

REPORT

Community based water quality monitoring in the Victoria River District, 2005



Greening Australia

Water for Life

Table of Contents

Acknowledgements.....	3
1. Introduction	4
1.1 The Victoria River.....	4
1.2 Aim of the study.....	4
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	15
4. Discussion.....	18
4.1 Conclusion.....	18
References	19
Appendix 1 – Map of AUSRIVAS sites.....	20
Appendix 2 - Taxa List from 2005 sampling.....	21

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1. Introduction

1.1 The Victoria River

Situated in the northwest of the Northern Territory, the Victoria River is the Territory's longest river and has a number of significant tributaries such as the Camfield and Humbert Rivers. Being typical of tropical rivers in general the Victoria River has highly seasonal flows and often annual flooding (Sample 2004). The catchment area is approx 88,000 square kilometres in area and the river discharges out into the Joseph Bonaparte Gulf. Rainfall within the catchment area ranges from 400mm in the south (Kalkarindji) to 1000mm in the north (Bradshaw). It is moderately variable from year to year and highly seasonal – most falling between November and March (Rajaratnam 1998). Unfortunately ongoing catchment based water quality data is limited in its availability. A number of brief projects over the years have investigated the rivers' condition, however regular review has not occurred.

1.2 Aim of the study

In an effort to address the knowledge gaps identified in *The Victoria River District Natural Resource Plan* (Sample 2004), data was collected on river health utilising the existing sites established by the Monitoring River Health Initiative in 1996. The aim of this study was to re-sample the original AUSRIVAS sites within the Victoria River catchment (VRC) 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 assessment and in 2005 there was a high level of interest from the VRDCA and landholders.

In addition to river health monitoring, station managers at a property level raised concerns about groundwater quality and suitability for human and stock use. Numerous water bores were sampled and water quality tests were conducted throughout the district. Assistance was provided on sampling techniques, equipment and data interpretation. A comparison of present day water quality data to data collected during the water resource assessments during the early nineties by Department of Lands, Planning and Environment and driller bore construction data from the sixties and seventies, was carried out.

This study was undertaken as a collaborative effort between Greening Australia and VRDCA members. It is hoped that regular monitoring of the same sites will continue and baseline information can be gathered over time. Ongoing monitoring of sites within the catchment will provide data integral to natural resource management process, and will also provide landowners with direct site assessment that can be translated into management actions where appropriate.

1.3 Purpose of this report

The purpose of this report is to:

- Explain AUSRIVAS.
- Provide results from the 1995 dry season sampling run.
- Provide results from the 2005 sampling program.
- Provide indirect comparative results for these same sites from the 1995-1996 sampling program.
- 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 water bugs 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, Finnis 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 site¹. 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>

¹ 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 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

The **Darwin-Daly early dry season edge family level model** was utilised in a similar project in the Katherine/Daly region (Schenkel and Davidson 2009). However as a similar model has not been developed for the Victoria River region, indirect AUSRIVAS style comparison was not possible in this study. Alkalinity was not measured during the 2005 sampling program and therefore the original **Top End combined season edge model** could not be used to provide a direct comparison for the 2005 data.

However in 2005, six of the original sites from the Victoria River catchment were re-sampled by the VRDCA and landowners in collaboration with Greening Australia based on sampling an edge habitat in the early dry season. The resulting macroinvertebrate data provides a useful indication of stream health and a valuable source of information for the future.

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	1995/6 AUSRIVAS	2005 macroinvertebrates	2005 water quality	1995/6 water quality
VC01	X		McDonalds Creek McDonalds Waterhole	X		X	X
VC01.5		X	Victoria River McDonalds Yards Road Crossing			X	
VC02	X		Victoria River Kalkarindji d/s road bridge	X		X	
VC03	X		Camfield River Camfield Homestead	X		X	X
VC03.5		X	Lonely Springs Creek			X	
VC04	X		Armstrong River Old Top Springs Roadhouse	X			X
VC05	X		Victoria River Dashwood Crossing	X	X	X	X
VC06	X		East Baines River Victoria Highway Crossing	X		X	X
VC07	X		West Baines River u/s Victoria Highway Crossing	X			X
VC07.5		X	Victoria River Longreach Waterhole			X	
VC08	X		Victoria River Pigeon Hole	X	X	X	X
VC09	X		Wickham River Billabong Road to Mt Sandford	X			X
VC09.5		X	Humbert River Homestead			X	
VC10	X		Gibbie Creek Road to Mt Sandford	X	X	X	X
VC11	X		Limestone Creek Limestone Gorge	X			X
VC12	X		Victoria River Victoria River Roadhouse	X	X	X	X
VC13	X		Cow Creek Cow Creek Falls	X			X
VC14	X		Jasper Creek Jasper Gorge	X	X	X	X
VC15	X		West Baines River Hurricane Hill Yards Amanbidji	X			X
VC16	X		Boxer Springs Creek	X			X
VC17		X	Behn River Duncan Road Crossing		X	X	

3. Results

3.1 AUSRIVAS site assessment

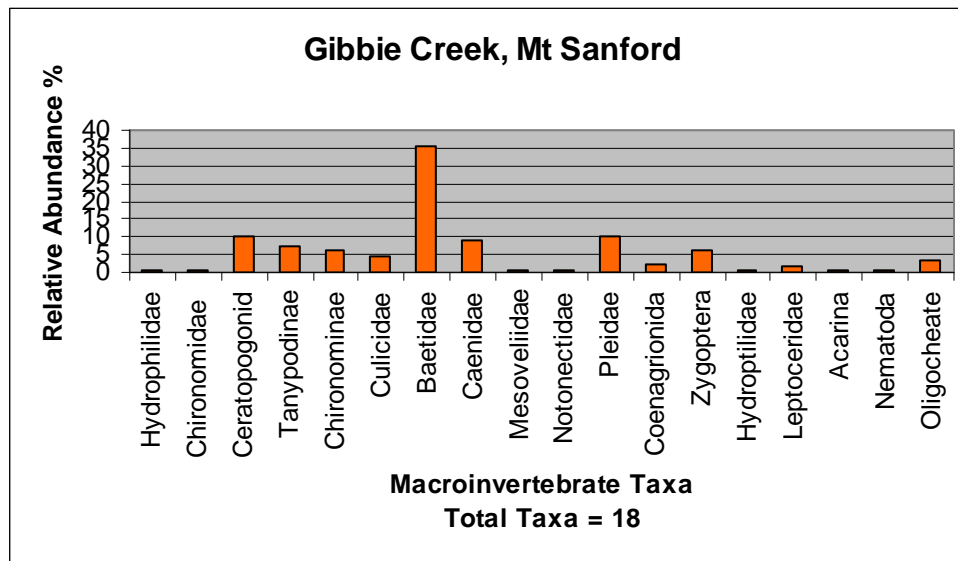
The original results from the 1990's AUSRIVAS sampling are presented here.

Table 3: Top End combined season edge model (1995-1999)

Code	Site Name	OE Score	BAND
VC01	McDonalds Creek	0.82	B
VC02	Victoria River Kalkarindji	0.96	A
VC03	Camfield River Homestead	0.79	B
VC04	Armstrong River	0.95	A
VC05	Victoria River Dashwood Crossing	1.15	X
VC06	East Baines River	1.07	A
VC07	West Baines River	0.89	A
VC08	Victoria River Pigeon Hole	0.89	A
VC09	Wickham River Rd to Mt Samford	1.05	A
VC10	Gibbie Creek Rd to Mt Samford	1.05	A
VC11	Limestone Creek	1.16	X
VC12	Victoria River roadhouse	0.98	A
VC13	Cow Creek	0.95	A
VC14	Jasper Creek	1.15	X
VC15	West Baines River Amanbidji	1.07	A
VC16	Boxer Springs Creek	0.88	B

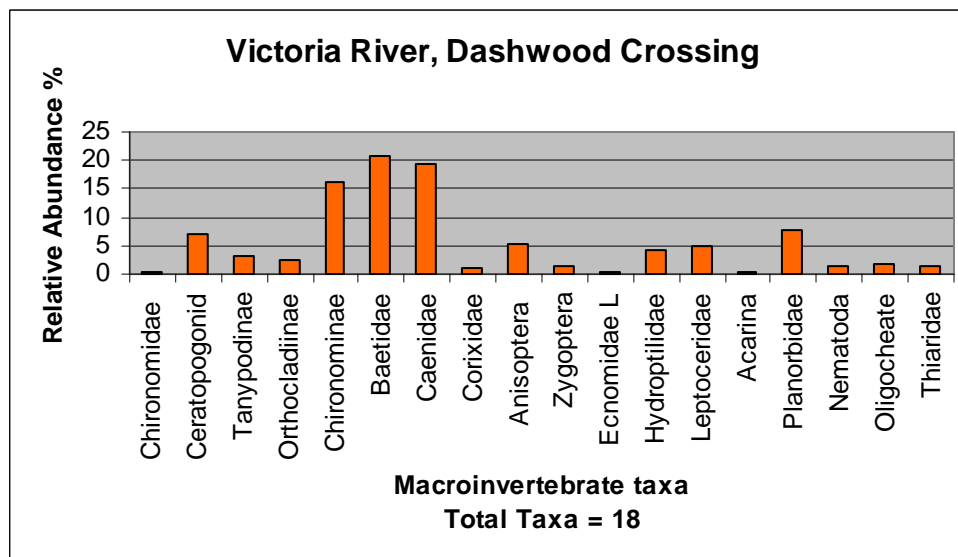
3.2 Macroinvertebrate diversity and abundance in 2005

Graph 1: Gibbie Creek Mt Sandford VC10



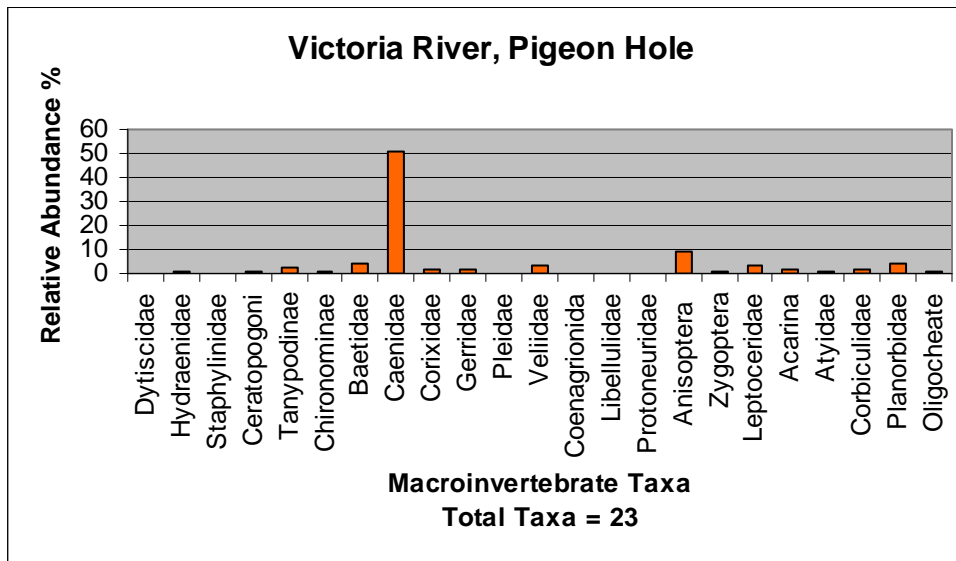
A total of 18 taxa were found for this site. Data is shown only for macroinvertebrate percent relative abundance. The *Baetidae* family of mayflies is the most abundant taxon, followed by the taxa *Pleidae* (prawns) and *Ceratopogonidae* (sandfly larvae). Mayflies are described as being sensitive to changes in water quality and their presence in high numbers is a good indicator that this site is in healthy condition.

Graph 2: Victoria River Dashwood Crossing VC05



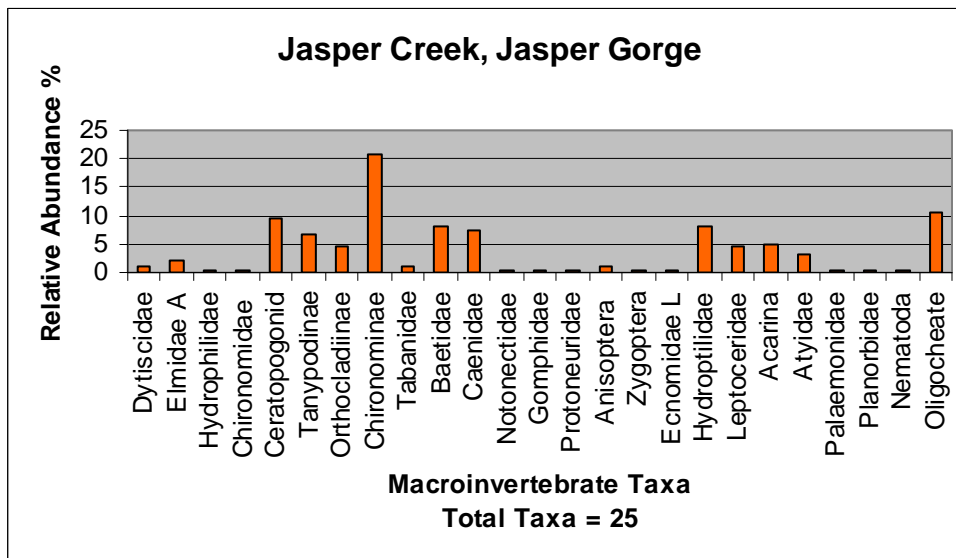
The mayfly taxons of *Baetidae* and *Caenidae* are the most abundant for this site. Non biting midges (*Chironominae*, *Orthoclaadiinae* and *Tanypondinae*) taxons were also well represented. A total of 18 taxa were found with a number of sensitive macroinvertebrates (damselflies, dragonflies and caddisflies) all represented. Of interest this site recorded the highest abundance of the taxa *Planorbidae* or freshwater snail, these macroinvertebrates graze on algae and decomposing vegetation.

Graph 3: Victoria River Pigeon Hole VC08



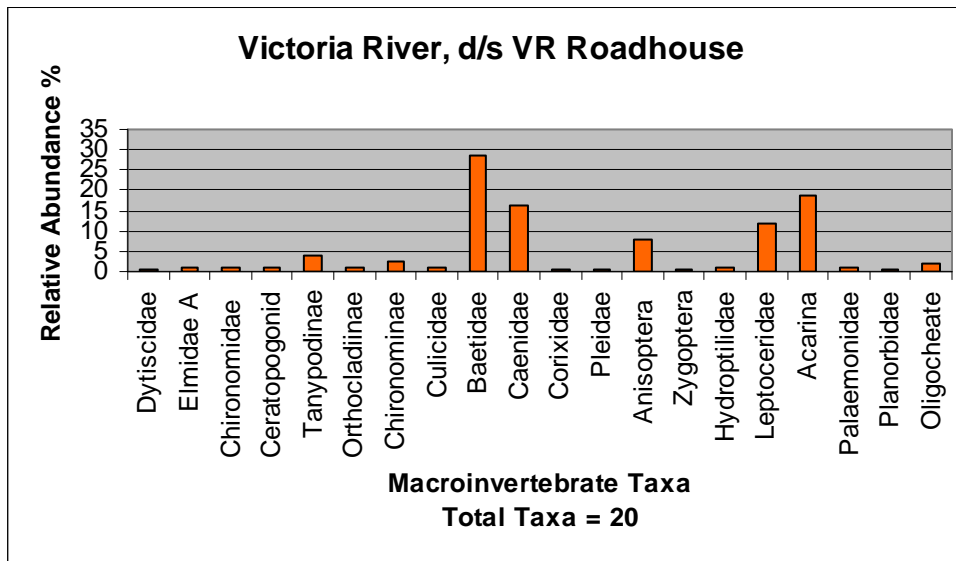
A total of 23 taxa were found at this site. The taxa *Caenidae*, Mayfly is the most dominant macroinvertebrate with the highest relative abundance percent recorded amongst all sites sampled in 2005. Damselfly nymphs the taxa *Anisoptera* and freshwater snails *Planorbidae* were present in good numbers with overall taxa richness being good.

Graph 4: Jasper Creek, Jasper Gorge VC14



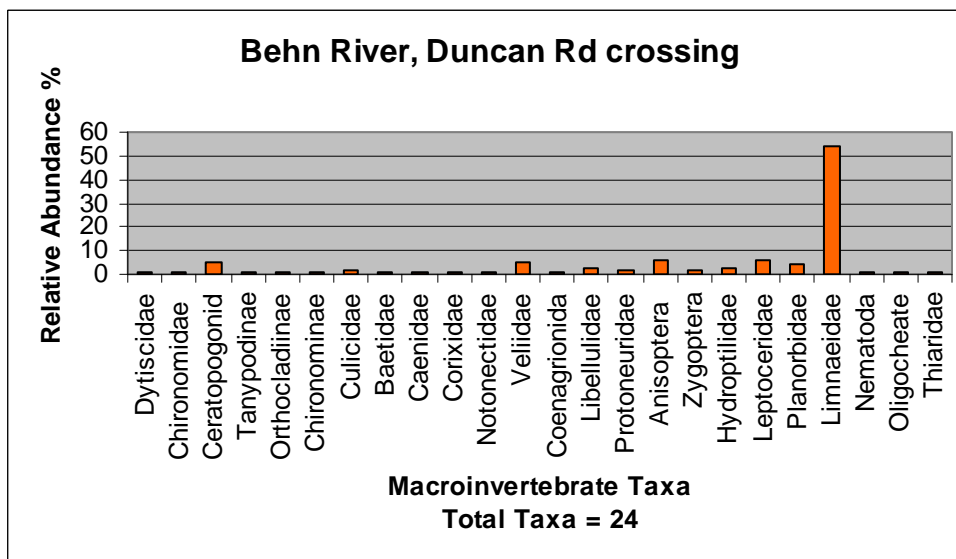
A total of 25 taxa were found at this site, the richest for all the sites sampled during the 2005 sampling run. The taxa of *Chironominae* or non biting midge are the most dominant taxa. Followed by the taxons of freshwater worms (*Oligocheate*), sandflies (*Ceratopogonidae*), caddisfly (*Hydroptilidae*). Overall abundance by all taxa was fairly evenly spread.

Graph 5: Victoria River d/s roadhouse VC 12



A total of 20 taxa were present at this site. The mayfly taxons of *Baetidae* and *Caenidae* were the most dominant followed by *Acarina* (water mites). This site recorded the highest relative abundance of water mites. Juvenile mites attach to insect hosts where they feed until full they then leave the host and become free swimming. Water mites are especially sensitive to heavy metal contamination in waterways.

Graph 6: Behn River Duncan Rd crossing



Although this site is not technically in the Victoria River catchment it was sampled due to the cross border partnerships that the VRDCA have established.

A total of 24 taxa were found at this site. The dominant taxa was *Limnaeidae* (freshwater snail). These snails thrive in eutrophic conditions which could be the case here. All other taxa were low in relative abundance. Decaying organic wastes can lower the dissolved oxygen to critical levels therefore reducing sensitive macroinvertebrates. Only very tolerant macroinvertebrates prevail in such conditions such as snails.

3.3 Water quality results

General water quality parameters pH, electrical conductivity, turbidity, dissolved oxygen and temperature were measured during the 2005 surface water sampling run (Table 4). The water quality data presented in this report is only a small subset collected to aid with the interpretation of the biological results. No samples were taken during the first rainfall events or wet season to investigate the major seasonal changes in water quality. Table 5 provides water quality results from 1995 early dry season sampling for information.

Table 4: Water Quality Results from 2005 early dry season sampling

Code	Site	pH	EC (μ S/cm)	Turbidity NTU's	Temp °C	Dissolved Oxygen
VC01	McDonalds Creek	8.1	151	2	31.0	4.2
VC01.5	Victoria River, McDonalds yards Rd crossing	8.0	110	5	25.0	6.0
VC02	Victoria River Kalkarindji	8.03	481	2	20.1	6.0
VC03	Camfield Creek homestead	7.4	346	56	19.0	6.0
VC03.5	Lonely Springs Creek	8.2	526	10	28.0	5.0
VC05	Victoria River Dashwood crossing	8.0	563	4	20.2	6.0
VC06	East Baines River	8.4	472	0	30.0	5.0
VC07.5	Victoria River Longreach Waterhole	8.7	222	46	29.4	4.0
VC08	Victoria River Pigeon Hole	8.3	399	11	22.6	7.0
VC09.5	Humbert River homestead	7.9	556	12	20.4	7.0
VC10	Gibbie Creek Rd to Mt Samford	8.3	96	4	20.5	6.0
VC12	Victoria River Roadhouse	7.7	440	5	25.5	8.0
VC14	Jasper Creek	8.6	72	25	20.6	7.0
VC17	Behn River	7.3	713	4	20.1	3.0

Sites VC04, VC07, VC09, VC11, VC13, VC15 and VC16 were not sampled in 2005.

pH

pH is a measure of the acidity or alkalinity of water. Values of pH range from 0 (highly acidic) to 14 (highly alkaline). Tap water is generally neutral at pH 7. The pH readings for the Victoria River sites ranged from 7.4 at Camfield Creek to 8.7 at Longreach Waterhole. Typically pH values in Top End rivers range between 6.5 -8.5 pH units and vary depending on geology, soils and catchment land use.

Electrical Conductivity (EC)

Electrical conductivity is the measure of water salinity. Lower conductivity values were recorded at Gibbie and Jasper Creeks whilst the highest value was recorded at Dashwood Crossing, Victoria River. All conductivity values were within typical EC values for Top End waterways ranging between 5 and 800uS/cm. Each waterway tends to have a consistent range of electrical conductivity that once known can be used as a baseline against which to compare regular measurements of conductivity. Dry season 'base' flow EC values of a river are determined by the geological surroundings whilst during the wet season EC drops due to dilution with rainwater and surface runoff.

Turbidity

Turbidity is measure of how clear or dirty the water is. Turbidity can indicate the presence of sediment that has run off from construction, land clearing maintenance of firebreaks, dirt roads and bare ground after hot fires. All sites except two sampled had clear flowing water with very low turbidity. Camfield Creek (56 NTU's) and Longreach Waterhole (46NTU's) both had higher dry season values when compared to the 12 other sites sampled. The increase in turbidity at the time of sampling was due to stock access to these water bodies.

Temperature

Water temperatures recorded were typical of Top End rivers and creeks.

Dissolved Oxygen (DO)

The dissolved oxygen values recorded from all sites were typical of flowing waters in the Top End ranging between 6.5 – 8.5mg/L. McDonalds Creek and Longreach Waterhole recorded the lowest values of 4.2 and 4.0mg/L.

Table 5. Water Quality Results from 1995 early dry season sampling.

Code	Site	pH	EC (μS/cm)	Turbidity NTU's	Temp °C	Dissolved Oxygen
VC01	McDonalds Creek	6.3	588	16	21.7	6.3
VC02	Victoria River Kalkarindji	Not sampled				
VC03	Camfield River homestead	8.1	1410	17	24.5	5.4
VC04	Armstrong River	7.7	624	25	23.5	3.9
VC05	Victoria River Dashwood crossing	8.1	482	6	21.5	6.1
VC06	East Baines River	8.0	390	8	25.4	5.0
VC07	West Baines River	8.4	414	35	27.2	4.8
VC08	Victoria River Pigeon Hole	8.1	358	14	24.5	5.5
VC09	Wickham River Rd to Mt Samford	8.0	493	3	23.2	4.9
VC10	Gibbie Creek Rd to Mt Samford	8.0	552	6	23.6	5.4
VC11	Limestone Creek	7.6	476	2	23.7	5.3
VC12	Victoria River roadhouse	8.1	438	9	25.4	6.2
VC13	Cow Creek	5.4	19	1	21.9	1.8
VC14	Jasper Creek Jasper Gorge	7.6	92	10	24.0	5.6
VC15	West Baines Amanbidji	8.1	463	23	24.9	4.7
VC16	Boxer Springs Creek	7.8	1050	1	27.1	6.8

4. Discussion

The Victoria River catchment was found to be in reasonably good condition at most sites assessed during the 1995 and 2005 sampling runs. 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.

Continued monitoring would provide improved baseline information of catchment condition and enable landholders, managers and the Northern Territory Government to determine whether catchment condition has improved or deteriorated over time.

4.1 Conclusion

The catchment study to compare AUSRIVAS sites sampled in 1995 and in 2005 provided no evidence of detectable effects from catchment land-use on the aquatic environment.

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 water quality in this region include the addition of pollutants from mining, sewage and increased agricultural pressure. To ensure the Victoria River catchment remains healthy a number of recommendations are suggested:

- Be pro-active in river management as it is cheaper and easier to avoid a problem than to fix one. Target the cause of problems rather than the symptoms.
- Address weeds and feral animals in a strategic and effective way that is sustainable.
- Protect and manage riparian areas to reduce erosion and bank slumping through fencing, effective grazing, relocating stock watering points off stream, and ensuring tracks and river crossings are properly designed, constructed and maintained.
- Approach catchment management issues as a community rather than individual basis, with cooperation and collaboration where possible.

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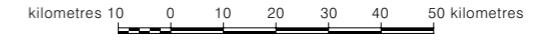


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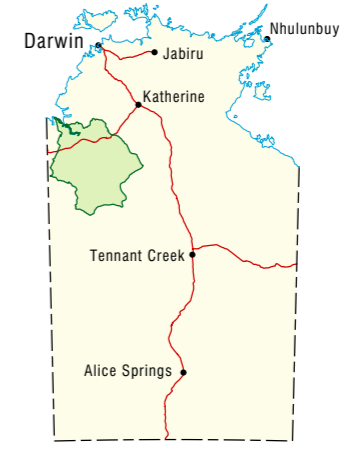


Transverse Mercator Projection, Map Grid of Australia (MGA) Zone 52
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Design File: Victoria-R_ausrivas-sites_m52
 Plot File: Victoria-R_ausrivas-sites

This map was produced on the Geocentric Datum of Australia 1994 (GDA 94)

LOCALITY PLAN



- Gas Pipeline
- Railway
- National Park
- Highway
- Major Road
- Minor Road
- River or Creek
- Coastline
- Timber Creek
- Bradshaw
- VC-05
- AUSRIVAS site
- NRETAS gauging station

AUSRIVAS Sites

- MR-VC-01 McDonald Ck McDonalds Waterhole
- MR-VC-02 Victoria R Kalkarindji. d/s road bridge
- MR-VC-03 Camfield R Camfield Homestead
- MR-VC-04 Armstrong R Old Top Springs Roadhouse
- MR-VC-05 Victoria R Dashwood Crossing
- MR-VC-06 E Baines Vic Hwy crossing
- MR-VC-07 W Baines u/s Vic Hwy crossing
- MR-VC-08 Victoria R Pigeonhole
- MR-VC-09 Wickham R Billong, Rd to Mt Samford
- MR-VC-10 Gibbie Creek road to Mt Samford
- MR-VC-11 Limestone Ck Limestone Gorge
- MR-VC-12 Victoria R Vic River Roadhouse
- MR-VC-13 Cow Ck Cow Ck Falls
- MR-VC-14 Jasper Ck Jasper Gorge
- MR-VC-15 West Baines R Hurricane Hill Yards, Amanbidji
- MR-VC-16 Boxer Springs Creek

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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) Orthocladiinae 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	