

REPORT

Community based water quality monitoring in the Katherine/Daly River region, 2005



Table of Contents

Acknowledgements.....	3
1. Introduction	4
1.1 Top End rivers and potential impacts	4
1.2 Aim of the study.....	5
1.3 Purpose of this report.....	5
2. Methods	6
2.1 Background to AUSRIVAS	6
2.2 AUSRIVAS in the Northern Territory	7
2.3 Selection of sites	9
2.4 Macroinvertebrate sorting and identification method	9
3. Results.....	11
3.1 AUSRIVAS site assessment.....	11
3.2 Macroinvertebrate diversity and abundance in 2005	12
3.3 Water quality results	21
4 Discussion.....	24
4.1 Taxa diversity and abundance.....	24
4.2 Sub-catchment summary.....	24
4.3 Conclusion.....	25
References	26
Appendix 1 – Map of AUSRIVAS sites.....	27
Appendix 2 - Taxa List from 2005 sampling.....	28

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1. Introduction

1.1 Top End rivers and potential impacts

Rivers in the Top End of the Northern Territory are considered to be relatively healthy compared to their southern counterparts. Native vegetation is still largely intact and impacts apart from pastoral activity are only slight (Dostine 2002). There are no major dams (Darwin River Dam and Manton Dam are a few exceptions), which means that hydrological integrity between headwaters and river mouth is largely intact (Douglas *et al.* 2005). There is, however, a general paucity of information relating to river health, largely as a result of the inaccessibility of much of the countryside, especially during the wet season, and a lack of resources to investigate and monitor the rivers.

Mounting pressures in the Top End include increasing urbanisation in the greater Darwin region, expanding horticultural and agricultural industries, and the growth of the mining sector. It is hoped that community water monitoring programs may be able to involve people in gathering valuable scientific information on rivers and wetlands in the Top End before environmental pressures impact upon catchment health.

Top End surface waters, being largely ephemeral, receive most of their inflow throughout the monsoonal wet season before drying up to pools and billabongs throughout the dry. Several rivers provide exceptions to this pattern, specifically the Katherine, Daly and Roper Rivers, which are all spring fed throughout the dry season from extensive groundwater basins. This input of groundwater means that these rivers produce water all year round and therefore lie in the Top End's region of expanding primary industry where groundwater extraction and land clearing are the two major potential future impacts.

It has been estimated that close to 95% of native vegetation in the Daly River catchment is still intact (Douglas *et al.* 2005). As a result, the aquatic ecosystem is largely buffered from the effects of pollutants. However, the waters of the Daly¹ have naturally low levels of the nutrients nitrogen and phosphorous, instead being dominated by calcium and magnesium ions flowing from permanent springs in limestone aquifers (Blanch *et al.* 2005). This makes these waters very susceptible to the addition of pollutants from horticulture or agriculture, especially if land clearing removes native vegetation. Plans for agricultural expansion in the region over the next two decades may mean that increasing loads of sediment end up in the rivers and streams in the catchment, and nutrient addition from agriculture is likely to place a further demand upon the aquatic ecosystem. Monitoring river health within this catchment is a priority for natural resource management planners, government bodies and local stakeholders.

¹ In the Douglas River, Townsend *et al.* (2002) found inflow from the Tindal limestone aquifer recorded nitrate concentrations 100 times higher than the Daly. It has been suggested that nutrients originating from animal faeces such as bat droppings may be responsible, or possibly seepage of nitrogen into the groundwater from current or past application of fertilisers (Schult and Metcalfe 2006).

1.2 Aim of the study

The aim of this study was to re-sample as many as possible of the original AUSRIVAS (see section 2) sites within the Daly River catchment (DRC) so as to be able to compare current stream health data from 2005 with the original AUSRIVAS assessment of these sites in 1995 and 1996. Ten years is a lengthy time between environmental assessments and many of the sites within the DRC are coming under increasing development pressure. There is a high level of interest from local community groups and landholders in the ecological health of the streams and rivers within the catchment.

This study was undertaken as a collaborative effort between Greening Australia, local landowners and landcare groups. It is hoped that regular monitoring of the same sites will continue and baseline information can be gathered over time to allow for the observation of trends. Ongoing monitoring of sites within the catchment produces data integral to natural resource management processes, and also provides landowners with direct site assessment that can be translated into management actions when appropriate.

1.3 Purpose of this report

The purpose of this report is to:

- Explain AUSRIVAS and the use of the various models.
- Provide results from the 2005 sampling program using the **Darwin-Daly early dry season edge family level model**.
- Provide indirect comparative results for these same sites originally sampled in the 1995-1996 sampling program using the early Top End models.
- Produce graphs showing the diversity and abundance of macroinvertebrates found at the sites.

2. Methods

2.1 Background to AUSRIVAS

In 1994 an initiative called the National River Health Program was established by the Commonwealth Government to assess the ecological “health” of rivers throughout Australia. One of the programs, the Monitoring River Health Initiative, focused on developing models to predict stream health from a set of reference conditions. AUSRIVAS stands for Australian River Assessment System - it was developed Australia wide as a tool to assess the health of freshwater rivers and streams.

‘Organisms living in streams and rivers can tell us about the condition or “health” of waterways’ (Fortune and Drewry 2009). By studying the macroinvertebrates (or water bugs) the health of a stream can be assessed as being in near natural or pristine condition (good health) or impacted (poorer health). A range of macroinvertebrates live in a healthy stream – this is called the reference stream. If a test stream has a similar macroinvertebrate diversity to the reference stream, then it can be said to be in good health. If a test stream has a lower diversity of macroinvertebrates than the reference stream, it can be said to be in poorer health. Poorer health in an impacted stream can result from pollution or habitat loss for the macroinvertebrates.

An AUSRIVAS biological assessment of waterways in each jurisdiction across Australia was undertaken based on the macroinvertebrate community composition at reference sites. These reference sites set baseline conditions to which test streams, which may or may not be disturbed, could be compared.

Environmental variables were built into the models in the form of predictor variables which describe some habitat characteristics. Predictor variables are factors such as longitude and latitude, water velocity, depth, and physico-chemical parameters such as alkalinity, some of which need to be measured in the field. Other potential predictor variables include the distance of a site from headwaters or (spring-fed) source, catchment area and proximity to rainforest vegetation. They can be measured from topographic maps using GIS techniques. These variables allow the models to predict the expected macroinvertebrate community at a particular site.

2.2 AUSRIVAS in the Northern Territory

To produce the models in the Northern Territory, 99 reference sites and 100 test sites were sampled between 1995 and 1999. The reference sites were the ones used to produce the models and were distributed throughout many catchments in the Top End of the Northern Territory. Test sites were sampled later in the monitoring program and selected from the catchments that were under most development pressure, these being the Adelaide, Daly, Finniss and Darwin region catchments. As a consequence, assessment of stream health has been largely confined to these catchments alone (Dostine 2002). These early models are all referred to as “Top End” models.

The information gathered was used to develop 6 predictive “Top End” models:

- Early dry season edge habitat.
- Late dry season edge habitat.
- Early dry season sand habitat.
- Late dry season sand habitat.
- Combined season edge habitat.
- Combined season sand habitat.

Each model was assessed to see how well it:

- 1) described the taxa richness (abundance and diversity) found at a reference site, and
- 2) could predict the taxa richness that would be expected at a test site.

This assessment produced an Observed to Expected ratio of richness, the O/E score, where a value of 1 meant that the observed community structure was the same as the expected community structure at a site². Each model was based on looking at all the different test sites for taxa richness and comparing them to the reference sites.

Taxa richness from the reference sites produced a range of results and so test sites which showed taxa richness within 80% of this range were considered to be in good health and given a Band “A” assessment. Subsequent Bands, B, C and D, represent grades of paucity from reference condition, i.e. taxa richness which fell outside this 80% range. It was therefore also possible for a test site to be more biologically diverse than a reference site if it had far more taxa than were found at 80% of the reference sites. This Band was called Band X. For further information on AUSRIVAS please refer to their website <http://ausrivas.canberra.edu.au>

² The AUSRIVAS analysis only takes into account the taxa that were calculated to have a probability of 50% or more occurrence at a site. The O/E50 score is therefore the ratio of “the observed to expected number of taxa with a probability of 50% or greater of occurring” (Lamche 2007).

Table 1: Explanation of Bands

Band	Description	O/E Score	Interpretations
X	More biologically diverse than reference	O/E greater than 90 th percentile of reference sites used to create the model	More families found than expected. Potential biodiversity hotspot or mild organic enrichment. Continuous irrigation flow in a normally intermittent stream.
A	Similar to reference	O/E within range of central 80% of reference sites used to create the model	Expected number of families within the range at 80% of reference sites.
B	Significantly impaired	O/E below 10 th percentile of reference sites used to create the model	Potential impact either on water and/or habitat quality resulting in loss of families. Several families not recorded.
C	Severely impaired	O/E below Band B. Same width as Band A	Many fewer families than expected. Loss of water and/or habitat quality.
D	Extremely impaired	O/E below Band C down to 0	Few of the families expected, only the hardy, pollution tolerant families remain.

(Source: Coysh *et al.* 2000)

Each of the 6 models produced differing results for the O/E scores when the reference sites were analysed. In other words, their results for taxa richness were all spread out to varying degrees so that 80% of the range was different for each model tested. The **Top End combined season edge model** produced results which were the least variable and therefore a higher percentage of sites fell around the range of 1, being similar to the reference sites, than for all the other models (Dostine 2004). This model was therefore considered to be the best one to use to assess all the sampling sites.

The **Top End combined season edge model** was however still found to be relatively insensitive to regional differences and placed a greater than expected number of sites (nearly one-third) into the Band B category of “significantly impaired” when many of these sites were small streams or upper reaches of large rivers that were very remote and could not have had any known impacts affecting them. It was recommended that a further model be developed for the Darwin-Daly region specifically, as this is where the majority of current and proposed potential impacts were and will be occurring. The Darwin-Daly region is made up of the catchments of the Mary, Adelaide, Finnis and Daly Rivers as well as several smaller rivers which drain into Darwin harbour. The region includes the city of Darwin and the town of Katherine. The Daly-Douglas area in particular has a very high potential for agricultural development and potential impacts within the Daly River catchment (Dostine 2004).

The first regional Darwin-Daly model was based on genus-level identification of macro-invertebrates and is considered very sensitive at detecting changes to stream health (Dostine 2004).

A second model based on family-level identification (the **Darwin-Daly early dry season edge family level model**) was also developed and, although not quite as sensitive, provides very useful baseline information on macroinvertebrate community structure within rivers and streams of the Darwin-Daly region (Lamche and Fukuda 2008). Ongoing family-level data will build up a picture of the health of the aquatic habitats and assist with detecting impacts from proposed development pressures. The family-level model is less resource intensive than the genus-level model and therefore able to be undertaken by a non-government organisation such as Greening Australia in collaboration with Landcare and community groups. Both genus and family level models are based on sampling an edge habitat in the early dry season.

2.3 Selection of sites

Only the sites from the Daly River Region that were sampled during the early dry season can be analysed through the **Darwin-Daly early dry season edge family level model**. Predictor variables for this model are: latitude, longitude, rainforest vegetation within 500m and stream width. Alkalinity is a predictor variable for the original Top End early dry and late dry season and combined edge models. Alkalinity was not measured during the 2005 sampling program and therefore the original Top End model could not be used to provide a direct comparison for the 2005 data. An indirect comparison can however be made using the **Darwin-Daly early dry season edge family level model** with the 2005 data and this information can be compared to the original **Top End combined season edge model** results for the same sites sampled back in 1995 and 1996.

In 2005, 14 of the original sites from the Daly River catchment were re-sampled by landowners and landcare groups in collaboration with Greening Australia, a further 4 new sites were also sampled at the request of landholders. 6 of the original sites were not re-sampled due to access issues.

11 of the sites had enough data from both sampling periods to allow for the AUSRIVAS indirect comparison to be made. However macro-invertebrate and water quality information from all of the sites sampled has been included where possible for future reference.

Table 2 provides a summary of the sites. The map at Appendix 1 shows the original AUSRIVAS sites.

2.4 Macroinvertebrate sorting and identification method

Macroinvertebrates were collected in the field using AUSRIVAS methodology. Macroinvertebrates collected from all sites were sorted in a laboratory using a stereo-microscope following standard AUSRIVAS sorting protocols. A sub-sample of approximately 2% is taken and sorted and progressive sub-samples added until a total of 200-220 animals are identified. Taxa are identified to family level except for water mites (Acarina) and worms (Nematoda and Oligochaeta). Sometimes the animals are too immature and small to be identified to the required level.

Table 2: Summary of sites and sampling undertaken

Code	Original AUSRIVAS	New sites 2005	Site	2005 AUSRIVAS	1995/6 AUSRIVAS	2005 macroinvertebrates	2005 water quality	1995/6 water quality
DA01	X		Daly River Dorisvale Crossing	X	X	X	X	X
DA02	X		Fergusson River Stuart Highway Crossing			X	X	
DA02.5		X	Katherine River Southern Rockhole			X	X	
DA03	X		Katherine River d/s Gorge crossing to 17 Mile Creek			X	X	X
DA03.5		X	Katherine River Knotts Crossing			X		
DA04	X		17 Mile Creek Crossing to Edith Falls					X
DA05	X		Flora River Kathleen Falls	X	X	X	X	X
DA06	X		Katherine River u/s Sewerage Operations					X
DA07	X		Daly River Beeboom Crossing					X
DA08	X		Daly River Mt Nancar	X	X	X	X	X
DA09	X		Daly River Ooloo Crossing	X	X	X	X	X
DA10	X		Douglas River u/s Ooloo Rd crossing	X	X	X	X	X
DA10.8		X	Edith River Plunge Pool			X	X	
DA11	X		Edith River u/s Mt Todd	X	X	X	X	X
DA12	X		Edith River d/s Mt Todd	X	X	X	X	X
DA13	X		Stray Creek Umbrawarra Gorge	X	X	X	X	X
DA14	X		Douglas River Butterfly Gorge	X	X	X	X	X
DA14.5		X	Douglas River Tippera			X	X	
DA15	X		Douglas River Crystal Falls	X	X	X	X	X
DA16	X		Douglas River Hot Springs			X	X	
DA17	X		Green Ant Creek					X
DA18	X		Fish River u/s Road Crossing					X
DA19	X		Copperfield Creek	X	X	X	X	X
DA20	X		Katherine River Eva Valley Road					X

3. Results

3.1 AUSRIVAS site assessment

AUSRIVAS results from the 2005 macroinvertebrate sampling are given in Table 3. All sites but one were assessed in reference condition. The obtained AUSRIVAS scores provide information on stream health but do not ascribe cause of impact if impairment (a reduced score) is noted (Lamche 2007). The Flora River was assessed as significantly impaired.

Table 3: Darwin-Daly early dry season edge family level model (2005)

Site Code	Site	O/E score	Band
DA01	Daly River Dorisvale Crossing	0.93	A
DA05	Flora River Kathleen Falls	0.53	B
DA08	Daly River Mt Nancar	0.83	A
DA09	Daly River Ooloo Crossing	0.94	A
DA10	Douglas River u/s Ooloo Road Crossing	0.98	A
DA11	Edith River u/s Mt Todd	1.07	A
DA12	Edith River d/s Mt Todd	0.99	A
DA13	Stray Creek Umbrawarra Gorge	0.90	A
DA14	Douglas River Butterfly Gorge	0.98	A
DA15	Douglas River Crystal Falls	1.04	A
DA19	Copperfield Creek	0.99	A

The results from previous sampling (Table 4) are variable but the overall picture is quite similar. The differences in band allocation (ie. DA12, DA13 and DA19) can not be interpreted as a change in condition as another AUSRIVAS model was used. Only the use of the same AUSRIVAS model for the 2 data collections would allow for the assessment that the condition of a site has improved or decreased in the ten years between sampling.

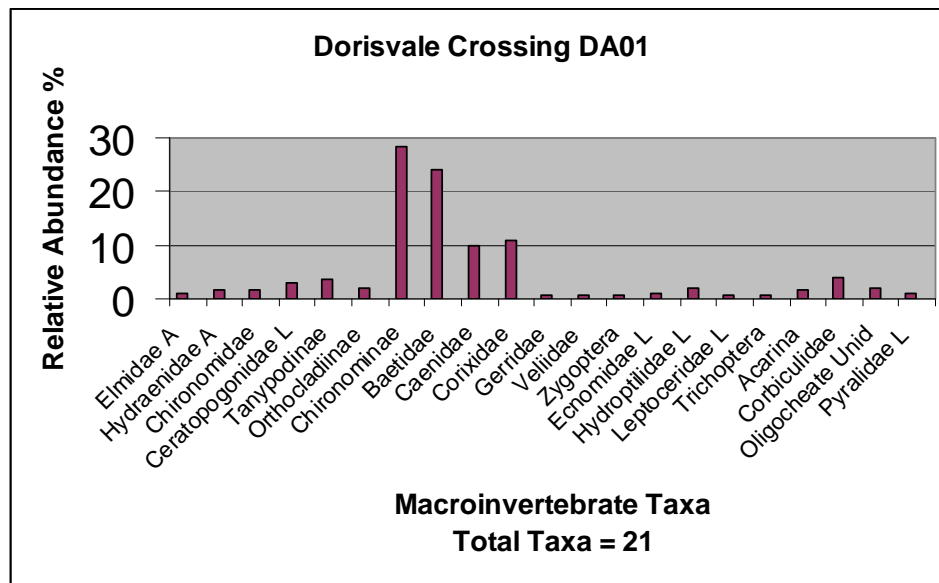
Table 4: Top End combined season edge model (1995-1999)

Code	Site	O/E	Band
DA01	Daly River Dorisvale Crossing	0.96	A
DA05	Flora River Kathleen Falls	0.84	B
DA08	Daly River Mt Nancar	1.08	A
DA09	Daly River Ooloo Crossing	1.03	A
DA10	Douglas River u/s Ooloo Road Crossing	1.02	A
DA11	Edith River u/s Mt Todd	1.05	A
DA12	Edith River d/s Mt Todd	1.19	X
DA13	Stray Creek Umbrawarra Gorge	0.83	B
DA14	Douglas River Butterfly Gorge	0.97	A
DA15	Douglas River Crystal Falls	1.02	A
DA19	Copperfield Creek	0.79	B

(Source: Dostine 2002)

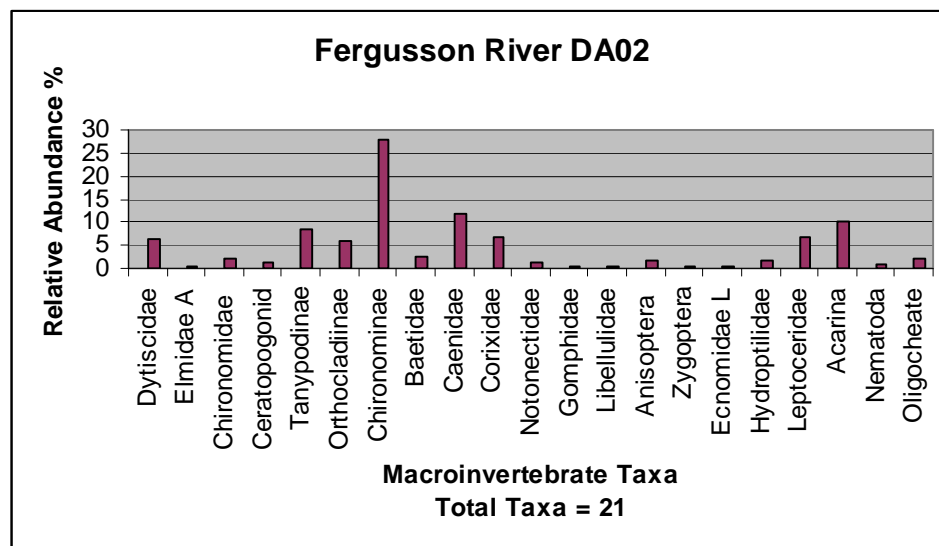
3.2 Macroinvertebrate diversity and abundance in 2005

Graph 1: Daly River Dorisvale Crossing DA01



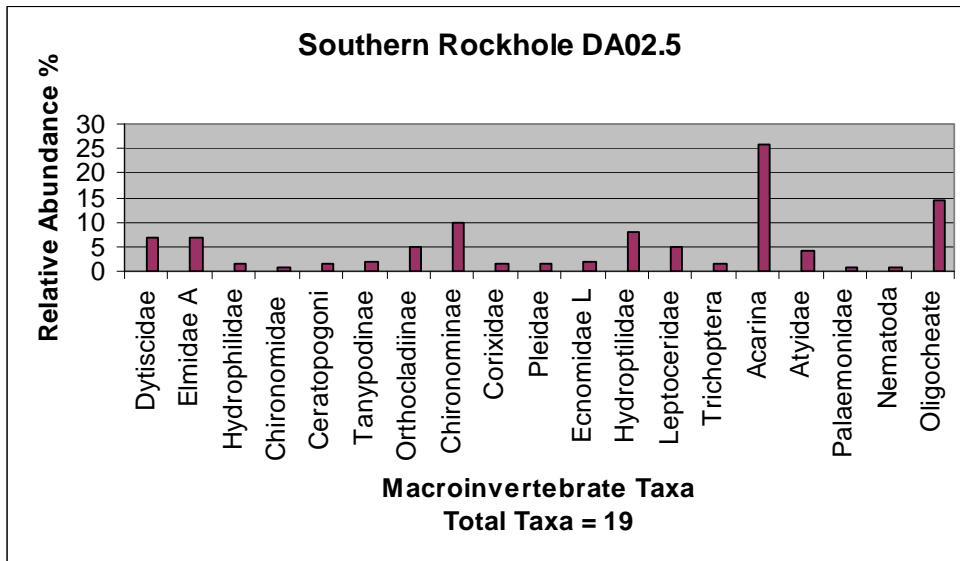
A total of 21 taxa were found at Dorisvale Crossing. Data is shown only for macroinvertebrate percent relative abundance. A sub-family of Chironomidae (Chironominae) is the most abundant taxon, followed by the Baetidae family of mayflies and Corixidae family of water bugs. Chironominae are non biting midges who feed on algae and bacteria in soft sediments. The family Chironomidae is often one of the most abundant families found at sites and was the dominant group found in the middle reaches of the Daly during an earlier study.

Graph 2: Fergusson River Stuart Highway Crossing DA02



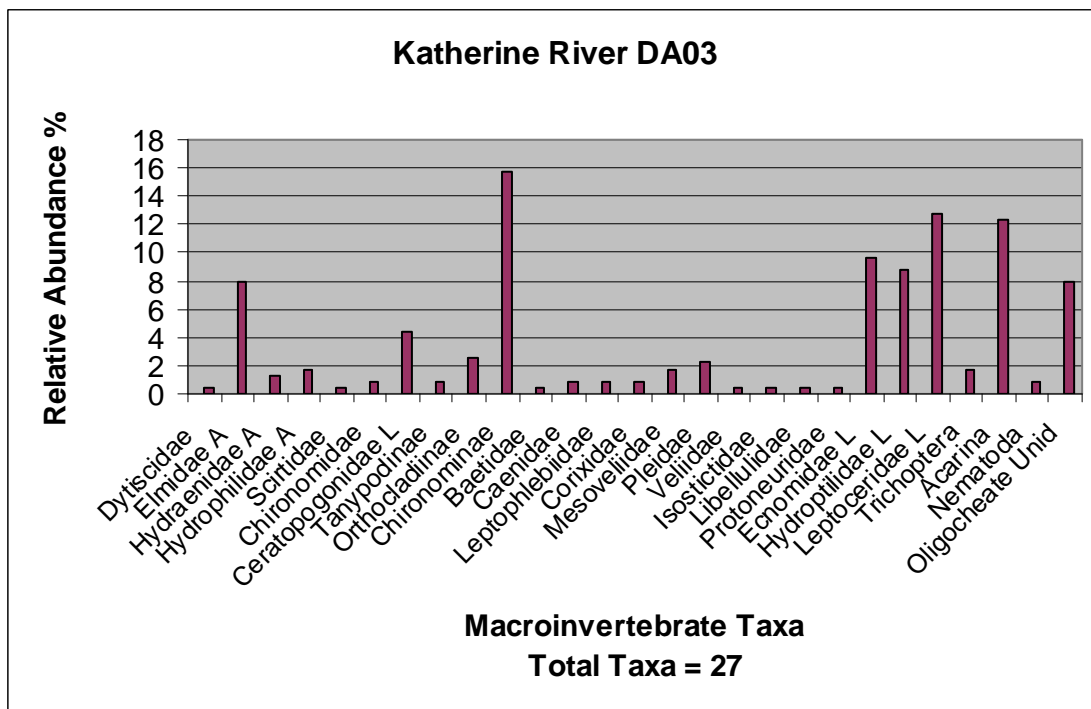
A total of 21 taxa were found for the Fergusson River site. Overall abundance at this site is relatively good with representation of many taxa. A sub-family of Chironomidae (Chironominae) is the most abundant taxon, followed by the Caenidae family of mayflies and Acarina order of water mites. Water mites are sensitive to pollutants in water especially heavy metals (Corangamite Waterwatch 2006).

Graph 3: Katherine River Southern Rockhole DA02.5



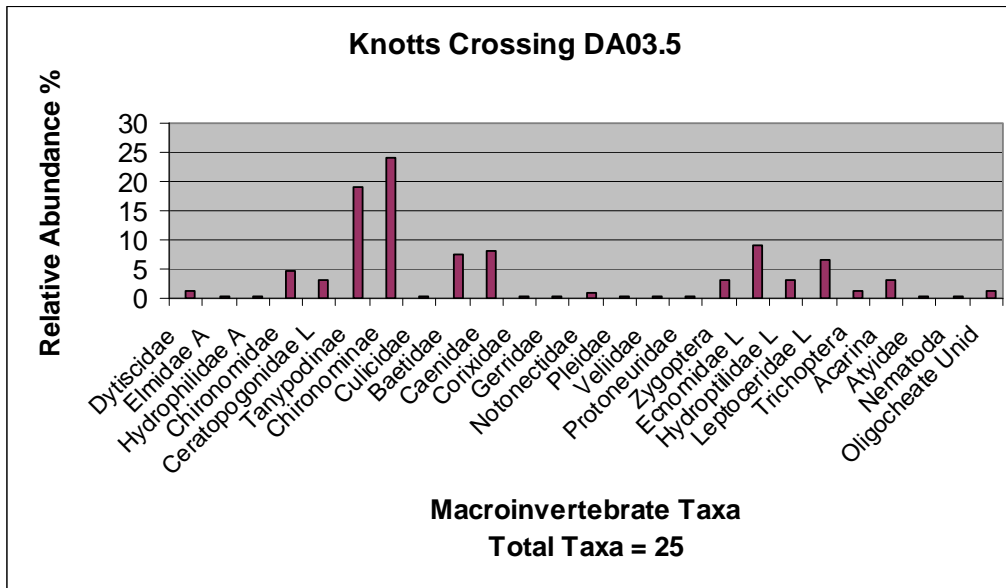
A total of 19 taxa were found at this site. Acarina (water mites) were the most abundant taxon followed by the Oligochaeta (worms) and Chironominae (non biting midges) taxa. This site is only one of a few to record the presence of Atyidae (prawns). Freshwater prawns breathe through gills located at the base of their legs. They can be collected in large numbers when sampling takes place during their migration along the river system.

Graph 4: Katherine River downstream Gorge, crossing to 17 Mile Creek DA03



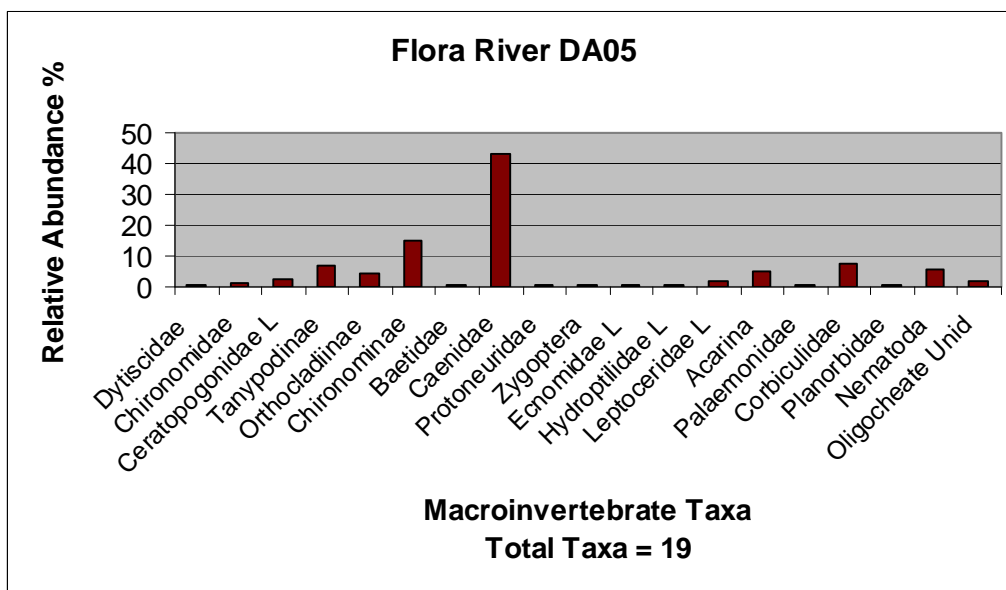
A total of 27 taxa were found at this site. The most abundant taxon is Chironominae (non biting midge) followed by Leptoceridae (caddisfly) and Acarina (water mites) taxa. Good populations of Elmidae (beetles), Ecnomidae (caddisfly), Hydroptilidae (caddisfly) and Oligochaeta (worms) were also present.

Graph 5: Katherine River Knotts Crossing DA03.5



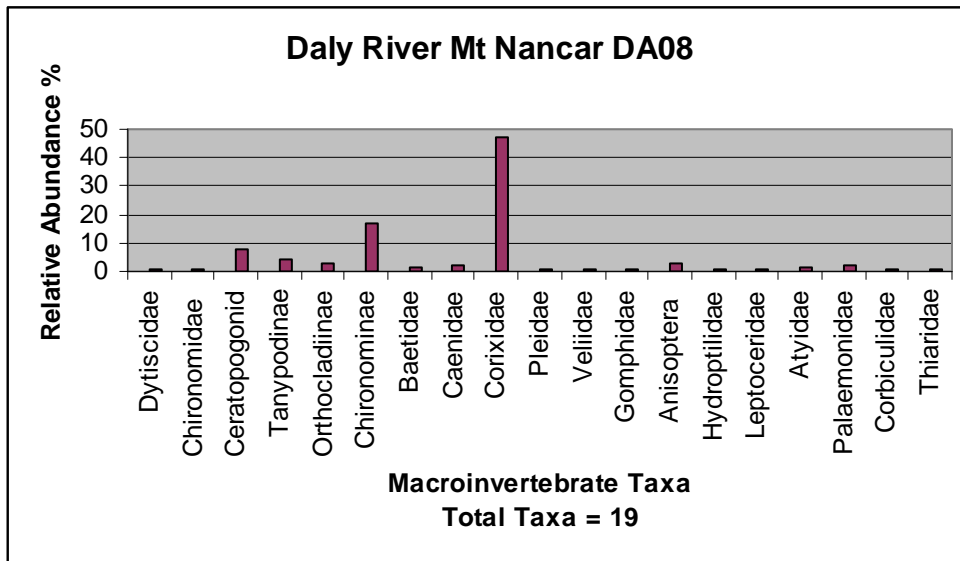
The total taxa found for this site was 25. Again Chironominae (non biting midge) were the most abundant taxa followed by Tanypodinae (fly) taxon. Two families of Ephemeroptera (mayflies)- Baetidae, Caenidae and Trichoptera (caddisflies) – Ecnomidae, Leptoceridae were also present in large numbers. (Site 4 was not sampled during this run).

Graph 6: Flora River Kathleen Falls DA05



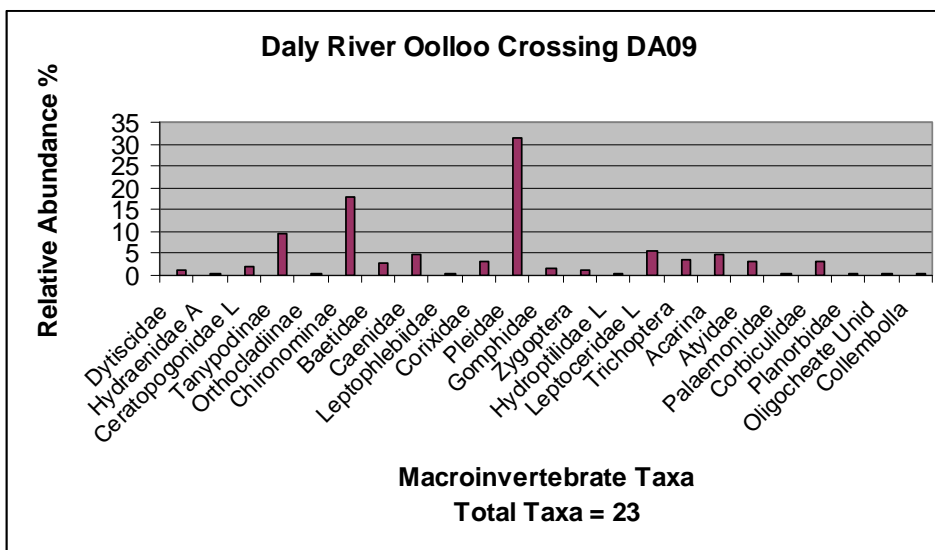
This site rated impaired (Band B) in the AUSRIVAS analysis. The macroinvertebrate community was dominated by Caenidae (mayfly). Mayflies spend most of their life in the water as a nymph. Also of interest was the presence of the taxon Corbiculidae a small bivalve mollusc. A total of 19 different taxa were found at this site showing lower diversity contributing to the lower AUSRIVAS score. This site was characterized by high calcium carbonate which provides a different habitat quality. This is a possible reason for this site to produce a lower AUSRIVAS score although the site appears pristine and might be so. (Sites DA06 and DA07 were not re-sampled during the 2005 run due to access issues).

Graph 7: Daly River Mt Nancar DA08



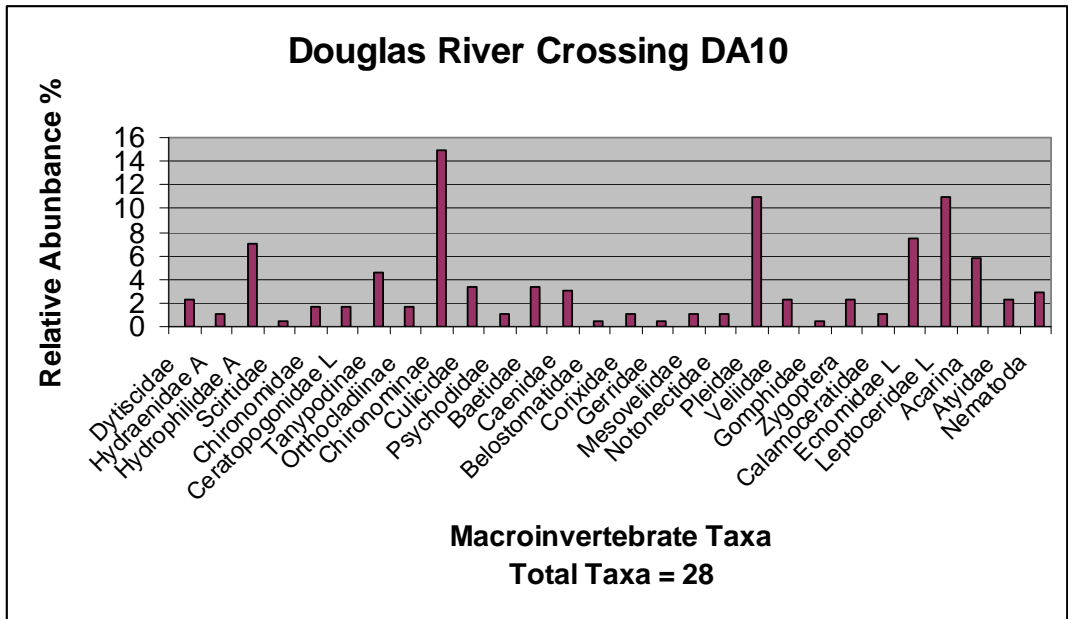
This site was heavily dominated by the Corixidae (water boatmen). Once again Chironominae occurred in relatively high abundance followed by Anisoptera (dragonfly) larvae. Overall, abundance at this site was low compared to other sites.

Graph 8: Daly River Oolloo Crossing DA09



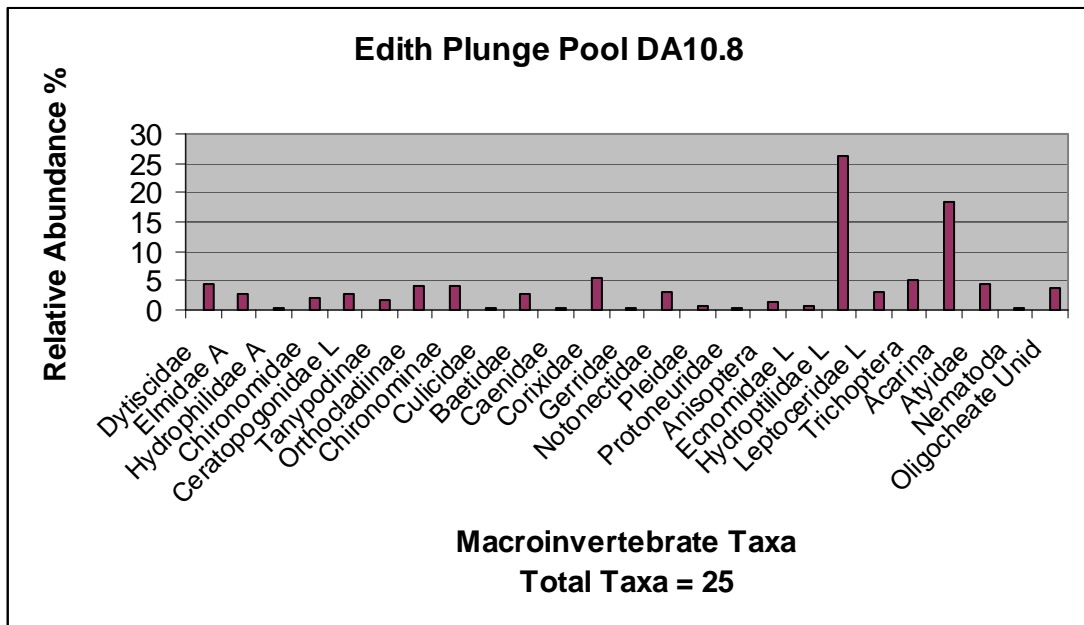
The Oolloo Crossing site recorded the highest numbers for Pleidae, the small pygmy backswimmer followed by two sub-families of Chironomidae; the Chironominae and Tanypodinae. The macroinvertebrate community was found to be diverse.

Graph 9: Douglas River upstream of Oolloo Road Crossing DA10



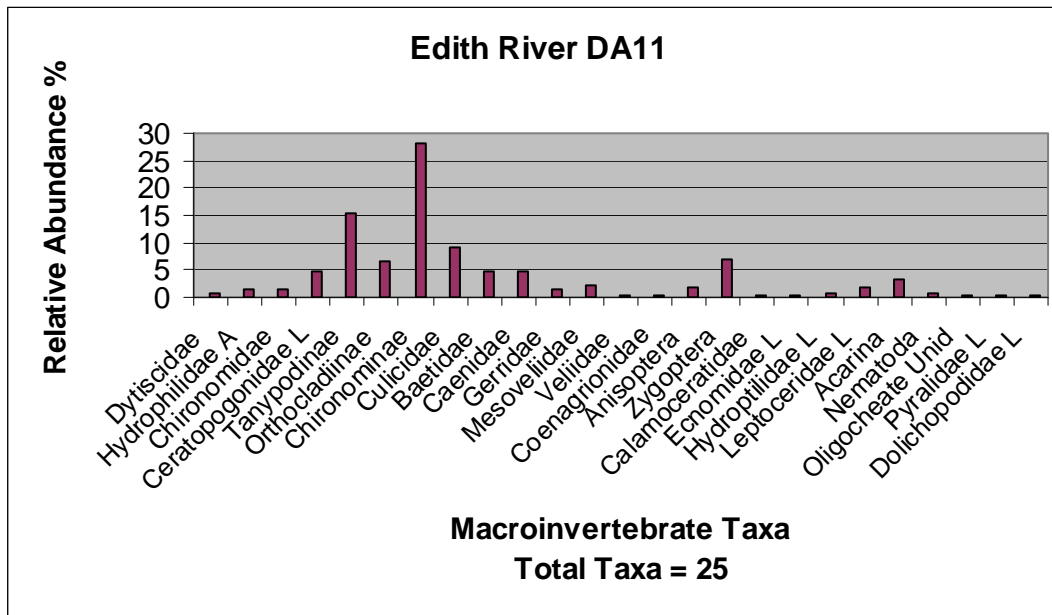
This site showed a very diverse range of animals with 28 taxa recorded from the site. The dominant macroinvertebrates are Chironominae (non biting midge), Pleidae (small pgymy backswimmer), and the caddis-fly families, Leptoceridae, and Ecnomidae. Abundance of animals is fairly evenly spread over the range of animals found.

Graph 10: Edith River Plunge Pool DA10.8



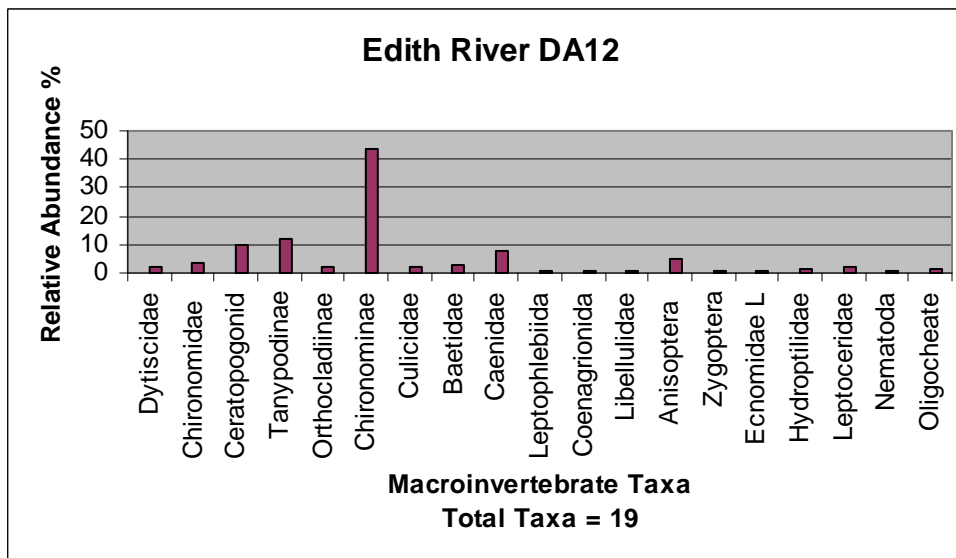
This site showed a diverse range of taxa with 25 recorded. The most abundant taxon is the Hydroptilidae (caddisflies) followed by Acarina (water mites). Diversity was high at this site with two dominant taxa the remaining ones being relatively evenly distributed.

Graph 11: Edith River upstream Mt Todd DA11



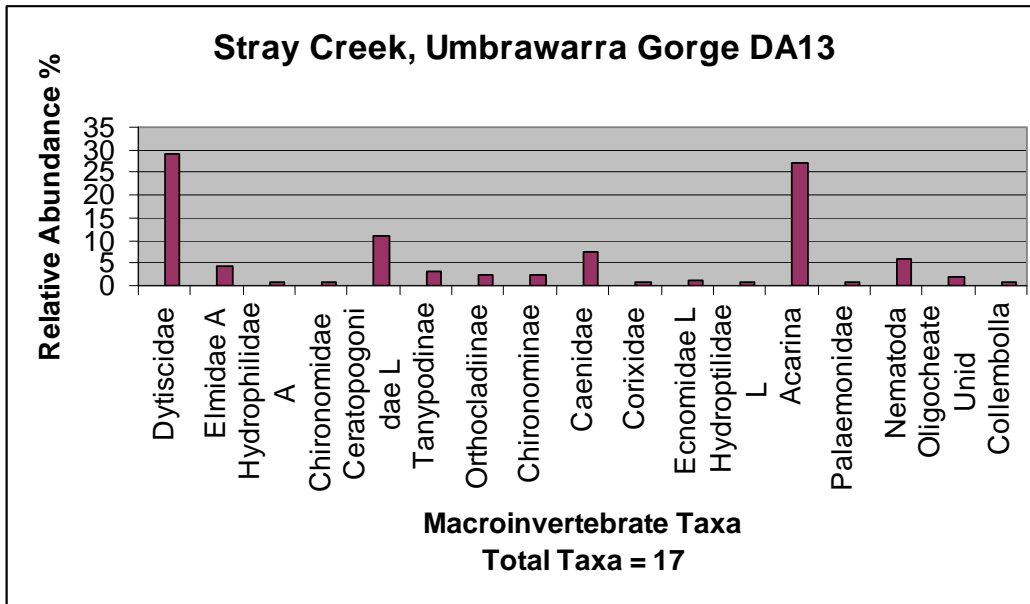
This Edith River site was dominated by Chironominae and Tanypodinae, the non biting midges; Culicidae or Mosquito larvae were also found in relatively high numbers. Two families of mayfly, Baetidae, Caenidae were present in higher numbers as well. Of interest this site recorded the highest relative abundance of Zygoptera (damselflies). Diversity was high with 25 taxa in total while overall relative abundance of the remaining taxa was evenly spread.

Graph 12: Edith River downstream Mt Todd DA12



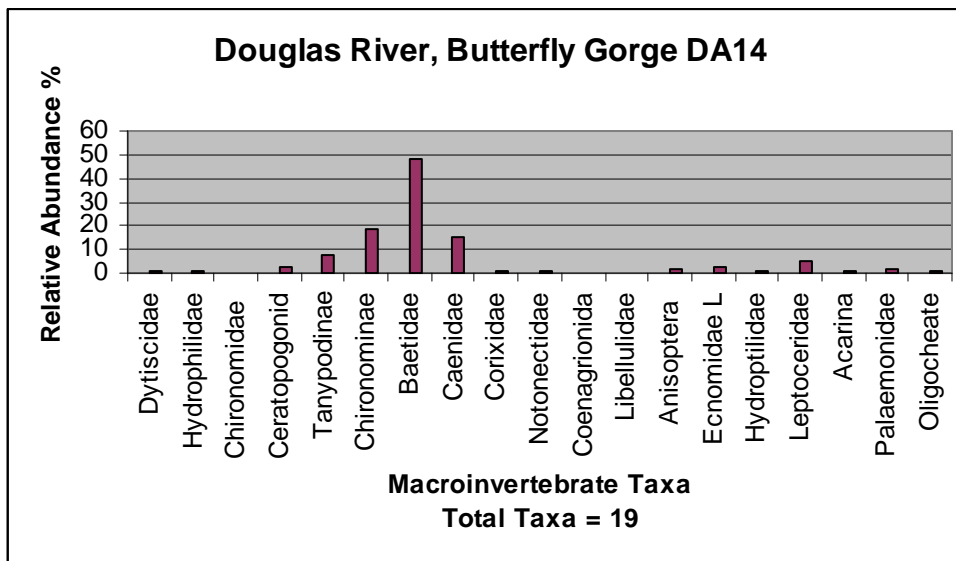
The downstream Edith River site was also dominated by Chironominae in very high numbers, followed by Tanypodinae and the sand flies (Ceratopogonidae). Of interest this site is one out of two to record the presence of Anisoptera (dragonflies).

Graph 13: Stray Creek Umbrawarra Gorge DA13



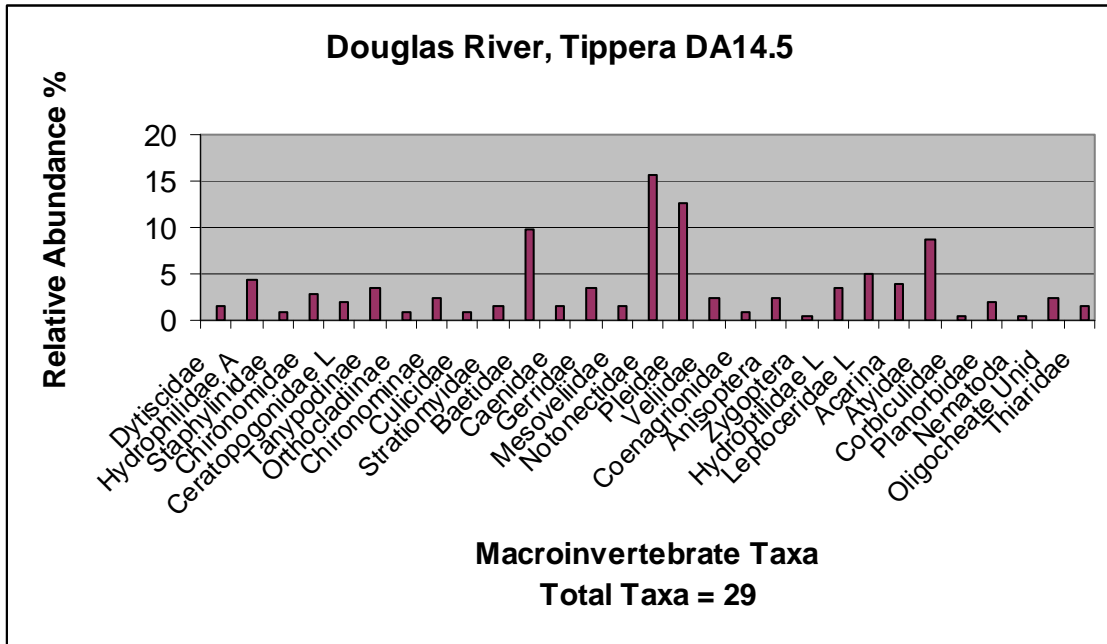
Stray Creek had high abundance of Dytiscidae (beetles) and Acarina (water mites). Ceratopogonidae (sand flies) were the next most abundant macroinvertebrate. Overall the diversity of macroinvertebrates was low with 17 taxa recorded.

Graph 14: Douglas River Butterfly Gorge DA14



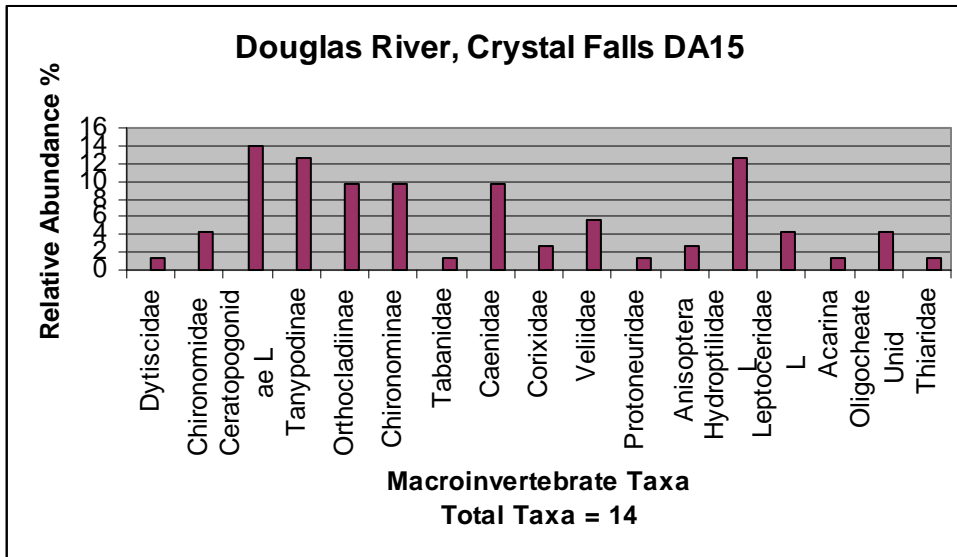
Butterfly Gorge had a very high abundance of the taxa Baetidae as well as Caenidae (mayflies). Mayflies prefer cooler habitats with clear flowing water and are therefore abundant in higher streams of the country (CSIRO 2009). Apart from the Chironomidae abundance and diversity of other taxa was relatively low.

Graph 15: Douglas River Tippera DA14.5



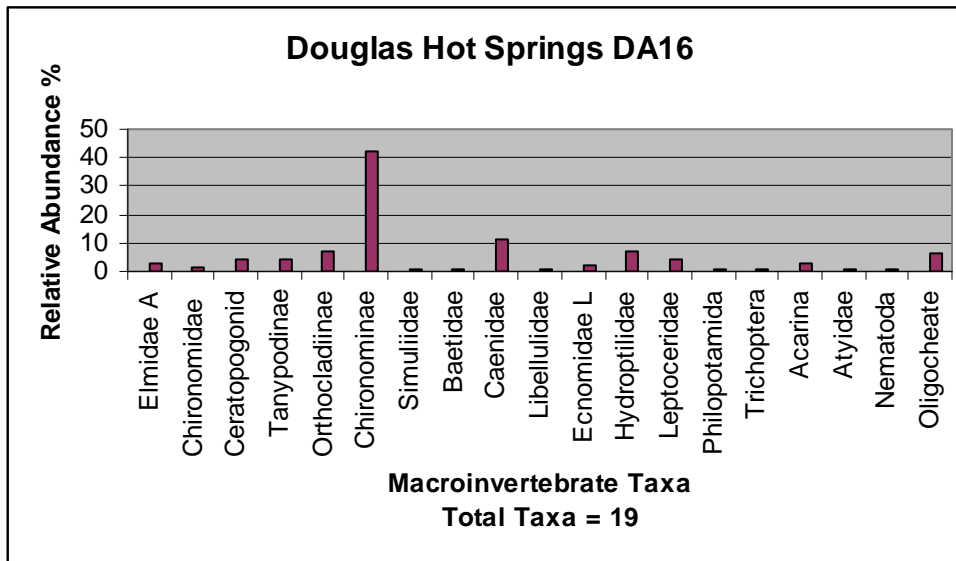
Tippera recorded the highest diversity of all sites with 29 taxa present. The most abundant taxa were Notonectidae (backswimmer) followed by Pleidae (small pigmy backswimmer). Baetidae (mayflies) and Atyidae (prawn) were also relatively abundant at this site. Overall, abundance was relatively even throughout the taxa present.

Graph 16: Douglas River Crystal Falls DA15



Ceratopogonidae (sand flies) are the most abundant taxa found at this site, followed by the three Chironomidae subfamilies Chironominae, Tanypodinae and Orthocladinae and Baetidae (mayflies). The remaining macroinvertebrate taxa are relatively evenly abundant however the total taxa number of 14 is rating the lowest compared to all other sites.

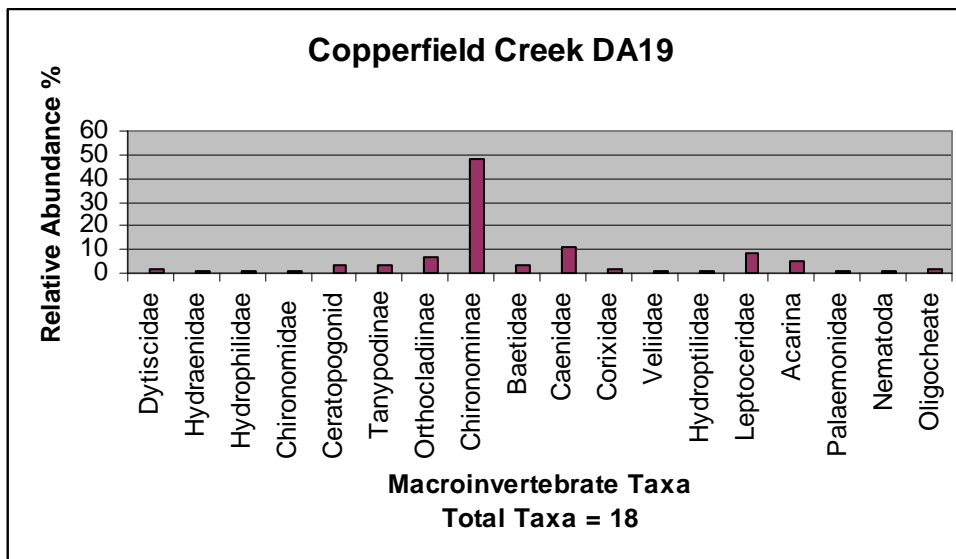
Graph 17: Douglas River Hot Springs DA16



This site recorded a total of 19 taxa. The community was dominated by the Chironominae (non biting midge). Abundance was low for all other taxa present at the site.

(Sites 17 and 18 were not re-sampled during this 2005 run due to access issues).

Graph 18: Copperfield Creek DA19



Copperfield Creek was found to have highest abundance of the Chironominae subfamily (non biting midges) with Caenidae (mayflies) and Leptoceridae (caddisfly) following in much lower numbers. All other macroinvertebrates were found in relatively low numbers this site recorded an overall low total taxa count of 18.

3.3 Water quality results

General water quality parameters pH, electrical conductivity, turbidity, dissolved oxygen and temperature were measured during the 2005 sampling run (Table 5). The water quality data presented in this report is only a small subset collected to help with the interpretation of the AUSRIVAS results. No samples were taken during the first rainfall events or wet season to investigate the major seasonal changes in water quality as this would be a major task by itself. Table 6 provides water quality results from 1995 early dry season sampling for information.

Table 5: Water Quality Results from 2005 early dry season sampling

Code	Site	pH	EC (µS/cm)	Turbidity NTU's	Temp °C	Dissolved Oxygen
DA01	Daly River Dorisvale Crossing	7.3	518	5	21.9	7.1
DA02	Fergusson River Stuart Highway Crossing	7.7	510	4	19.9	6.0
DA02.5	Katherine River Southern Rockhole	7.8	31	7	30.0	6.0
DA03	Katherine River crossing to 17 Mile Creek	7.3	19	5	30.0	4.9
DA05	Flora River Kathleen Falls	7.5	749	5	26.7	3.0
DA08	Daly River Mt Nancar	7.2	528	10	26.5	5.0
DA09	Daly River Ooloo Crossing	7.4	578	2	23.9	5.0
DA10	Douglas River u/s Ooloo Rd crossing	6.7	223	2	26.7	6.0
DA10.8	Edith River Plunge Pool	8.0	13	8	32	6.8
DA11	Edith River u/s Mt Todd	8.1	130	1	22.9	6.0
DA12	Edith River d/s Mt Todd	8.4	170	4	24.0	5.0
DA13	Stray Creek Umbrawarra Gorge	6.0	40	11	18.5	6.0
DA14	Douglas River Butterfly Gorge	7.5	17	1	28.4	5.0
DA14.5	Douglas River Tippera	6.7	491	3	25.3	6.0
DA15	Douglas River Crystal Falls	8.1	47	12	29.5	5.0
DA16	Douglas Hot Springs	6.5	25	4	21.9	6.0
DA19	Copperfield Creek	6.5	70	3	29.0	5.0

pH

pH is a measure of the acidity or alkalinity of water. Tap water is generally neutral at pH 7. The pH readings for the Douglas River sites ranged from 6.5 to 8.1. The river waters increased in pH from the top of the catchment upstream of Douglas Hot Springs down to the site at Crystal Falls. In comparison the Katherine River sites had very little change in pH ranging between sites from 7.3 to 7.8. The Edith River sites also had little variation with a pH of 8 recorded at the plunge pool to pH 8.4 recorded at the downstream site of Mt Todd. The Daly River sites had little variation amongst sites ranging between 7.2 and 7.4.

Electrical Conductivity (EC)

Electrical conductivity is a measure of water salinity. Conductivity values at all sites generally were lower in the upper sites of sub-catchments and increased in the lower downstream sites. For example the Katherine River sites ranged between 19 and 31 $\mu\text{s}/\text{cm}$. In comparison all of the Daly River sites had slightly higher EC values ranging between 518 to 578 $\mu\text{s}/\text{cm}$. During the wet season EC drops due to dilution with rainwater and surface runoff. The recessional flow measures the 'base' EC of the stream as determined from the geological surroundings. The Flora River displayed an EC value much higher than all other sites, contradicting the trend stated above that EC values are lower in the downstream parts of subcatchments and the whole of the Daly catchment. The high carbonate levels observed during the sampling explain the higher EC value. This indicates that the Flora River provides a habitat which is different to the reference sites of the AUSRIVAS model, which could be the explanation for the lower score of this otherwise healthy appearing site.

Turbidity

Turbidity is a measure of how clear or dirty the water is. All sites sampled had clear flowing water with very low turbidity. During the wet season turbidity changes markedly as runoff carrying sediment from the land is washed into rivers and creeks within the catchment. It is important to carry out AUSRIVAS sampling during recessional flow when streams display low turbidity values.

Temperature

Water temperatures were typical of Top End rivers and creeks.

Dissolved Oxygen

The dissolved oxygen values in all sites were typical of flowing waters in the Top End. The Flora River site was the only exception recording a low dissolved oxygen value of 3.0. It is important to note further monitoring is required to determine whether this is a consistent value for that site. In some cases lower dissolved oxygen is due to the groundwater source or springs lacking aeration when the water emerges at the surface. This could also be a reason for the lower AUSRIVAS score.

Table 6: Water Quality Results from (1995) early dry season sampling

Code	Site	pH	EC ($\mu\text{S/cm}$)	Turbidity NTU's	Temp C	Dissolved Oxygen
DA01	Daly River Dorisvale Crossing	7.94	315	5	25.9	7.1
DA03	Katherine River crossing to 17 Mile Creek	7.02	19	3	26.5	6.8
DA04	Seventeen Mile Creek	6.73	15	3	26.2	5.9
DA05	Flora River Kathleen Falls	7.59	671	7	26.0	6.9
DA06	Katherine River d/s sewage operations	7.42	453	5	27.9	5.6
DA07	Daly River Beeboom Crossing	7.89	503	6	28.5	7.0
DA08	Daly River Mt Nancar	7.98	395	5	25.7	6.9
DA09	Daly River Ooloo Crossing	7.63	385	3	26.4	6.8
DA10	Douglas River u/s Ooloo Rd crossing	7.21	208	3	27.1	5.5
DA11	Edith River u/s Mt Todd	6.3	11	7	25.9	6.2
DA12	Edith River d/s Mt Todd	7.02	31	3	26.3	7.2
DA13	Stray Creek Umbrawarra Gorge	6.11	22	4	23.0	4.2
DA14	Douglas River Butterfly Gorge	5.23	17	3	26.0	6.9
DA15	Douglas River Crystal Falls	7.86	425	4	26.3	6.9
DA17	Green Ant Creek	8.08	568	1	23.4	6.5
DA18	Fish River u/s road crossing	7.06	57	34	25.2	5.1
DA19	Copperfield Creek	7.36	46	12	22.2	5.8
DA20	Katherine River, Eva Valley Road	7.58	31	5	26.9	6.4

DA02, DA16 not sampled

4 Discussion

4.1 Taxa diversity and abundance

As can be seen from the graphs presented, there is a wide range of taxa diversity and abundance found across the sites. Taxa which tended to dominate the samples were the non biting midge (Chironominae subfamilies), the sandfly family (Ceratopogonidae), the mayfly family Baetidae, the water bug families Corixidae and Pleidae, and beetle family Dytiscidae, water mites (Acarina), and the caddisfly family Leptoceridae.

The majority of sites sampled in 2005 when compared to 1995/96 recorded no taxa drift with the expected number of families identified within the range “similar to reference sites in undisturbed condition”. Two sites (DA13 Stray Creek and DA19 Copperfield Creek) had a higher AUSRIVAS score in 2005 compared to 1995/6. However, this may be due to the refined model used in data analysis. The Flora River site (DA05) maintained its score of Band B recorded in 1995/6 and 2005.

4.2 Sub-catchment summary

The Katherine River site (DA03) again scored a Band A for 2005. Additional sites (DA02.5 and DA03.5) were established by the Parks and Wildlife Service and Katherine Landcare Group at the Southern Rockhole and Knotts Crossing. Both sites recorded high taxa abundance, diversity and composition typical of a healthy river system.

The Douglas River sites (DA10, DA14, DA15) all recorded Band A's. However the upper sites recorded lower taxa diversity (19 taxa) compared to the middle sites which both recorded the highest taxa diversity and abundance of all sites (28 and 29). Crystal Falls (DA15) recorded the lowest taxa count of 14. This site had evidence of bank erosion, degraded riparian vegetation and increased weed density on the river banks. One new site (DA14.5 Tippera) was established on the Douglas River by staff at the Douglas Daly Research Farm staff.

A new site was established at the main plunge pool within the Edith River National Park (DA10.8), sites DA11 and DA12 within this sub-catchment scored Band A.

The Daly River sites (DA01, DA08 and DA09) too recorded healthy taxa diversity and abundance recording Band A results. Mt Nancar (DA08) recorded the lowest taxa count of 19 when compared to the other two Daly sites.

When interpreting macroinvertebrate data it is important to note that taxa richness can be affected by many natural factors such as edge-water habitat condition, shading, current velocity, flow, water chemistry, timing of the sample collection. Human impacts such as changed land-use, habitat degradation or pollution can largely affect the macroinvertebrate community, reduce diversity and change abundance to few dominant taxa.

4.3 Conclusion

This catchment study to compare AUSRIVAS sites sampled in 1995 and in 2005 provides no evidence of detectable effects from catchment landuse on the aquatic environment.

Water analysis results for general water chemistry were typical of Top End rivers and creeks and support that the sites studied are mostly in a healthy state.

No unusual or rare aquatic invertebrates were found in the biological survey which is however not expected when identification is conducted to the family level or higher. The results suggest that some sites might have improved in macroinvertebrate diversity.

A number of threats to the water quality in this region include the addition of pollutants from mining, horticulture, agriculture and increased tourism and recreational pressure. Plans for development in the region over the next two decades may increase the likelihood of these threats. Monitoring river health within this catchment needs to continue in order to detect impairment and bring about appropriate management actions. Monitoring is a team approach as there are many people who care about the creeks and rivers and associated country within this catchment.

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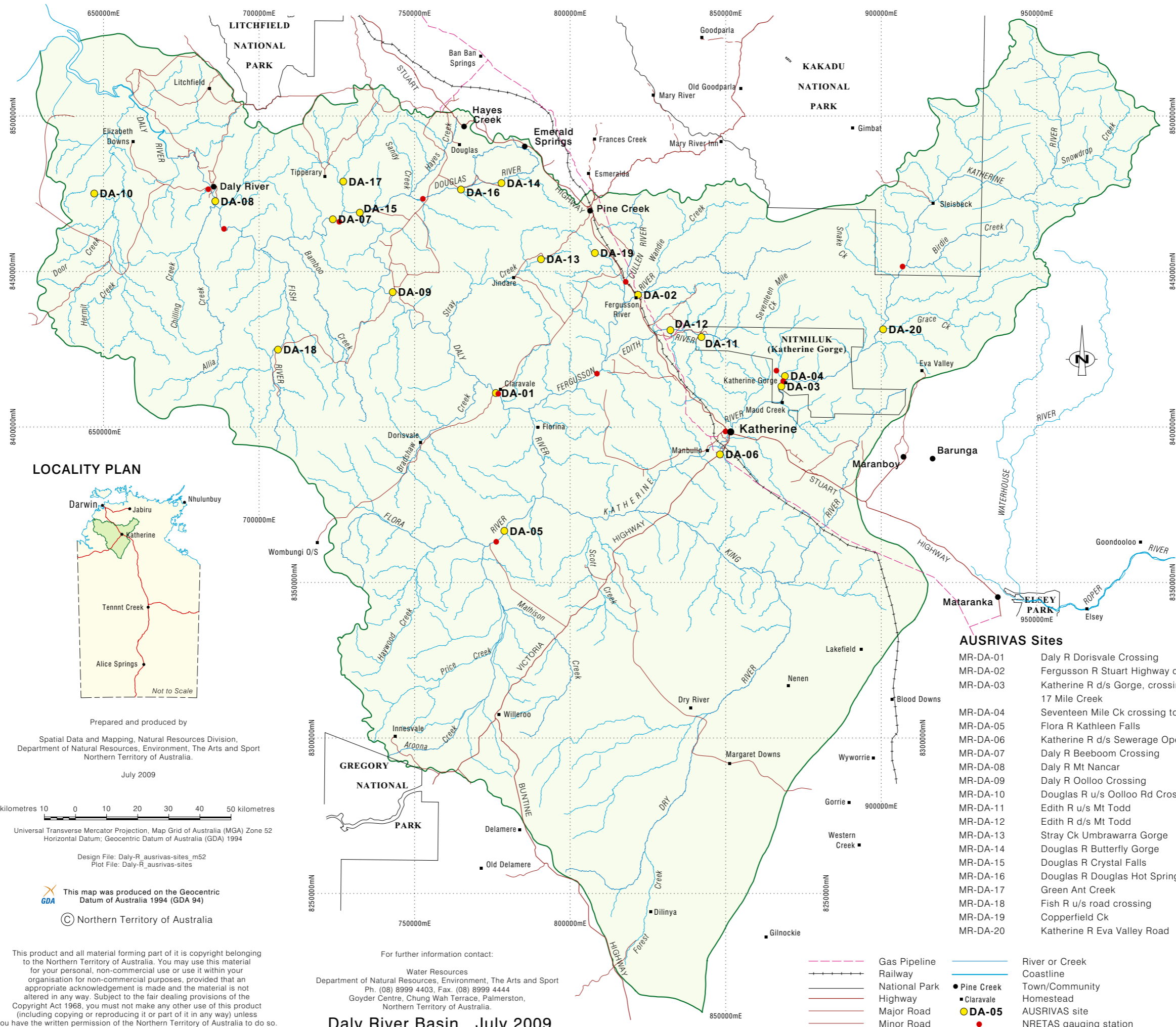
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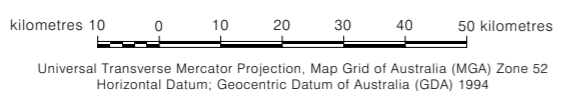
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Daly River Basin July 2009



AUSRIVAS Sites

MR-DA-01	Daly R Dorisvale Crossing
MR-DA-02	Fergusson R Stuart Highway crossing
MR-DA-03	Katherine R d/s Gorge, crossing to 17 Mile Creek
MR-DA-04	Seventeen Mile Ck crossing to Edith Falls
MR-DA-05	Flora R Kathleen Falls
MR-DA-06	Katherine R d/s Sewerage Operations
MR-DA-07	Daly R Beeboom Crossing
MR-DA-08	Daly R Mt Nancar
MR-DA-09	Daly R Oolloo Crossing
MR-DA-10	Douglas R u/s Oolloo Rd Crossing
MR-DA-11	Edith R u/s Mt Todd
MR-DA-12	Edith R d/s Mt Todd
MR-DA-13	Stray Ck Umbrawarra Gorge
MR-DA-14	Douglas R Butterfly Gorge
MR-DA-15	Douglas R Crystal Falls
MR-DA-16	Douglas R Douglas Hot Springs
MR-DA-17	Green Ant Creek
MR-DA-18	Fish R u/s road crossing
MR-DA-19	Copperfield Ck
MR-DA-20	Katherine R Eva Valley Road

- Gas Pipeline
- Railway
- National Park
- Highway
- Major Road
- Minor Road
- River or Creek
- Coastline
- Town/Community
- Homestead
- DA-05 AUSRIVAS site
- NRETAS gauging station

AUSRIVAS Water Quality Monitoring Sites

Appendix 2 - Taxa List from 2005 sampling

Order	Family	Sub Family
Acarina (water mites)		
Anisoptera (dragonflies)	Gomphidae Libellulidae	
Coleoptera (beetles)	Dytiscidae Elmidae Hydraenidae Hydrophilidae Scirtidae Staphylinidae	
Decapoda (prawns)	Palaemonidae Atyidae	
Diptera (flies)	Ceratopogonidae (sandflies) Chironomidae	Chironominae (non biting midges) Orthoclaadiinae Tanypodinae
	Culicidae (mosquitoes) Dolichopodidae Stratiomyidae Psychodidae	
Ephemeroptera (mayflies)	Baetidae Caenidae Leptophlebiidae	
Hemiptera (water bugs)	Belostomatidae Corixidae (water boatmen) Gelastocoridae Pleidae (small pygmy Gerridae Mesoveliidae Notonectidae (backswimmers) Veliidae	
Lepidoptera (moths)	Pyralidae	
Mollusca (molluscs)	Corbiculidae (bivalve molluscs) Planorbidae Thiaridae	
Nematoda (worms)		
Oligochaeta (worms)		
Trichoptera (caddisflies)	Calamoceratidae Ecnomidae Hydroptilidae Leptoceridae	
Zygoptera (damselflies)	Coenagrionidae	