosystems within the catchment that were associated in some way to stream flow. For instance, gallery forests along the Andromache River have a direct association with stream flow, occurring in close proximity to the stream channel, and are related to the elevated moisture regime of the stream bank area. Ecosystems occurring on alluvial plains may occur some distance from the stream and have no direct link to the flows within stream banks, but the alluvial landform is dependent on sediment laden overbank flows to deposit nutrients and soil material and provide occasional flooding.

4.7.1 Ecosystem groups

Regional ecosystems occurring in coastal and alluvial land zones (Land Zones 1 and 3, Sattler and Williams 1999) were considered as potentially flow dependent ecosystems. Based on the landforms occurring within the study catchment, three main groups of flow dependent regional ecosystems were identified and are summarised in Table 4-5.

Table 4-5 Main flow dependent regional ecosystem groups identified for the Proserpine and O'Connell rivers within the plan area

Flow-dependent regional ecosystem group	**Comments**	**Typical examples of the ecosystem**
In-stream and fringing ecosystems including seasonal and permanent pools and riparian woodlands or forests	These ecosystems include the vegetation communities occurring between the high banks of the stream. These ecosystems experience the highest level of exposure to streamflows given their proximity to the stream channel.	• Blue gum gallery forests with other eucalypts and bloodwoods • Melaleuca gallery forests
Frontage woodlands on alluvial levees, terraces and floodplains including eucalypt and Melaleuca-dominated ecosystems	Typically more extensive woodland and shrub land ecosystems that are associated with overbank flows. These ecosystems once comprised the most extensive component of the flow-dependent ecosystems within the plan area.	• Blue gum and Moreton Bay ash woodlands on alluvial plains near the coast • Melaleuca woodlands on alluvial plains near the coast • Poplar gum woodlands away from the coast
Frontage woodlands incorporating seasonal and permanent wetland features	Essentially similar woodland and shrubland ecosystems on alluvium to those described immediately above, but seasonally inundated or incorporating wetland features. These areas may be inundated by overbank flows from streams or by local rainfall and run-off.	• Melaleuca fringed floodplain wetlands
Grasslands on alluvial plains and drainage lines	Typically grasslands on old marine plains and floodplains near the coast, especially Goorganga Plain.	• Couch and blady grass dominated grasslands with sedges in depressions
Coastal ecosystems including seasonally inundated grassy plains, estuaries and inter-tidal flats	Relatively extensive areas of these coastal ecosystems occur between the mouth of the Proserpine and O'Connell rivers.	• Mangrove-lined channels • Sparsely vegetated saline clay plains • Salt couch grasslands

A list of the flow-dependent regional ecosystems mapped for the Proserpine River and O'Connell and Andromache rivers is provided in Table 405 and Table 4-6 respectively

It is important to note that in stream and wetland ecosystems are not well delineated by the regional ecosystem approach. Although not explicitly identified by regional ecosystem mapping, these floodrunner and in-stream pool wetlands represent important components of the flow-dependent ecosystems in the catchment.

Table 4-6 Flow dependent regional ecosystems mapped by the Queensland Herbarium for the Proserpine River catchment

[NB: colour codes refer to those used in Table 4-5]

Regional ecosystem	**Description**	**Status (VMA)**
8.3.1	Semi-deciduous notophyll and mesophyll vine forest fringing watercourses on alluvial plains	*of concern*
8.3.3	*Melaleuca leucadendra* or *Melaleuca fluviatilis* ± *Casuarina cunninghamiana* open forest to woodland, fringing watercourses	*not of concern*
8.3.6	*Eucalyptus tereticornis*, *Corymbia intermedia* and *Lophostemon suaveolens* (or *C. tessellaris* dominant) open forest on alluvial levees and lower terraces	*of concern*
8.3.5	*Corymbia clarksoniana*, *Lophostemon suaveolens*, *Eucalyptus platyphylla* woodland; or *E. platyphylla* woodland on alluvial plains	*of concern*
8.3.13a	Mixed Melaleuca woodlands on marine plains or alluvial plains	*of concern*
8.3.13c	*Eucalyptus tereticornis* and/or *Corymbia tessellaris* woodland with a secondary tree layer of *Melaleuca* spp. on marine and alluvial plains adjacent to estuarine areas	*of concern*
8.3.2	*Melaleuca viridflora* woodland often with emergent eucalypts and grassy or herbaceous ground layer, on seasonally inundated alluvial plains with impeded drainage	*endangered*
8.3.11	*Melaleuca* sp. *aff. viridflora* closed forest to woodland in broad drainage areas (wetlands)	*endangered*
8.3.13b	*Melaleuca dealbata* woodland with grassy understorey on swampy marine or alluvial plain (wetland) adjacent to mangroves	*of concern*
8.3.12	Grassland on alluvial and old marine plains	*endangered*
8.1.1	Mangrove vegetation of marine clay plains and estuaries; estuarine wetland	*not of concern*
8.1.2	Samphire open forbland to isolated clumps of forbs on saltpans and plains adjacent to mangroves; estuarine wetland	*of concern*
8.1.3	*Sporobolus virginicus* grasslands on marine sediments; estuarine wetland.	*of concern*
8.1.4	*Paspalum* spp. and *Fimbristylis ferruginea* sedgeland or grassland (estuarine wetland); includes areas of deep open water with clumps of *Schoenoplectus littoralis* ± *Eleocharis dulcis*	*of concern*
8.1.5	*Melaleuca* spp. and/or *Eucalyptus tereticornis* and/or *Corymbia tessellaris* woodland to open forest (estuarine wetland) with a ground stratum of salt-tolerant grasses and sedges, usually in a narrow zone	*of concern*

Table 4-7 Flow-dependent regional ecosystems mapped by the Queensland Herbarium for the O'Connell River catchment

[NB: colour codes refer to those used in Table 4-5]

Regional Ecosystem	**Description**	**Status (VMA)**
8.3.1a	Semi-deciduous (complex) notophyll or mesophyll vine forest; occurs on Cainozoic alluvial plains fringing or in vicinity of watercourses	*of concern*
8.3.3a	*Melaleuca leucadendra* or *M. fluviatilis* and/or *Casuarina cunninghamiana* fringing open forest to woodland on sandy or rocky creek beds	*not of concern*
8.3.6a	*Eucalyptus tereticornis*, *Corymbia intermedia* (or *C. clarksoniana)* and *Lophostemon suaveolens* open forest; occurs on river and creek terraces and alluvial fans	*of concern*
8.3.5	*Corymbia clarksoniana*, *Lophostemon suaveolens*, *Eucalyptus platyphylla* woodland; or *E. platyphylla* woodland on alluvial plains	*of concern*
8.3.13d	*Eucalyptus tereticornis* and or *C. tessellaris* woodland; occurs on marine and alluvial plains adjacent to estuarine areas	*of concern*
8.3.2	*Melaleuca viridflora* woodland often with emergent eucalypts and grassy or herbaceous ground layer, on seasonally inundated alluvial plains with impeded drainage	*endangered*
8.3.11	*Melaleuca* sp. *aff. viridflora* closed forest to woodland in broad drainage areas (wetlands)	*endangered*
8.3.13b	*Melaleuca dealbata* woodland with grassy understorey on swampy marine or alluvial plain (wetland) adjacent to mangroves	*of concern*
8.3.12	Grassland on alluvial and old marine plains	*endangered*
8.1.1	Mangrove vegetation of marine clay plains and estuaries; estuarine wetland	*not of concern*
8.1.2	Samphire open forbland to isolated clumps of forbs on saltpans and plains adjacent to mangroves; estuarine wetland	*of concern*
8.1.3	*Sporobolus virginicus* grasslands on marine sediments; estuarine wetland	*of concern*
8.1.5	*Melaleuca* spp. and/or *Eucalyptus tereticornis* and/or *Corymbia tessellaris* woodland to open forest (estuarine wetland) with a ground stratum of salt tolerant grasses and sedges, usually in a narrow zone	*of concern*

4.7.2 Current condition of ecosystems

RE mapping for the plan area illustrates the general pattern of remnant vegetation occurrence within the Proserpine catchment, with the majority of vegetation removed from lowland areas of low relief in the mid to lower catchment area, with the majority of regional ecosystems persisting along the coast and on the ranges along the western rim of the study catchment. This reflects the pattern of historic vegetation clearing based on suitability for agriculture.

Similarly, the majority of vegetation has been removed from lowland areas of low relief in the mid to lower catchment areas of both the O'Connell and Andromache river basins with the majority of REs persisting along the ranges along the western and eastern rims of the study catchment and on a tongue of more dissected lowlands that extends from the south-western ranges north-east towards the confluence of the Andromache and O'Connell rivers. Atypically the very upper catchment of the O'Connell River basin, including both the valley floor and steeper slopes that were historically vegetated with rainforest, has also been extensively cleared for pastoral development. Unlike the Proserpine River basin there is essentially no native vegetation retained in the near coastal floodplain areas and agricultural development has extended all the way to and into mangrove dominated vegetation of the near coastal marine plains.

As of 2001, 66 per cent of the original remnant vegetation remained in the Proserpine catchment area (Accad et. al. 2003). However, this figure refers to a larger catchment area than the portion of the Proserpine catchment under consideration in this section, for which it is estimated that 40 per cent of remnant vegetation remains. The Proserpine catchment riparian zone has been estimated at 23 142 hectares of which 60 per cent currently retains natural vegetation (although not necessarily remnant vegetation) (Hardy 2004).

Aerial imagery and RE mapping clearly indicates a denuded riparian strip along the mid to lower Proserpine River (i.e., lower PR-4 and PR-5 reaches) although there are limited areas in which revegetation and significant recruitment of riparian pioneer species has or is occurring. In their assessment of riparian vegetation condition, Aylward and Trendell (1999) found the mid to lower reaches of the Proserpine River to support zero to moderate density of native trees with a weedy understorey. They also noted that the original riparian vegetation would have been dominated by fire sensitive riverine rainforest. This vegetation has declined under a succession of effects resulting from direct clearing for agriculture, grazing and sand and gravel extraction, frequent firing associated with burnt cane harvesting, and subsequent weed invasion and encroachment.

In these degraded areas, pioneer species including Leichhardt tree (*Nauclea orientalis*), weeping bottlebrush (*Callistemon viminalis*), weeping paperbark (*Melaleuca leucadendra*) and river she-oak (*Casuarina cunninghamiana*) have become established (Aylward and Trendell 1999) and provide some values for riparian fauna. However, these species are not truly representative of the rainforest canopy that would have occupied much of the area and are unlikely to be succeeded by rainforest species under current management regimes. Significantly, relatively dense stands of these species have established within the stream channel as a result of the current artificial flow regime in the river (i.e., elevated dry-season base flows and absence of larger flood flows). These stands serve to return limited elements of the previous riparian vegetation values to the river, including a shaded in-stream and waterline habitat, availability of feeding resources for fauna (both nectar and as a substrate for insects) and shelter for fauna. With a directed management effort that facilitated ongoing succession of these stands (primarily control of grass-weed understorey and associated wildfire events) a more diverse riparian vegetation community representative of the original gallery forest could be re-established in the longer term.

With respect to the current impacts of the Proserpine River Water Supply Scheme on riparian ecosystems in the mid to lower Proserpine River (i.e., PR-4 and PR-5), the impacts of an artificial perennial base flow and reduced flood flows are superimposed on an already significantly impacted system. The additional impacts due to water resource development in this area are, therefore, probably minimal. However, the current condition of the riparian vegetation along the mid to lower Proserpine River is moribund at best, and when evaluated against current social expectations of ecological sustainability would most likely be regarded as unacceptable.

Downstream of this area (i.e., reaches PR-6 and LE-3), adjacent to the estuarine reaches of the Proserpine River and Lethe Brook, a mosaic of different estuarine and floodplain remnant vegetation remains predominantly intact. Aylward and Trendell (1999) mapped the riparian vegetation of the Proserpine River estuarine reaches (i.e., PR-6) as predominantly intact native vegetation but with some disturbance of the understorey and occurrence of weeds.

The estuary and southern floodplain of the Proserpine River, including the connected Lethe Brook and Goorganga Creek systems, forms a significant component of the Goorganga Plain wetland (Blackman et al. 1999), which is recognised to have values of national significance and is listed in the *Directory of Important Wetlands in Australia* (DEH 2001). Although this wetland aggregation represents one of the highest value ecological assets within the plan area (see Section 5.3), extensive areas of the Goorganga Plain, particularly east of the highway, is now dominated by introduced pasture species (see below). West of the highway, native grassland, sedge and emergent macrophyte communities were noted to be more dominant within riparian and associated floodplain areas.

In the vicinity of the Peter Faust Dam a continuous riparian forest corridor persists downstream (assisted by the permanent flows from the dam), and a continuous though less well developed riparian forest corridor persists upstream, leading into the headwaters against the Clarke Range. Vegetation below the dam is predominantly native vegetation with varying levels of weeds in the understorey and ground cover. Upstream of the dam the riparian vegetation is predominantly intact, including the understorey, but with some effects associated with selective clearing or weeds (Aylward and Trendell 1999). However, a localised infestation of the serious riparian or wetland woody weed *Mimosa pigra* occurs around the periphery of Lake Proserpine.

Riparian vegetation along the mid and upper reaches of Lethe Brook and Kelsey, Goorganga and Albert creeks (i.e., LE-1, LE-2 and G-1) has faired better than mid reaches of the Proserpine, with more or less continuous narrow corridors persisting. In the case of Goorganga Creek a very high integrity riparian corridor with contiguous ecotonal and floodplain woodland vegetation extends west of the highway all the way to the coastal ranges providing a significant regional habitat feature.

Throughout the Proserpine, O’Connell and Andromache catchment areas the riparian vegetation community is generally both floristically and structurally diverse, providing a multitude of habitat opportunities for fauna. Fauna usage of riparian communities in some areas is, however, limited by:

- the relative isolation of the riparian corridor from other natural habitats as a result of extensive clearing of adjacent alluvial and non-alluvial plains
- poor condition of riparian areas due to invasion of the ground stratum by weeds such as guinea grass and elephant grass and the water margins by para grass
- poor condition of ground habitat due to the effects of cattle activity (primarily only lower reaches and floodplain areas)
- poor habitat condition due to frequent hot fires often promoted by introduced grasses such as guinea grass.

Grazing pressure varies according to the palatability and value of pasture occurring within the ecosystems. Fringing and frontage areas are often favoured by cattle since these areas often provide rich alluvial soils and better moisture regimes relative to upland ecosystems. Grazing-induced impacts on flow dependent ecosystems include:

- alteration to natural floristic composition due to selective grazing pressure
- erosion and subsequent decline of vegetation in frontage areas and on stream banks
- grazing, trampling and pugging of seasonal wetlands following recession of water levels.

While impacts attributable to cattle grazing pressure were observed in some grazed reaches of the middle and lower Proserpine River and floodplain areas of the adjoining Lethe Brook and Goorganga Creek systems, it was apparent that in most instances associated ecosystem impacts were less than those observed in ungrazed areas where invasive exotic pasture species had become the dominant groundcover (discussed below).

With respect to environmental weeds, the Proserpine catchment is relatively free of significant canopy weeds such as cats claw creeper (*Macfadyena unguis-cati*) and rubber vine (*Cryptostegia grandiflora*), although small amounts of the latter are present. This is a significant positive aspect of the current condition of riparian vegetation, as these weeds are incurring significant damage to riparian vegetation in nearby catchments to the south and north. Other significant ground weeds are present in the plan area, including parthenium (*Parthenium hysterophorus*) and giant mimosa (*Mimosa pigra*).

However, it is the grassy weeds such as guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*) that are causing the most significant riparian vegetation condition impacts by colonising riparian areas, and subsequently excluding native groundcover vegetation and promoting a regime of frequent hot fires. Such a fire regime suppresses regrowth of riparian trees and halts recovery of riparian ecosystems. This was apparent in much of the mid reaches of the Proserpine River and isolated floodplain wetland habitat remnants within cane growing areas of the southern Proserpine floodplain. In the absence of grazing, the fuel load generated by exotic pasture species, combined with a relatively frequent fire regime prevalent in agricultural areas, has lead to the loss of mature canopy trees, native understorey and fringing vegetation, and associated habitat values.

Within the channel of the mid and lower Proserpine River (PR-4 and PR-5) and tributary streams (Lethe Brook, Goorganga Creek, Le-1, LE-2 and G-1) and back levee swamps of the Goorganga Plain wetland the other main class of environmental weeds observed was exotic aquatic grasses otherwise known as ‘ponded pasture’ species. While para grass (*Urochloa mutica*) has long been established within the plan area and remains a significant environmental weed in the Proserpine River main channel and floodplain systems, two more recent introductions, hymenachne (*Hymenachne amplexicaulis*) and aleman grass (*Echinochloa polystachya*), were observed to be causing significant ecological condition impacts in infested areas. The combined impacts of these species include loss of native emergent vegetation communities, including important waterfowl and fish habitats, smothering and organic loading of surface waters with resulting water quality impacts (particularly dissolved oxygen depletion) and increased sediment trapping efficiency within stream channels and floodplain drainage depressions (Tait 1994; Tait & Perna 2001; Houston & Duivenvoorden 2002; Hyland 2002; Perna & Burrows 2005). While the loss of native emergent wetland vegetation (and associated waterfowl and fish habitat values) due to competition with these species was observed in both stream channel and floodplain habitats, particularly in shallow ephemeral floodplain wetlands of the Goorganga Plains, the water quality and geomorphic impacts although not immediately observable would also be assumed to be significant.

As of 2001, 52 per cent of the original remnant vegetation remained in the O'Connell catchment area, which includes the Andromache River (Accad et. al. 2003). Riparian vegetation comprises a range of vegetation types with eucalypt-dominated open forest prevalent along the lower reaches of both streams and rainforest vegetation becoming more prevalent along mid to upper reaches. Coastal vegetation types, including mangroves, salt couch (*Sporobolus virginicus*) grasslands, and blue gum (*Eucalyptus tereticornis*) or Moreton Bay ash (*Corymbia tessellaris*) woodlands, occur on the lower O'Connell (lower sections of OC-4). However, there is a virtual absence of native riparian forest downstream of the Andromache confluence (see below), indicating that only small patches of these vegetation types occur along the main river channel.

The most common weeds encountered in riparian vegetation by Lobegeiger and Otto (1999) comprised lantana (*Lantana camara*), guinea grass (*Panicum maximum*), sicklepod (*Senna obtusifolia*), elephant grass (*Pennisetum purpureum*), para grass (*Urochloa mutica*) and castor oil plant (*Ricinus communis*).

Aerial imagery and RE mapping clearly indicates a nearly totally denuded riparian strip along the O'Connell downstream of the Andromache confluence (OC-4), similar to the mid Proserpine. Upstream of this point the riparian vegetation varies with respect to the integrity of the canopy, with small pockets of intact canopy interspersed with highly disturbed canopy. Weeds are prevalent in these areas, particularly guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*) and, as for the Proserpine River, have given rise to a regime of frequent hot fires that typically suppress natural regeneration of the riparian canopy. However, during the field inspection for the study, a number of sites were observed along reaches OC-2 and OC-3, where relatively dense recruitment of blue gum (*Eucalyptus tereticornis*), Moreton Bay ash (*Corymbia tessellaris*) and weeping paperbark (*Melaleuca leucadendra*) was occurring. Significant regeneration of these areas could be achieved with appropriate management.

A feature of the mid O'Connell River (OC-3) are pockets of dense riparian vegetation comprising weeping paperbark (*Melaleuca leucadendra*) and rainforest species that occur apparently in association with seepage from Tertiary terrace aquifers. These areas contribute significantly to the local diversity of riparian vegetation types, and provide valuable refugia for riparian and non-riparian fauna.

There is a potential that existing utilisation of groundwater from the Tertiary terrace aquifers may have already impacted on the permanency and availability of water in these moist pockets. Reductions in the temporal availability of water levels in these areas is likely to impact on the vigour and composition of moist vegetation pockets and subsequent habitat values for fauna.

Similarly, extensive areas of denser moist riparian forest occur along the upper reaches of the Andromache (And-1, And-2) including Mares Nest Creek, and the O'Connell River (OC-1 and OC-2, although many areas are now cleared) where the streams intersect fractured bedrock aquifers, producing perennial base flow and perennial pool conditions. These represent significant refugial areas for riparian flora and fauna and non-riparian fauna that may utilise riparian habitats especially during the dry season. It is unclear as to whether existing water resource use has affected these areas.

For both the O'Connell and Andromache riparian corridors, reaches and riparian locations with higher conservation values were observed and a non-exhaustive listing of exemplary sites is detailed in Chapter 5. Typically these sites included areas where perennial aquatic habitats co-occurred with higher integrity riparian vegetation, particularly that which was more diverse, structurally complex or representative of threatened vegetation types (e.g., rainforest and threatened alluvial levee regional ecosystems). For the broader faunal community, which has only a seasonal or non-obligate dependence on riparian and other flow-dependent ecosystems, higher ecological value was also attributed to sites where adjoining ecotonal vegetation and terrestrial ecosystems was contiguous with the stream reach.

Similar to the Proserpine River catchment, the O'Connell and Andromache catchment is largely free of significant canopy weeds such as cats claw creeper (*Macfadyena unguis-cati*) and rubber vine (*Cryptostegia grandiflora*), although small amounts of the latter were present, and this was a significant positive aspect of the condition of riparian vegetation. Ground weeds such as parthenium (*Parthenium hysterophorus*), also occurred in this catchment, along with grassy weeds such as guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*) that exclude native groundcover vegetation and promote a regime of frequent hot fires. Hymenachne (*Hymenachne amplexicaulis*) was also observed in reaches of the upper Andromache, but to date potential impacts have been moderated by the existing grazing regimes.

4.8 Estuarine, coastal and marine habitats

There are very limited biological data available on which to assess the ecological condition of the estuarine, coastal and marine habitats associated with the plan area, particularly in terms of change from natural. Available biological survey information and cursory observation of the TAP from field site visits and the aerial flyover indicate a diverse, productive and relatively high integrity coastal and marine ecosystem complex.

4.8.1 Proserpine River catchment

The high value Goorganga Plain wetland (Blackman et al. 1999; DEH 2001) extends into the coastal and marine ecosystem complex of the plan area and is described in detail in Chapter 5. Condition impacts observed within this wetland aggregation include grazing pressure and invasive aquatic weeds described above. Towards the areas of marine influence another apparent physical impact observed was some minor bunding of tidally influenced drainage channels.

High values associated with the estuarine, coastal and marine elements of this wetland aggregation and the broader marine ecosystem complex generally include a very diverse assemblage of mangrove species (Duke 1985), fishery nursery habitats, including seagrass ecosystems (Coles et al. 1987), barramundi nursery swamps (Hyland 2002), significant migratory wader bird populations (Driscoll 1995), a high value recreational fishery and populations of marine species of conservation interest, including estuarine crocodiles, dugong and marine turtles (Blackman et al. 1999).

The three main sources of information that would support inferences concerning potential impacts in the coastal zone are those that indicate changes in freshwater flow, sediment and nutrient discharges to the Proserpine estuary and coastal waters referred to in preceding sections. The nature of ecological impacts associated with these changes and whether they are negative or positive in terms of biological diversity and productivity remains unknown.

Certainly the elevated nutrient levels recorded in the lower reaches of the Proserpine River would generally be interpreted as a risk factor in terms of eutrophication potential in more poorly flushed parts of the estuary and for adjoining marine ecosystems, possibly including the GBR lagoon. Seeking to reduce nutrient exports from the basin would be in line with the Reef Water Quality Action Plan being implemented by state and federal governments (DEH 2005). However, the overall nutrient export balance from the basin would also be affected by the reduced frequency and magnitude of peak flood flows following construction of the Peter Faust Dam and the overall net impact is unknown. Short of eutrophication impacts occurring, elevated nutrient levels in freshwater discharges could also be generating increased productivity in receiving environments such as mangroves and seagrass communities.

The occurrence of regulated base flows in the dry season would also be expected to be having an impact on the salinity regimes within the estuary, although again the nature of the impact is unknown. In tropical Australia more diverse mangrove assemblages are often associated with estuaries that have more evenly distributed freshwater discharges and broader associated salinity regimes (Duke 1985).

The coastal geomorphological impacts of Proserpine River flow regulation are also difficult to discern and are probably still in a state of flux given competing influences of past and current resource development impacts. Anecdotally, long term local residents report that the estuary is silting up and this is most readily attributed to the loss of peak flood flows following construction of the Peter Faust Dam. However other factors that are operating include a general increase in sediment supply to both the Proserpine and contributing O'Connell rivers due to catchment land use and loss of vegetation cover, the trapping of upper catchment sediment supplies behind the Peter Faust Dam, extensive sand and gravel extraction from the Proserpine River channel in recent decades and the increased sediment trapping efficiency of the river channel associated with riparian vegetation (grassy and woody) colonisation under regulated dry-season base flows. The contribution of all of these factors to the longer term dynamics of the coastal geomorphology of the plan area require further analysis before definitive statements could be made regarding the existence or potential future impacts of regulated flows on the condition of the coastal and marine environment.

4.8.2 O'Connell and Andromache river catchments

Some of the broader marine system values identified for the Proserpine River, such as fisheries productivity, mangrove and seagrass fishery nursery habitats and habitat for marine species of conservation interest (i.e., estuarine crocodiles, dugong and marine turtles) also apply to the O'Connell River system (see Chapter 5) but others do not.

In contrast to the Proserpine River system the lower estuarine reaches of the O'Connell River do not retain good condition riparian vegetation or a contiguous high value remnant floodplain wetland complex, although retained mangrove areas do abut and form part of the mapped Goorganga Plain wetland (Blackman et al. 1999). Agricultural development has also extended up to and in some cases into these coastal mangrove vegetation communities.

The O'Connell River is not dammed and retains relatively 'natural' flow and sediment discharge characteristics, albeit modified to some degree by water and sand and gravel resource extraction patterns within the basin.

4.9 Other threatening processes (non-flow related)

The majority of non-flow related ecological condition-threatening processes have been referred to in the preceding discussion on aquatic and flow dependent ecosystems of the Proserpine River basin. Although these threatening processes may be described separately, they are not mutually exclusive and have significant interaction effects, including with flow based processes. To summarise, they include the following events.

4.9.1 Vegetation clearing

As described above, between 40 and 60 per cent of the Proserpine River catchment's natural vegetation cover and approximately 50 per cent of the O'Connell River's natural vegetation cover have been cleared and replaced with pasture, crops and more intensive land uses. The impact of this on the condition of aquatic and flow dependent ecosystems occurs primarily through altered runoff and landscape water balance characteristics, including groundwater recharge behaviour, elevated sediment and diffuse nutrient loads delivered to the river system. Most of the vegetation clearing within the basin has occurred in past decades and the potential for further clearing is significantly reduced under new state vegetation management legislation. Relatively recently cleared floodplain areas on sodic soils in the upper Goorganga and Lethe Brook subcatchment appear to present condition impact risks to adjoining drainages.

Clearing on sodic soils has also occurred in the tributary Boundary Creek system that drains to the mid reaches of the O'Connell River. Elevated conductivity measurements within this subcatchment may herald changes in landscape water balance and salt mobilisation associated with this clearing. Several areas of alluvial terraces and adjoining plains of the mid Andromache and O'Connell rivers also appear to have been relatively recently cleared (less than 10 years before the present) and may result in ongoing erosion and mobilisation of sediment to the system if wetter periods return to the basin.

4.9.2 Riparian clearing

Vegetation clearing within the riparian zone has perhaps the greatest potential to create direct impacts on in-stream and flow dependent ecosystem condition. In addition to the complete removal of drainage line vegetation observed on some lower order creek systems referred to above, examples of past catchment clearing extending into the riparian zone with consequent impact to bank stability and in-stream habitat condition were also observed in a number of drainage systems within the Proserpine River catchment area, including lower and mid reaches of the Proserpine River and mid reaches of Myrtle Creek. In the O'Connell and Andromache catchment, examples of past catchment clearing extending into the riparian zone included the complete removal of drainage line vegetation observed in upper Boundary Creek (see above) and occurred in a number of reaches throughout the O'Connell basin and its other tributaries and the lower to mid reaches of the Andromache and its tributaries.

4.9.3 Land use

Land use is ultimately the primary driver of the majority of threatening processes affecting aquatic and flow dependent ecosystems and is also directly linked to flow related condition impacts through associated surface and groundwater resource use. In addition to the direct impacts of vegetation clearing referred to above, the other key non-flow related land use impacts are associated with the management of land following clearing and development in terms of 'off-farm' (or 'off-settlement') exports of contaminant loads to the river system. Principal among these contaminants is sediment derived from soil erosion associated with grazing stock, land development or tillage practices, nutrients associated with sediments or derived from agricultural fertilisers, domestic animals and human populations and chemical contaminants associated with industry and pesticide use. All of these risk factors were observed within the Proserpine, O'Connell and Andromache river catchments, and modelled data (NLWRA 2002; ACTFR 2004) suggests significantly elevated nutrient and sediment loads associated with land use in these basins.

In terms of measured water quality impacts within the plan area, elevated nutrient loading associated with agricultural runoff, STP and industrial (sugar mill) discharges would appear to be the most significant, with elevated nutrient levels recorded in the Proserpine and Kelsey Creek systems (discussed above) almost certainly having land-use (including urban) origins and in the case of irrigated agriculture sources a 'water use' origin. For the O'Connell and Andromache catchments, elevated nutrient loading associated with agricultural and pastoral land runoff would appear to be the most significant factor.

The potential for these elevated nutrient levels to cause eutrophication impacts is partially dependent on interactions with flow. Water quality data, macrophyte masses and algal scum observed within the lower reaches of the Proserpine and Lethe Brook systems and the mid and lower reaches of the O'Connell and Andromache rivers would suggest that some ecosystem condition impacts are attributable to elevated nutrients derived from land-use sources.

Another form of land or natural resource use that has more directly impacted stream condition within the Proserpine River is sand and gravel extraction. Although this resource exploitation has now ceased, historic sand and gravel extraction has left a legacy of deep in-stream excavations and incision and armouring of the low flow channel (FSI 1999). Some of these excavated areas now have ecological values in terms of providing deepwater fish habitats. Sand and gravel extraction operations were phased out of the Proserpine River following the FSI 1999 study.

4.9.4 Nutrient loading

As discussed above, elevated nutrient loads within the basin have their origins primarily in land-use practices and are a significant management issue in terms of maintaining the condition of aquatic and flow dependent ecosystems within the plan area, particularly for the O'Connell and Andromache catchment that appears to be stressed by low flows and water extraction levels.

4.9.5 Soil and bank erosion

Soil and bank erosion are also essentially land-use issues. Although soil and bank erosion appeared much less prevalent in the Proserpine River basin than the O'Connell River basin, areas of higher risk and existing erosion were observed in the Proserpine basin, including cleared banks and riparian levees of the mid and lower Proserpine River and Myrtle Creek, heavily grazed channels on Goorganga Creek, cleared flood flow paths on the Proserpine floodplain and more recently cleared areas on sodic soils in floodplain areas of the upper Goorganga and Lethe Brook subcatchments.

Several examples of significant bank erosion were observed within the O'Connell and Andromache catchment, particularly the mid Andromache and upper tributaries (i.e., Mares Nest Creek, And-1, And-2), and the lower and uppermost O'Connell (OC-1, OC-4). The consequences of this erosion were apparent in terms of elevated bed loads, aggraded channels, reduced pool depth, reduced channel heterogeneity and available nutrients, including phosphorous.

In-stream sand and gravel extractions have impacted the bed of the O'Connell River (refer FSI 1999), but the impact is not as extensive as that observed for the Proserpine River.

4.9.6 Invasive and translocated species

As noted above, much of the plan area was notable for the generally moderate levels of weed infestation, particularly by canopy invading riparian species or floating aquatic species and for the generally low level of exotic aquatic biota, including freshwater fish.

The most significant weeds in the plan area in terms of existing condition impacts to aquatic and flow dependent ecosystems were aquatic and riparian grasses, including guinea grass, elephant grass, para grass, hymenachne and alemen grass. In the case of the former two riparian grass weeds there is a significant impact interaction with fire and grazing, and in the case of the latter aquatic grass weeds a significant impact interaction with grazing and flow, with large flows required to reduce infestation levels through scouring or sustained inundation. All of the grass weeds were most significant in ungrazed stream reaches of the plan area.

4.9.7 Fire regime

In a seasonal environment such as the plan area, fire regime (frequency, season and intensity) is a major driver of ecosystem condition. Factors that affect fuel loads (i.e., grazing and understorey vegetation type) have major interacting effects on fire regime. Within the plan area the predominant impact of fire regime on flow dependent ecosystems was that of too-frequent and intense fires associated with ungrazed exotic pasture grasses impacting fire sensitive riparian vegetation communities. This condition impact was prevalent through almost all ungrazed stream reaches (i.e., agricultural areas, although the advent of green cane trash blanketing in the sugar industry appears to have reduced the frequency of hot fire events in recent years) and in many areas dense recruitment of riparian canopy species was occurring in areas infested with these grasses.

Alternatively, reduced fire frequency on grazed and exotic pasture dominated floodplain wetland areas (i.e., Goorganga Plain) was also observed to be generating ecological condition impacts apparent in terms of woodland thickening and loss of native groundcover and wetland species to dominance by fire-sensitive ponded pasture species.

4.10 Six Mile Creek

Field time constraints did not permit a site visit to Six Mile Creek and the following observations are based on interpretation of 1998 aerial photography. Six Mile Creek has its origins in overbank flow distributary drainage depressions that drain the back levee of the northern bank of the middle Proserpine River near reach PR-4. The defined channel drains towards the north-east to the Bruce Highway before turning to the north and joining the Gregory River. The system receives regulated flows in its uppermost reaches and acts as a conduit for irrigation water, supplying adjoining cane farms extending to the north of the Bruce Highway with surface water supplies.

4.10.1 Condition

The uppermost reaches of the creek are in poor ecological condition having been cleared of all riparian vegetation and essentially reduced to a farm drainage channel. Downstream from this point condition improves to a relatively contiguous (albeit narrow) riparian vegetation corridor dominated by rainforest associated species extending to the rail line. Between the rail line and the Bruce Highway the stream channel and riparian corridor becomes wider, though canopy cover is more broken. An understorey of exotic pasture grasses (guinea grass and para grass) extends into and along the entire length of the corridor, presenting hot fire risks and limiting natural recruitment processes. North of the highway the riparian vegetation corridor broadens to include ecotonal dry sclerophyll vegetation and an apparently better developed canopy cover is present. Banks dominated by exotic grasses and a broken canopy cover occur immediately adjacent and north of the highway. Channel hosted pools are also visible in this lower reach, though such features (albeit smaller scale) would be assumed to be present beneath the canopy cover of upper reaches. The confluence of Six Mile Creek and the Gregory River appears to be adjacent to the upstream limit of estuarine influence. Water quality conditions within the Six Mile Creek system are likely to be periodically impacted by exotic grass infestations driving organic loading and water column smothering, though this may be mitigated to some degree by the effect of regulated flows and riparian shading preventing grass infestation in all reaches.

4.10.2 Values

The primary values of Six Mile Creek include:

- relatively diverse rainforest-associated riparian vegetation
- wildlife habitat corridor in intensive agricultural landscape (although the potential value of this creek as a wildlife corridor is limited by its isolation from hilly habitat remnants that occur adjacent to its uppermost reaches)
- ecotonal riparian vegetation (lowermost reaches)
- perennial freshwater aquatic habitats and refugia.