Biological and Ecological Data (excluding fisheries) on the Dawson River System with Particular Reference to the Proposed Nathan Dam: August 1995.

Centre for Land and Water Resource Development

Central Queensland
UNIVERSITY

DOCTRINA PERPETUA

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August, 1995

L. J. Duivenvoorden
River and Wetland Ecology Group
Centre for Land and Water Resource Development,
Central Queensland University,
Rockhampton, Queensland.

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1.0 INTRODUCTION

The recent announcement of the proposed development of a new dam on the Dawson River in Central Queensland has prompted the Queensland Department of Primary Industries (Water Resources) to seek information pertaining to the environmental flow requirements for the dam. It has been proposed that an Environmental Flows Expert Panel be set up to determine and assess the types of studies required to meet the environmental concerns relating to the construction of the dam. To obtain the best current information on the Dawson River system, the Department approached Central Queensland University because of their extensive involvement in the collection of biological and chemical data on parts of this system since the early 1980s - as a consequence of which a considerable database of information (published and unpublished) has been amassed on the river system.

In response to this approach, the present report was produced. It aims to:

(1) Summarise the biological and ecological data (excluding fisheries) presently available on the Dawson River and it's tributaries and
(2) Provide other relevant information for members of the Environmental Flows Expert Panel.

Data for a report on fish resources of the Dawson River are being prepared by Mr Peter Long of QDPI (Rockhampton). Provision of this information and that in this report will minimise any delays in the deliberations of the panel.

To achieve these aims, current knowledge of various aspects of the biology and ecology of the Dawson River has been summarised in separate sections for each major component. Data for the aquatic plants, phytoplankton and aquatic invertebrate components have been collated and compared with other data collected in earlier studies of the Dawson and Fitzroy River systems. The chapter following these sections provides information on the terrestrial flora and fauna of the Dawson River system and was written by A. Melzer and L. Childs (CQU Centre for Land and Water Resource Development). Comment is then made on the water quality of the Dawson catchment and environmental flow requirements for the Dawson River system are discussed. A report written by Bob Noble and the QDPI-CQU project team on the water quality of the Fitzroy catchment with emphasis on the Dawson and Comet River systems follows in Appendix II.

1.1 Background

The Dawson River system totals 50,830 km^2 (Baxter, 1992), about one third of the area of the Fitzroy River Catchment, the largest catchment on the east coast of Australia (Ryan, 1992). It is situated to the south of the Fitzroy River (Figure 1.1) and has an estimated mean annual discharge of 1,377,000 megalitres (ML). This discharge is relatively small when one considers the area of its catchment. For example, the

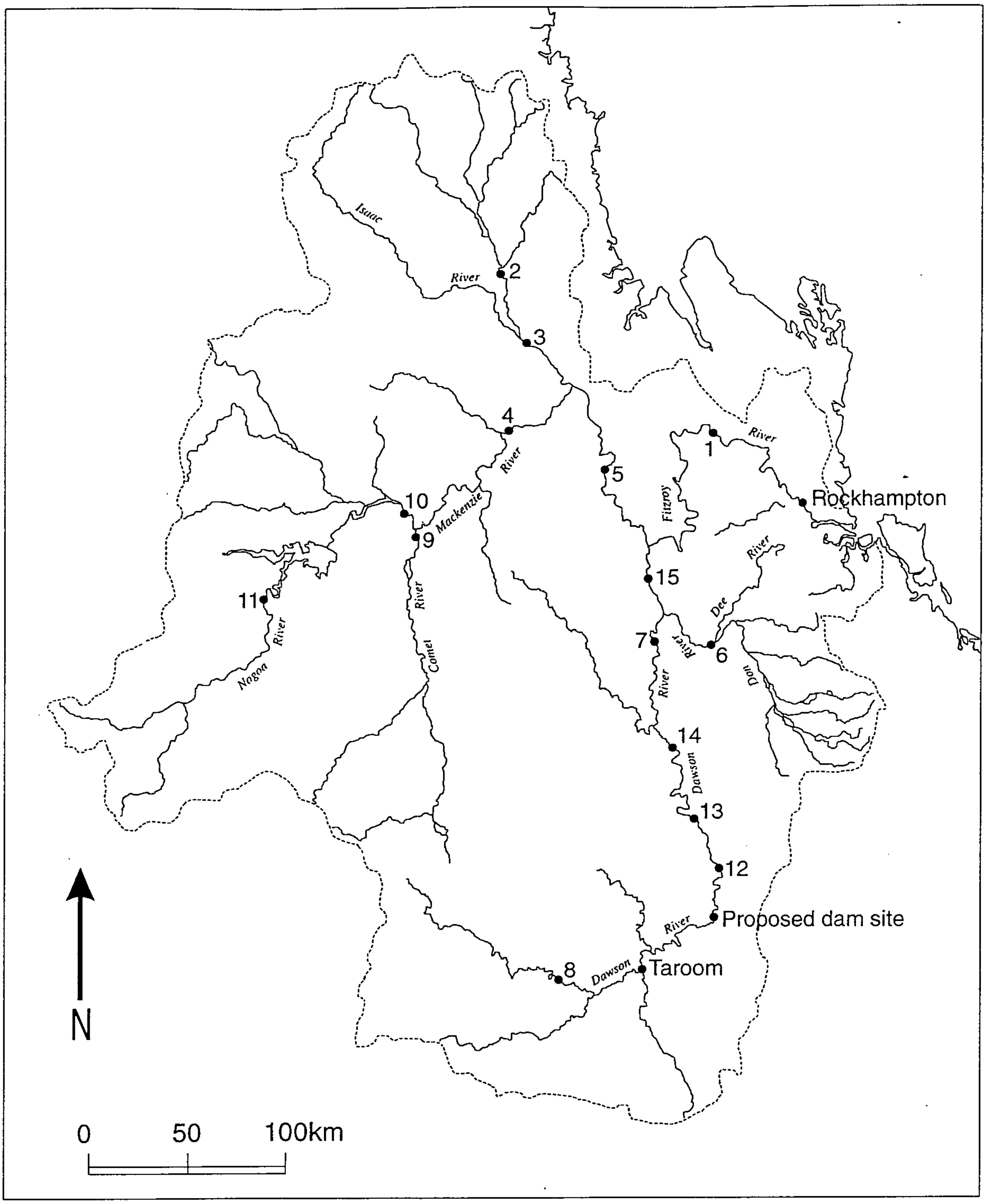


Figure 1.1 Monitoring sites in the Fitzroy River catchment. 1. Eden Bann; 2. Twin Bridges; 3. Yatton; 4. Bingegang; 5. Coolmaringa; 6. Rannes; 7. Beckers; 8. Baroondah; 9. Comet; 10. Duckponds; 11. Craigmore; 12. Dawson River at the Delusion Creek junction; 13. Theodore Weir; 14. Moura Weir; 15. Dawson River at the Capricorn Highway crossing.

Connors River (to the north of site 2 in Figure 1.1) has a catchment area of only 9,945 km^2, but has an estimated mean annual discharge of 1,771,000 ML (Baxter, 1992). This relatively low discharge may be accounted for by the generally semi-arid environment that prevails over much of its area. Most of the rainfall is restricted to the summer months, when cyclonic events may at times be resposible for a large proportion of the annual rainfall. Further details of climate, geography and land and water resources of the region can be obtained from many papers in the Proceedings of the Fitzroy Catchment Symposium (Duivenvoorden *et al.* 1992).

At present there are six weirs in operation along approximately 310 km of the Dawson River and they supply water for a variety of uses including irrigation, urban, industrial, stock and domestic (Baxter, 1992). These weirs are the Glebe, Gyranda, Orange Creek, Theodore, Moura and Neville Hewitt. Supplies in these weirs are fully committed while the demand for water is increasing, with current entitlements totalling 56, 787 ML per year (Q.D.P.I., 1995). The new water stoarge proposed for the Dawson will help to alleviate this problem and could provide 150,000 ML per year for the expansion of agricultural, industrial and extractive industries (Q.D.P.I., 1995). Further information about the dam may be found in an "Initial Advice Document" produced by the Queensland Department of Primary Industries (Water Commercial) (Q.D.P.I. 1995). This report states that the site for the dam that appears to have the greatest potential is located approximately 72 km downstream from Taroom and upstream of Nathan Gorge (see Figure 1.1).

2.0 AQUATIC MACROPHYTES

Aquatic macrophytes form an integral part of the aquatic ecosystem, serving important functions such as increasing the complexity of habitats, provision of nesting sites for other organisms (especially fish fry and birds), recycling nutrients, increasing sedimentation of suspended sediments, reducing bankside erosion, provision of food for aquatic animals and making water bodies more aesthetically pleasing. As such, they are an important component of the riverine system and should be considered in any biological study of the possible impact of the proposed Nathan dam on the Dawson River.

2.1 Previous Studies

The first published study of aquatic macrophytes in the Dawson River system was carried out between 1981 and 1986 by Mackey (1988) as part of an investigation of the effects of acid mine discharge from the Mount Morgan mine on the biota of the Dee River, a tributary of the Dawson (Figure 1.1). It provides information on the number and types of plants that may be found in the headwaters of streams in the Dawson River system. The study involved recording details of the aquatic macrophytes at an unaffected (relatively pristine) site upstream of the mine, as well as seven downstream sites which were adversely affected to by the toxic runoff. The unaffected (or control site) had 10 different species of aquatic macrophytes and for the 8 sites sampled, a total of 11 species were recorded. The highest number of species at sites downstream of the mine was 5 at a site about 50 km downstream, indicating the extent of the adverse affects of the acid mine discharge.

Duivenvoorden (1992a) also studied the aquatic macrophytes of the Dee River system in relation to acid-mine drainage (in 1988) and reported on the distribution of the plants as well as the levels of heavy metals present in their tissues. He later extended this study to 10 sites including one on the Don River and one on the Dawson (Duivenvoorden, 1989). In the first of these studies the total number of species of aquatic macrophytes found was 24, with the control site and a site about 26 km downstream from the mine sharing the highest species richness with 11 species.

During the second study in 1989, 35 species of aquatic macrophytes were recorded, with the upstream control site on the Dee River having 17 of these species. A large proportion of species at this control site was dominated by submerged and floating species and all but one of these species were recorded within 51 km downstream of the mine site. At sites severely affected by acid mine discharge, however, few species were recorded. For example, at a site about 20 km downstream of the mine only one species was recorded while further downstream the site on the Don River had 15 species and that on Dawson River had 12 (Duivenvoorden, 1989)..

A much more extensive survey of the macrophytes in the Dawson River system was started in 1989 as part of a larger study examining the spatial and temporal variation in aquatic macrophyte distribution of the whole Fitzroy River system (Duivenvoorden, 1990; 1992b). This study involved surveys in 1989, 1990 and 1991 of 101 sites in the

Fitzroy catchment (including 39 in the Dawson River sub-catchment) (Figure 2.1). Details of the locations of the sites surveyed in the Dawson River sub-catchment are given in Appendix II. In this study a total of 105 aquatic and semi-aquatic species were recorded. Only ten of the 101 sites had more than 15 species of aquatic plants and half of these ten sites were permanent water bodies. On average, most sites surveyed had between 2-5 species of aquatic plants at any one time and the sites with relatively high numbers of species had surface water year-round (Duivenvoorden 1992b). A large proportion of the sites had two or less species: 43% of sites in 1989, 25% in 1990 and 46% in 1991. The species most commonly occurring at these sites were species *of Cyperus*, *Juncus* and *Lomandra,* which are capable of tolerating very dry conditions. Many of the sites with two or less species were largely in the drier areas, where they made up only a small proportion of the bankside vegetation (Duivenvoorden 1992b).

Of particular relevance to studies of the macrophytes of the Dawson River system is the annual variation found by Duivenvoorden (1992b) in the number of macrophyte species at any one site. Figure 2 .2 (reproduced from Duivenvoorden (1992b)) shows the variation in the mean number of species that were recorded per site over the 3-year study period in 8 of the sub-catchments of the Fitzroy River system. **These results also show that some species are lost and replaced by others each year, indicating a very dynamic plant distribution** (Duivenvoorden 1992b). **Additionally, large reductions in species numbers at many sites occurred following the January 1991 flood and subsequent drought, indicating that such environmental variables need to be considered in any surveys of the aquatic macrophyte flora.** The survivors of such environmental extremes were most commonly species of *Cyperus* and *Juncus,* while species of *Persicaria* were often lost (Duivenvoorden 1992b).

A more recent (though more localised) study of aquatic macrophytes in the Dawson River system is one carried out in March, 1995 on the plants in the Dee River system (Duivenvoorden, 1995a). This study was similar to that of Mackey (1988) on the biota of the Dee River in relation to acid mine drainage, but included studies of the fish and provided data on the response of aquatic biota to acid mine drainage. In addition, three other control or reference sites were studied. The results indicated that the river was recovering from the effects of the acid mine drainage, with many more species of aquatic plants being found in areas closer to the mine site than in earlier studies. The number of aquatic macrophyte species in this study ranged from 11-19 species, with the highest number of species occurring at one of the upstream control sites. A total of 36 different species of aquatic macrophyte was recorded from the 11 sites surveyed. Many of the species recorded in 1995 had not been recorded previously at the sites studied, and again emphasises the variation that may occur from one year to the next in the number of species present.

2.2 Current CQU-QDPI Studies

More recent studies of the aquatic macrophytes of the Dawson River system include that of Duivenvoorden (1995b). This on-going study is part of a larger collaborative research project between Central Queensland University and Q.D.P.I. The study (titled the Downstream Effects of Land Use) is headed by Mr Bob Noble of Q.D.P.I. (Biloela)

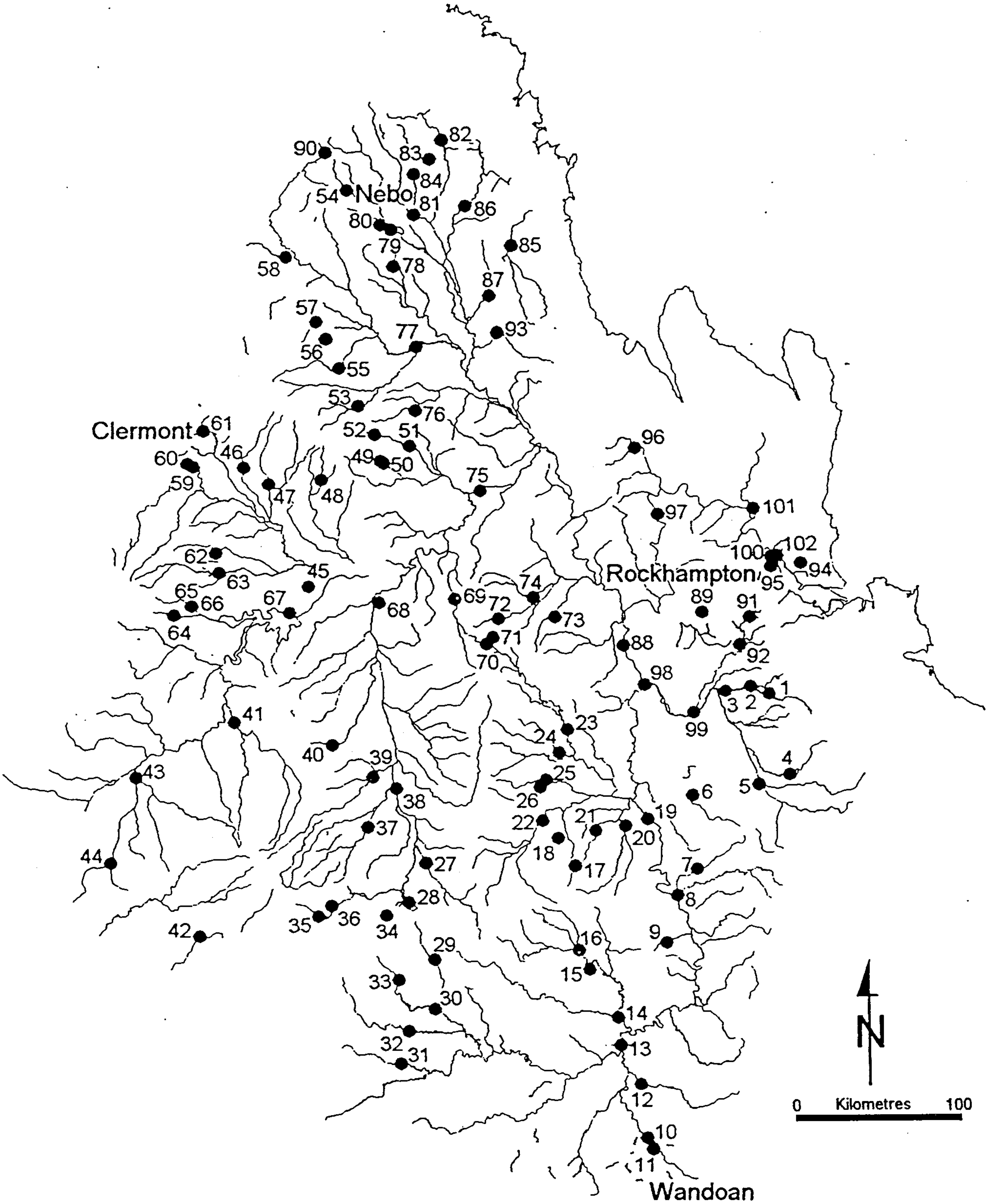


Figure 2.1 Location of sites sampled for aquatic macrophytes in 1989, 1990, and 1991. (Taken from Duivenvoorden, 1992). (Details of the locations of sites in the Dawson subcatchment are given in AppendixII).

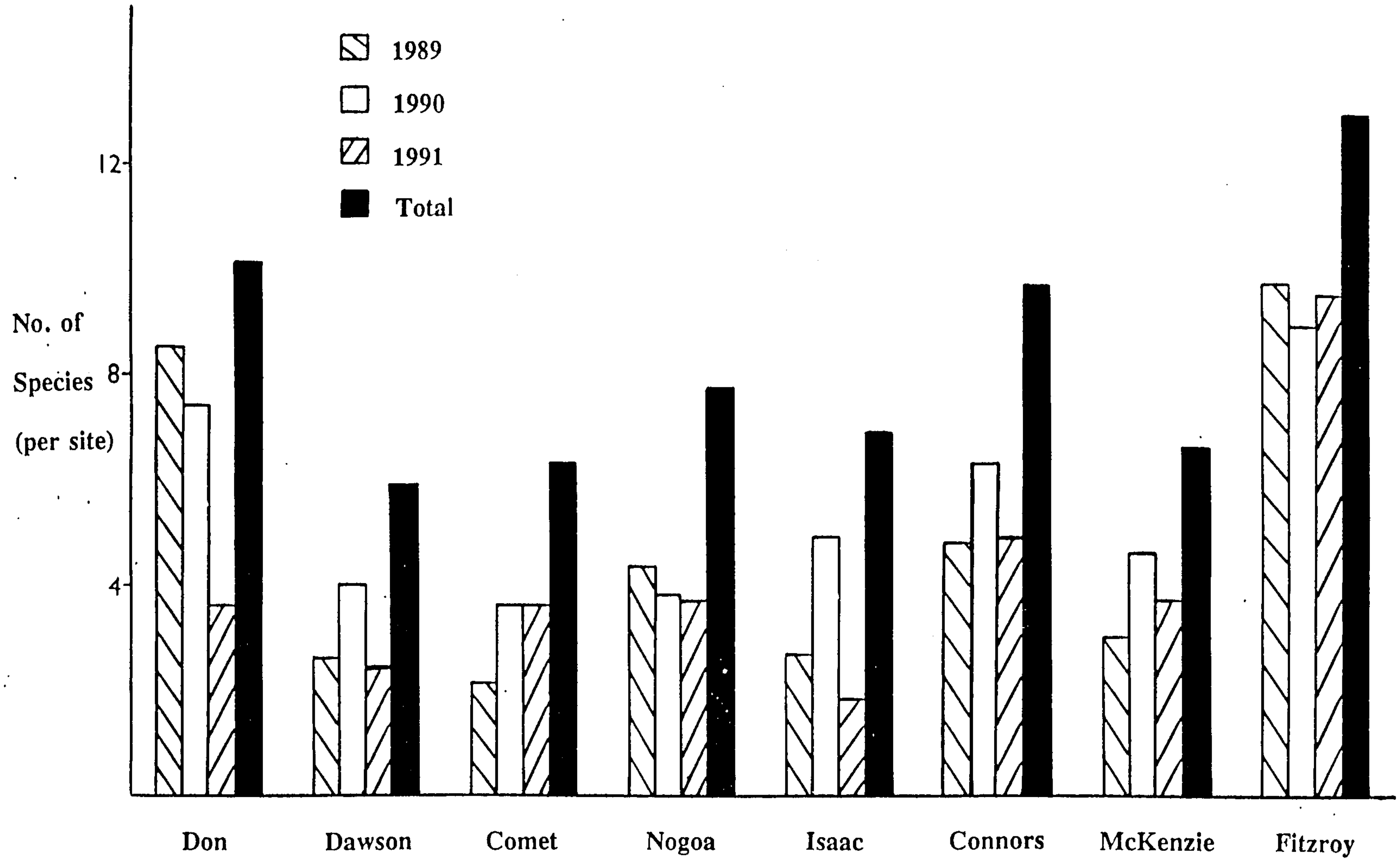


Figure 2.2 Mean numbers of aquatic macrophyte species recorded in subcatchments of the Fitzroy River basin in 1989, 1990, and 1991. Total mean numbers refer to species recorded over the three year period at each site. (Taken from Duivenvoorden, 1992).

and involves not only aquatic macrophytes but also studies on the aquatic invertebrates, phytoplankton, fish, zooplankton, riparian (terrestrial) vegetation and water chemistry (Noble *et al.* 1995). Results of this study are described in this study in separate sections for each component. The study commenced in June 1994 and includes analysis of eleven sites in the Fitzroy catchment, three of which are in the Dawson sub-catchment, and these have been sampled in June, 1994, October, 1994 and May, 1995.

The three sites in the Dawson River system are located at Q.D.P.I. (Water Resources) guaging stations on the upper and lower Dawson River and at Rannes on the Don River, a tributary of the Dawson. The upper Dawson site is located at Baroondah (Yebna) upstream of Taroom and the lower Dawson site at Beckers, about 10 km downstream of the Baralaba weir (Figure 1.1). Rannes is located just downstream of the junction between the Dee and Don Rivers. Although not located close to the proposed Nathan dam, these sites have provided useful background information on the biology and ecology of the Dawson River system. Table 2.1 shows the number of aquatic macrophyte species found at these sites during the D.E.L.U. study, as well as the average of and range in the number of species found per site.

Table 2.1 Aquatic macrophyte richness at three sites in the Dawson River system compared to the range in the number of species and average number of species per site taken over 11 sites in the Fitzroy River Catchment.

	June 94	Oct 94	May 95
Beckers	8	7	10
Baroondah	9	8	6
Rannes	2	4	
Range in no. of sp.	2-9	3-11	5-12
Ave. No. of sp./site	6.1	7	8.45

The data shown in Table 2.1 indicates that the sites on the Dawson River are relatively rich in aquatic macrophyte species compared to other sites in the Fitzroy catchment. The site at Rannes had relatively fewer species and this may have been due to the high grazing intensity at this site. Table 2.2 provides a comparison of species found at Beckers and Baroondah on the Dawson River.

Table 2.2 Comparison of aquatic macrophyte species for Beckers and Baroondah on the Dawson River found during the DELU Study.

	June 94		Oct 94		May 95	
Species	**Beckers**	**Baroondah**	**Beckers**	**Baroondah**	**Beckers**	**Baroondah**
Azolla pinnata					√	
Bacopa monnifera		√		√		√
Cyperus betchei						√
C. difformis	√					
C. javanicus	√		√		√	
C. sp. *1*	√	√				
C. rotundus	√		√		√	
Juncus sp. *1*		√				
Juncus polyanthemus				√		
Lomandra spicata		√				
Lomandra sp.	√	√	√	√	√	√
Ludwigia peploides				√	√	
Marsilea drummondii		√				
Muelenbecia sp.			√		√	
Persicaria sp	√	√				
Persicaria orientale			√	√	√	√
Polygonum attenuatum	√		√		√	
Potamogeton crispus				√		
Rumex	√	√	√	√	√	√
Spirodela oligorrhiza					√	

As shown in the table, the number of species found at these sites varied between 7 -10 at any one time, which is typical of water bodies with permanent water within the catchment (unpublished data). *Persicaria* (2 species), *Cyperus* (2 species) and *Juncus* (2 species) were important components of the aquatic macrophyte vegetation and were also found to be very common in earlier studies of the Fitzroy system by Duivenvoorden (1992b). Table 2.2 also shows the variation in the number of species present at any one site from one sampling occasion to the next, again illustrating the dynamic nature of aquatic macrophytes as discussed above.

3.0 PHYTOPLANKTON

The potential of phytoplankton to cause water quality problems in the form of toxic blue-green algae was illustrated recently with the largest bloom of these algae in the world being recorded in Australia (Bowling, 1992). The problems that these algae create has underlined their significance in aquatic ecosystems and emphasises the need to assess their potential to create water quality problems in water storages such as the one proposed for the Dawson River.

3.1 Previous studies

Few studies have been published on the phytoplankton of central Queensland. The earliest was a survey of diatoms, including epiphytic forms (that is, those attached to plant material) from a site on each of the Dawson and Dee Rivers by Foged (1978). All other studies in this area have been carried out by members of the River and Wetland Ecology Group at Central Queensland University (CQU) and Q.D.P.I. staff collaborating with this group. The main research projects covering this work are (a) a study of the spatial and seasonal distribution of phytoplankton in the lower Fitzroy River and accompanying physico-chemical parameters; and (b) a study (in conjunction with QDPI) of the phytoplankton at selected sites in the Fitzroy River catchment including several on the Dawson River. Both published and unpublished information gained from this research is summarised in this section.

Foged (1978) made observations of the phytoplankton on 2 July 1966 of a Dawson River site of unknown location. He described the water body at the site as a big pond with rather turbid water, having a pH of 7.2 and 55 taxa of diatoms (including epiphytes). On the same day he described a site on the Dee River as a big river, rich in stagnant clear water containing the aquatic macrophytes *Phragmites, Myriophyllum* and *Chara* and having a pH of 7.0 and 22 taxa of diatoms (including epiphytes). Other algal groups were not surveyed.

Early studies of the phytoplankton of the lower Fitzroy River (Fabbro and Duivenvoorden, 1992a) were based on monthly sampling of the phytoplankton and found that cyanobacteria (blue-green algae) dominated the phytoplankton in the impoundment behind the Fitzroy River Barrage from late winter to summer. All major genera of bloom forming cyanobacteria (including *Anabaena, Aphanizomenon, Microcystis, Cylindrospermopsis, Gleotrichia* and *Oscillatoria*) were recorded during the study. Information available with respect to a large bloom of *Anabaena circinalis* in September, 1989 was also given, including information on turbidity, which decreased rapidly in August and September of that year.

Further studies of phytoplankton in the Fitzroy River Barrage impoundment identified a toxic bloom dominated by *Nostoc* cf *linckia* upstream of the mouth of Alligator Creek in August, 1993 (Fabbro and Duivenvoorden, 1993) and blooms of predominantly coiled *Cylindrospermopsis raciborskii* in the summers of 1992 and 1993 (Fabbro and Duivenvoorden, in preparation). Complementary studies of the physical and chemical water quality parameters of the lower Fitzroy River just prior to this time (Fabbro and Duivenvoorden, 1992b) were published in the proceedings of the Fitzroy Catchment symposium (Duivenvoorden *et al.* 1992) and indicated an increase in the levels of nutrients compared with those recorded earlier by Connell *et al.* (1981). The study also found that factors known to enhance the possibility of cyanobacterial dominance - stratification, temperatures above 25 °C, hypolimnetic anoxia and epilimnetic denitrification - were present in spring and summer. The data also indicated that large flushes of water or substantial rainfall was required in the wet season to modify water quality parameters or remove established blooms from this impoundment.

3.2 Current CQU-QDPI Studies

The current joint CQU-QDPI research project examining the phytoplankton of the Fitzroy River system has 11 primary sampling sites throughout the Fitzroy River Catchment including one on the Don River at Rannes and two on the Dawson River - one at Beckers (near Baralaba) and the other at Baroondah (upstream of Taroom) (Figure 1.1). As with the aquatic macrophytes, these sites were sampled in June 1994, October 1994 and May 1995. In addition to these sites, samples to assess the potential for cyanobacterial bloom development in the Dawson River system were taken at intervals of two months (from August to December, 1994) from the Dawson River at its junction with Delusion Creek, from Theodore Weir, from Moura Weir and from a site where the Capricorn Highway crosses the Dawson River. Duplicate samples (taken with a vertical hosepipe or composite volume samples) representative of an average population and cell density throughout the water column were used for analyses. All samples were preserved in the field using calcium buffered 4% formalin or Lugol's Iodine, concentrated (10X), identified and counted at the species level where possible using a Sedgwick-Rafter counting cell.

3.2.1 Primary sampling sites: Results for June 1994

Species richness (the number of algal species detected per sample) was depauperate (less than five) at Rannes, Beckers and Baroondah in June 1994 with no Fitzroy River catchment site sampled at this time yielding greater than fifteen species. Rannes was the only site during this sampling time where a cell density greater than 100 cells mL^{-1} was recorded. These samples were dominated by flagellated forms whereas those from Beckers and Baroondah showed a dominance of diatoms with cyanobacteria (26% of the total abundance) recorded in one sample from Baroondah. (Diatoms are a common component of cool, well mixed or flowing water.)

3.2.2 Primary sampling sites: Results for October 1994

In October 1994, the phytoplankton at Baroondah in the upper Dawson River catchment was predominantly diatoms, while chlorophytes (green algae), euglenophytes (flagellated green algal forms), pyrrophytes (dinoflagellates) and cyanobacteria were recorded at Beckers with no sample having a cell density greater than 700 cells mL^{-1}. There was a general trend for species richness and algal density to be higher at Beckers. The taxa recorded at this time indicate that high turbidity (or sediment load) and lack of flow favour flagellated forms and cyanobacteria, as these groups can gain a favourable position in the water body with respect to light and nutrients.

3.2.3 Primary sampling sites: Results for May 1995

In May 1995 all Dawson and Don River sampling sites had similar depauperate species richness and cell densities compared to those found in June 1994, with the exception of a bloom (>15000 cells mL^{-1}) dominated by the cyanobacterial genera *Pseudanabaena* and *Merismopoedia* at Rannes. (Sampling in June 1994 at this site found cell densities less than 4000 cells mL^{-1} and a population dominated by chlorophytes (green algae)). Diatoms were dominant in the upper catchment at Baroondah and flagellated forms were present in impoundments.

3.2.4 Records of cyanobacterial blooms and taxa recorded in the Dawson Sub-catchment

Phytoplankton taxa recorded to date from sites within the Dawson River sub-catchment are listed in Table 3.1. Of particular note is the range of common cyanobacterial taxa including the genera *Anabaena* and *Pseudanabaena.* Supplementary sampling found increasing levels of *Anabaena circinalis* on 18 October, 1994 at the Capricorn Highway site and a bloom of *Anabaena torulosa* (> 15,000 cells per mL) in Moura Weir on 6 December 1994 following inflows. One factor that coincided with the latter bloom was a decreasing sediment load (Johnstone *et al.* 1985). This data suggests that the algae at this site may have been limited by light earlier on in the season - when turbidities were higher.

For the Fitzroy River catchment generally, the studies have found species richness and cell density to be relatively low at most locations (Fabbro and Duivenvoorden, 1995). Sampling throughout the catchment in October, 1994 found algal densities were higher at some sites than in June that year, with phytoflagellates (algae capable of movement using flagellae) and cyanobacteria becoming more important components of the phytoplankton. Cyanobacteria dominated in the Fitzroy and Mackenzie River sites and included the genera *Anabaenopsis, Aphanizomenon, Cylindrospermopsis* and *Pseudanabaena.* While cell densities were elevated at these primary sampling sites, blooms of greater than 15000 cells per mL were only detected in the weir at Moura in December, 1994 and at Rannes in May, 1995.

Overall, for the Dawson sub-catchment, analysis of physico-chemical information and algal taxa present indicates an algal population limited by the light environment. This is suggested by a decrease in sediment load at times of phosphate bioavailability and nitrate depletion in the spring and summer which coincided with cyanobacterial bloom formation in Moura Weir. The significance of this should be considered in studies aimed at assessing the potential of cyanobacteria to create water quality problems in the proposed dam on the Dawson River.

Table 3.1 Phytoplankton taxa recorded to date from CQU-QDPI Dawson River sampling sites. Sites are the same as those provided in Appendix III: No. 6 is Rannes, 7 is Beckers, 8 is Baroondah, 12 is the Dawson River at the Delusion Creek junction, 13 is Theodore Weir, 14 is Moura Weir and 15 is the Capricorn Highway site.

Taxon	6	7	8	12	13	14	15
Chrysophyta							
Cocconeis placentula			x				
Cymbella			x				
Dinobryon sertularia							x
Diploneis ovalis							x
Fragillaria						x	
Fragillaria ungeniana			x				
Frustulia magaliesmontana			x				
Frustulia rhomboides			x				
Frustulia rhomboides var *elongatissima*		x					
Frustulia rhomboides var *saxonica*							x
Gomphonema lanceolatum							x
Gyrosigma			x				
Mallomonas						x	
Melosira distans			x				
Melosira granulata	x	x					
Navicula	x	x					
Navicula cf *placentula*							x
Nitschia	x	x					x
Stauroneis			x				
Synedra	x		x				
Synedra ulna	x		x	x	x		
Chlorophyta							
Ankistrodesmus	x	x					
Botryococcus braunii						x	
Carteria cf *Klebsii*	x						
Chlamydomonas bicocca	x						
Closterium	x	x					
Pandorina morum		x			x		
Pteromonas					x		
Pyranimonas			x				
Scenedesmus	x						
Scenedesmus accuminatus	x						
Scenedesmus armatus		x					
Scenedesmus dimorphus	x						
Scenedesmus quadricauda	x	x					
Tetrastrum		x					
Unicellurar chlorophytes	x	x	x	x	x		
Westella		x					
Euglenophyta							
Euglena	x	x	x		x	x	x

Table 3.1 (continued)

<u>Euglenophyta</u> (continued)							
Euglena acus	x					x	x
Euglena cf *clavata*							x
Euglena mangini	x				x		x
Euglena oxyuris	x	x					
Lepocinclis salina					x		
Phacus pleuronectes	x						
Strombomonas urceolata	x	x			x	x	x
Trachelomonas	x				x	x	x
Trachelomonas eurystoma var *nuda*					x		
Trachelomonas intermedia	x						
Trachelomonas oblonga						x	x
Trachelomonas oblonga var *australicum*		x	x	x	x	x	x
Trachelomonas ovalis						x	
Trachelomonas pulcherrima var *latior*		x					
Trachelomonas scabra						x	
Trachelomonas scabra var *cordata*						x	
<u>Pyrrophyta</u>							
Glenodinium							x
Glenodinium oculatum var australicum	x	x					
Glenodinium oculatum var circulatum		x	x		x		x
Peridinium		x			x	x	x
Peridinium inconspicuum	x						
<u>Cryptophyta</u>							
Cryptomonas	x				x	x	
<u>Cyanobacteria</u>							
Anabaena circinalis		x					x
Anabaena solitaria var *planktonica*			x				
Anabaena spiroides	x						
Anabaena torulosa						x	
Chrococcus	x						
Cylindrospermopsis raciborskii	x						
Gleocapsa	x						x
Merismopoedia minima	x	x					
Phormidium			x				
Pseudanabaena	x		x				
Pseudanabaena limnetica	x						
Pseudanabaena musicola	x						
Raphidiopsis curvata	x						
Spirulina laxa	x						

4.0 AQUATIC INVERTEBRATES

Aquatic invertebrates play very significant roles in the ecology of streams. They are extremely important in nutrient cycling and serve as the link between detrital matter and the larger organisms that feed on them, such as fish and birds. Invertebrates also feed on benthic and epiphytic algae which are important primary producers in aquatic ecosystems. They are also of significance to aquatic ecosystems in that some of them are good indicators of environmental 'health' and so are often used in environmental assessment studies.

4.1 Previous Studies

The earliest known study dealing with the aquatic invertebrates of the Dawson River system was published in 1979 by Lee and Fielder. This study recorded the migratory movements of the freshwater prawn, *Macrobrachium australiense* Holthius below the Glebe Weir on the Dawson River. The Glebe weir is situated approximatelty 180 km from its source (Lee and Fielder, 1979) and consists of a 6 m high spillway with a steplike buttress on one side. It was observed that juvenile freshwater prawns were able to climb the 6 m high weir while adequate water was flowing over it. The period of greatest activity occurred shortly after the spillway was fully shaded. The major conclusion from this study was that while water flowed over the Glebe Weir, the water currents provided a stimulus for the prawns to migrate upstream.

Leggett (1986) conducted a small scale survey of the aquatic biota of several upper tributaries of the Burnett and Dawson Rivers. In this survey the presence of aquatic plants was noted (though the species were not recorded) as was the presence of numerous Decapoda, Coleoptera and Odonata. The study did offer some basic data on the water quality, but little quantitative information.

One of the first more detailed studies on aquatic biota of the Dawson River system was published by Mackey (1988) (as referred to earlier in section 2.0). The purpose of this study was to assess the impact of acid mine drainage on a section of the Dee River (a major tributary of the Dawson River). Samples of the study area were taken during 1981/82, and again in 1985/86. The study involved the qualitative sampling of aquatic invertebrates at eight sites stretching along approximately 50 km of the river, using pond nets of mesh size 1mm, taking eight two minute samples at each site. Several physical/chemical water quality parameters such as pH, conductivity and the concentrations of various dissolved metals were also recorded. Although this study may not be directly relevant to the current Nathan Dam proposal, it is useful for comparative purposes. It provides information on the types and numbers of taxa of aquatic invertebrates that may be expected to be found in a major tributary of the Dawson River.

Over the period of the study 40 invertebrate taxa were recorded from the (unpolluted) control site. A total of 33 of these taxa was found during the first of the two sample periods (1981 -1982), while during the second (4 years later) 29 were found. Although the difference in numbers was slight, the families that made up these two samples were quite different. Only 22 of the 33 taxa found in 1981/1982 were still present in 1985/1986.

Similar results were found more recently in a study aimed at assessing the biological status of the Dee River system in March, 1995 (Duivenvoorden, 1995a). This study utilised similar sampling methods and the same study sites as Mackey (1988), plus three additional unpolluted sites - two on the Dee River and one on Fletcher Creek, a tributary of the Dee River. The number of taxa found in this study at a control site upstream of the mine was similar to that found at the same site by Mackey (1988), with a total of 30 taxa being recorded. Of the other two unpolluted sites on the Dee River, one had 26 taxa and the other 31. (The third unpolluted site (on Fletcher Creek) had only 19 taxa). Although the number of taxa recorded from the control site in Mackey (1988) and those in Duivenvoorden (1995) were very similar, the families recorded were quite different. Of the 30 taxa found by Duivenvoorden (1995a) only 16 of them were present in samples taken in 1985/86 by Mackey (1988). This represents a replacement by other invertebrate families of nearly 50% of the taxa recorded in 1985/86 by Mackey (1988). This is significant in that it indicates that a "once off" survey of the aquatic invertebrates is very unlikely to produce records of the full complement of aquatic invertebrates that may inhabit a stream in the Dawson River system at any one location. This has important ramifications for the types of studies that may be required to determine the environmental flow requirements of the Dawson River downstream of the proposed dam. This is further discussed in Chapter 6.

4.2 Current CQU-QDPI Studies

The most recent invertebrate studies in the Dawson River system are a result of a joint effort by the Central Queensland University and the Queensland Department of Primary Industries studying the Downstream Effects of Land Use (DELU) throughout the Fitzroy River Catchment (Noble *et al.* 1995). As part of this study, three sites were selected within the Dawson River sub-catchment, two on the Dawson River itself (at Baroondah and Beckers) and one on the Don River just downstream of the junction with the Dee River at Rannes (Figure 1.1) (Duivenvoorden, Roberts and Holmes, 1995).

The sampling strategy used for this ongoing research involves taking four 2-minute replicate samples at each site, using pond nets of 1mm mesh size. Since the project's inception, three field surveys have been conducted, one during June 1994, another in October 1994 and the most recent in May 1995.

Data collected on the invertebrates at these sites is shown in Figures 4.1 and 4.2, along with data from other sites in the Fitzroy Catchment for comparative purposes. Generally the number of taxa at most sites was between 23 to 30 per site and the average abundance of invertebrates between 200 to 500 animals per sample. The sites in the Dawson River system were generally not markedly different from most of the other sites in these respects, though the site at Baroondah had a very high abundance of invertebrates (mainly Dipteran fly larvae) in October of 1994 (Figure 4.1 and 4.2). The families of aquatic invertebrates found in the major invertebrate orders recorded in the two sites on the Dawson River are provided in Table 4.1. These data show that in

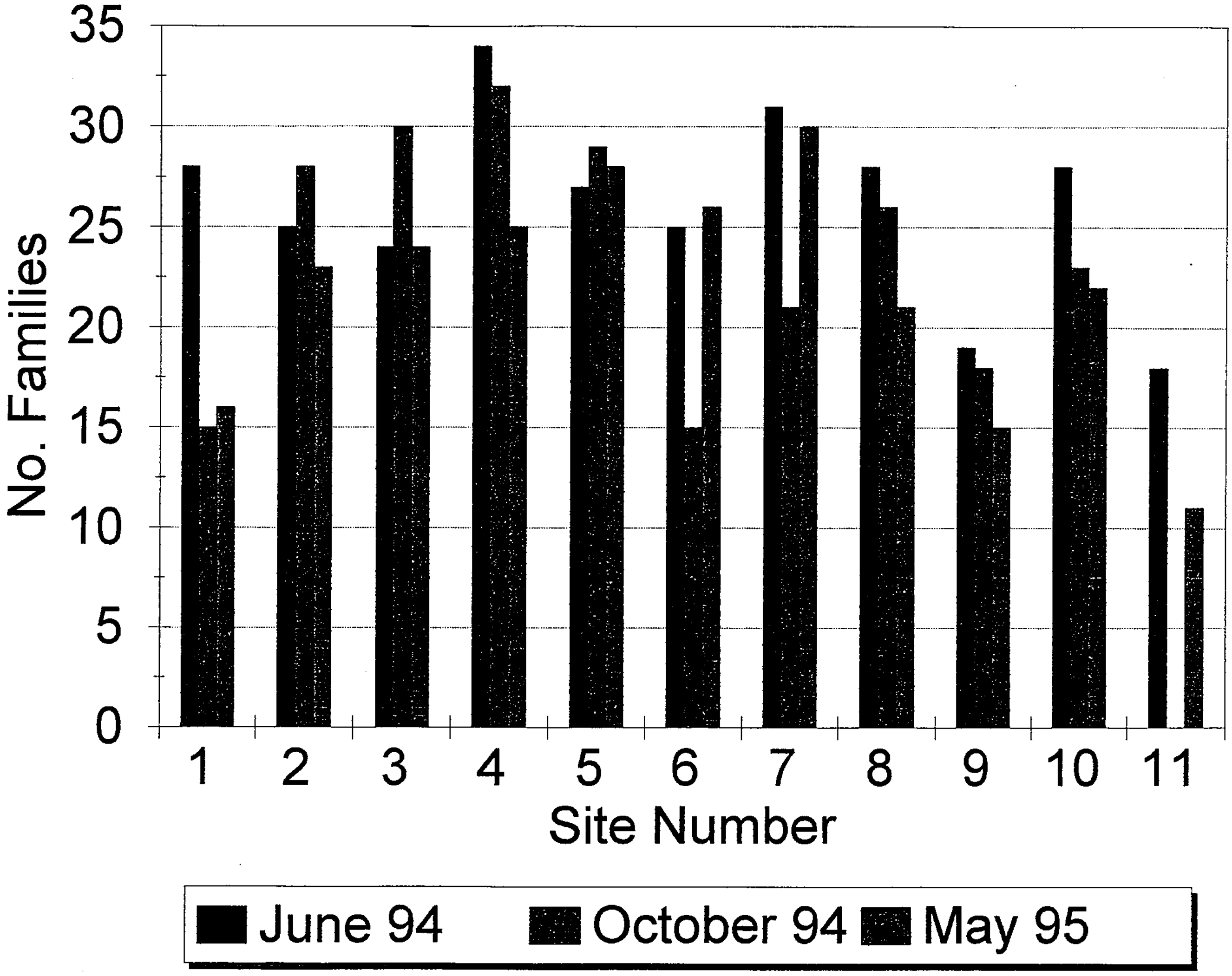


Figure 4.1 Number of aquatic invertebrate families recorded from four samples collected at 11 sites in the Fitzroy River Catchment in June and October, 1994 and May, 1995. Site numbers 6, 7 and 8 refer to the sites at Rannes, Beckers and Baroondah in the Dawson Catchment, respectively.

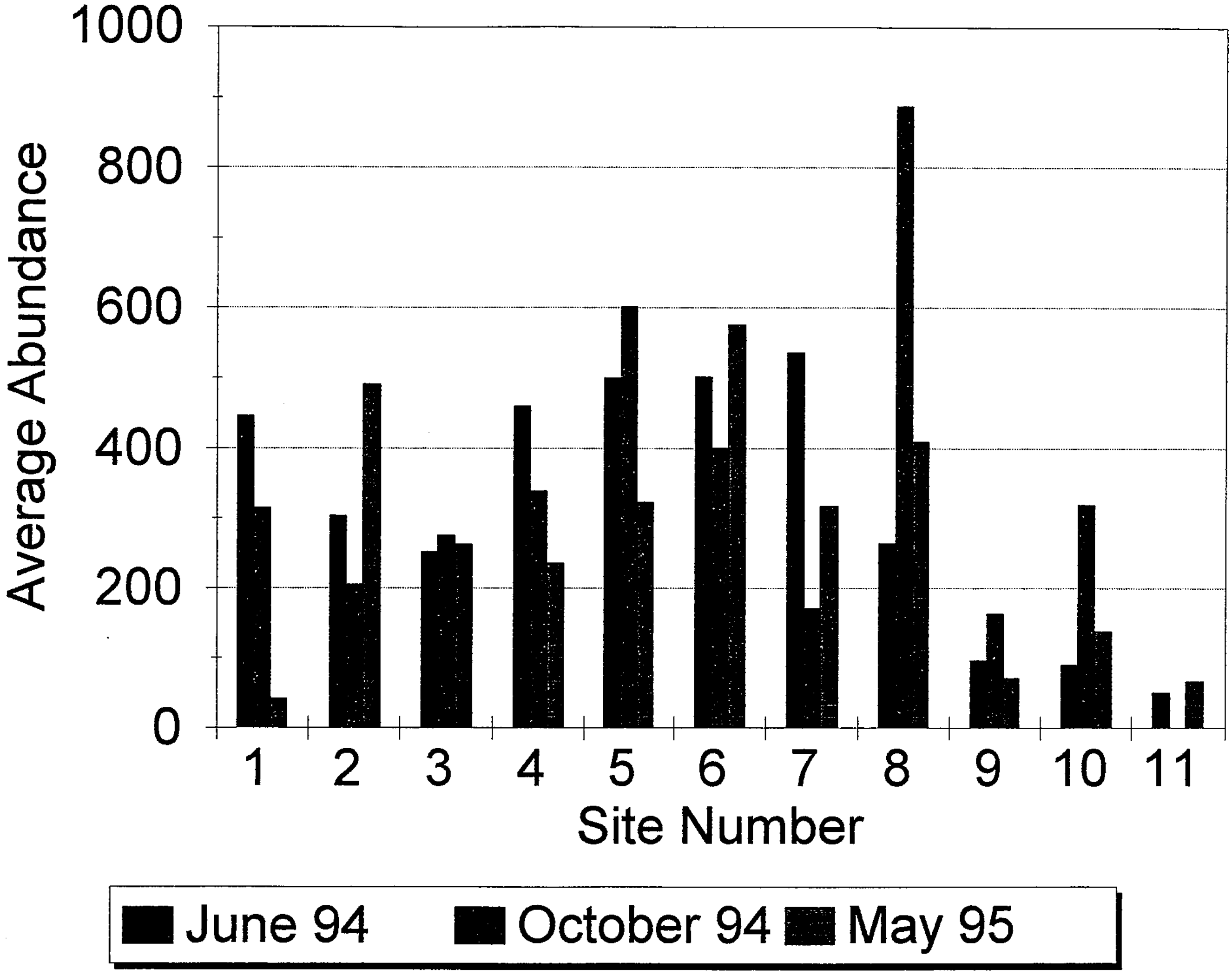


Figure 4.2 Average abundance of four replicate samples of aquatic invertebrates collected at 11 sites in the Fitzroy River Catchment in June and October, 1994 and May, 1995. Site numbers 6, 7 and 8 refer to the sites at Rannes, Beckers and Baroondah in the Dawson Catchment, respectively.

Table 4.1 Number of aquatic invertebrate families in various orders at two sites (Beckers and Baroondah) on the Dawson River for June and October, 1994 and May, 1995

Order	June 1994		October 1994		May 1995	
	Beckers	Baroondah	Beckers	Baroondah	Beckers	Baroondah
Coleoptera	8	6	3	7	4	3
Diptera	3	3	3	3	4	4
Ephemeroptera	2	4	2	3	2	2
Hemiptera	6	4	2	4	5	5
Odonata	2	2	0	2	2	1
Trichoptera	2	2	4	3	4	2
Bivalvia	1	1	1	1	3	1
Gastropoda	4	4	4	2	3	1
Decapoda	2	1	2	1	2	1
Isopoda	1	1	0	0	1	1
Total	31	28	21	26	30	21

Table 4.2 Average abundance of four samples of aquatic invertebrates at 11 sites in the Fitzroy River catchment for June and October, 1994 and May, 1995. Sites in the Dawson sub-catchment are site 6 (Rannes), site 7 (Beckers) and site 8 (Baroondah).

Site	June 94	October 94	May 95
1	446	315.25	42
2	303.75	205.25	491.25
3	252	275.3	262.75
4	460	339	236.25
5	500	601.5	323.25
6	501.25	400.5	576
7	536	171	316.75
8	264.25	888	409
9	96.5	162.75	71
10	90	319.25	137.75
11	50.25	0	66.5
Average	318.18	334.35	266.59

terms of the number of families represented, the Coleoptera, Hemiptera, Diptera and Gastropoda are important components of the invertebrate fauna of the Dawson River Sytem.

Aside from these general features of the data, it is important to note the extent of the variability that exists in both the number of taxa per site and the abundance of individuals per sample between both sampling times and sites. For example, the number of families recorded per site at Rannes and Beckers decreased between June and October, 1994 by 40 and 32%, respectively, whereas this did not occur at most of the other sites. By May, 1995 the number at these two sites had returned to those in June of 1994, while the number at Baroondah had decreased by a small amount (Figure 4.1). Variation in the abundance of populations between sites is clearly seen in Figure 4.2, with some sites much lower in average abundance than others. Changes in abundance with time are well illustrated by the populations monitored at the three sites in the Dawson River system. In June 1994, samples taken from Beckers and Baroondah reveal populations at Beckers to be the most abundant with 536 invertebrates, approximately twice the number at Baroondah (with 264) (Table 4.2). The following sample in October 1994 shows a complete reversal with the population at Baroondah being over five times the number of invertebrates (888) as at Beckers (171). This is not an unusual feature of these populations, with other sites showing similar changes. These data further illustrate that aquatic invertebrate populations in the Fitzroy River system are very dynamic and emphasises the need to take this into consideration in any future studies of the invertebrate fauna of the Dawson River system which may be undertaken in relation to the proposed dam.

One other study currently in progress investigating the aquatic invertebrate fauna in the Dawson River system is the Monitoring River Health Initiative funded by the Commonwealth Environment Protectiion Agency through the Land and Water Resource Research and Development Corporation. This project uses a rapid sampling and assessment protocol and is being handled by staff of QDPI Water Resources in Rockhampton for the Dawson valley. Four sites have been selected within the Dawson system and some samples have been taken, but results of the analyses are not yet available (N. Kelly, Pers. Comm.). Two of the four sites are at Baroondah and Beckers and are the same as those studied in the D.E.L.U. project reported above.

5.0 TERRESTRIAL FLORA AND FAUNA

Alistair Melzer, Leise Childs
Centre for Land and Water Resource Development
Faculty of Applied Science
Central Queensland University

5.1 Introduction

The Dawson Valley forms part of the Fitzroy River drainage system and is wholly contained within the brigalow belt of Eastern Australia. As such the valley has been extensively developed for rangeland grazing, agriculture and forestry since the early 1960's. Agriculture has continued to develop and intensive dryland and irrigation cropping is widely developed. The intensification of agricultural and other uses of the Dawson Valley has resulted in an intensification of impacts on the natural systems of the valley. The possible impact of the Nathan Dam needs to be considered in this context and the collation of the information in this report is one of the first steps in this process. The report identifies source material which will contribute to an assessment of the distribution, species composition and conservation status of the terrestrial flora and fauna of the proposed dam site.

5.2 Terrestrial flora of the Dawson Valley

5.2.1 Literature

Currently there is no detailed description of the floristic composition and structure of the terrestrial vegetation of the Dawson Valley. The literature is available, however, to derive a description from regional descriptions of the vegetation and geomorphology of the brigalow belt of eastern Australia and various studies of the Fitzroy - Dawson area.

The terrestrial vegetation of the Dawson Valley was described as part of a general vegetation description of the Dawson - Fitzroy area by Speck (1968). The Dawson - Fitzroy vegetation was classified into 74 floristic communities within forms of subtropical rainforest, forest, woodlands and grassland. The rainforest classifications followed Webb (1959) while the other structural forms were classified according to Beadle and Costin (1952). These communities, together with topography and soils, formed components of 63 land systems which were used to map the Dawson - Fitzroy area according to the methods of Christian and Stewart (1953) cited in Wilson (1968). The land system map is quite detailed and, in conjunction with ground truthing, would provide the basis for a structural and floristic interpretation of the Dawson Valley.

The distribution of brigalow communities throughout eastern Australia was mapped by Isbell (1962) from aerial photography at a scale of 1in. - 4 miles. The basis for the mapping was brigalow dominated communities and "communities in which brigalow may occur as a minor component were deliberately excluded". Unfortunately the map was missing from the volume available to the authors so comment on its interpretive value to a study of the Dawson Valley is not possible. The report, however, provides a discussion of the structure and floristic composition of the main brigalow communities (see Appendix 1, pp. 51-59, in Isbell 1962) and together with the map may provide a significant adjunct to the lands systems report discussed previously. The basis for Isbell's discussion of community structure was Webb (1959) and Wood and Williams (1960). An unpublished report of the Bureau of Investigation by Isbell undertaken in 1959 involving soils and landuse surveys of part of the Dawson Valley may include some vegetation analysis (Forster pers. comm.). This report is currently being sought by Bruce Forster (QDPI Rockhampton).

Major structural groups of vegetation within the Fitzroy region (including the Dawson Valley) were described in Gunn and Nix (1977). In contrast to the previous studies, the classification of vegetation structure was based on Specht (1970) and there is some discussion of the effects of land clearing on some vegetation groups.

A more extensive discussion of the vegetation of the brigalow belt of eastern Australia was provided by Johhnson (1984) and subsequently, constructed from this, an account of the vegetation of the Fitzroy catchment by Johnson (1992). No maps were provided with either report and their interpretation in terms of the Dawson Valley should be undertaken in conjunction with the land systems maps. Johnson (1992) is particularly useful as it relates plant formations to geomorphic categories and to the geology of exposed surfaces.

R.L. Specht and others (Specht in press) are currently publishing a conservation atlas of plant communities in Australia. The atlas has been derived from published floristic lists over the last 70 years and the communities have been defined using the numerical analysis package on CSIRONET; TWINSPAN. The occurrence of the major plant communities was used to create a floristically-based biogeographic regionalisation of Australia (A. Specht pers comm). The plant communities are defined on half degree grid cells (about 70 km x 70 km) and are probably going to be too coarse to adequately resolve the plant communities of the Nathan Dam site. They may, however, provide a national basis for assessing the conservation significance of the vegetation of the Dawson Valley.

A draft report of the Queensland Department of Environment and Heritage (QDEH 1995) examines the conservation status of the state's plant communities or "bioregional ecosystems". Nine hundred and twenty four regional ecosystems are recognised and their conservation status classified as endangered (less than 5% pre-European extent remains), vulnerable (5 -10% pre-European extent remains), of concern (greater than 10-30% pre-European extent remains), and no concern at present (greater than 30% pre-European extent remains and more than 5% is protected within reserves). They conclude that 40 (4%) ecosystems are endangered, 101 (11%) are vulnerable, 124 (14%) are of concern and 659 (71%) are of no concern at present. Within the brigalow belt (including the Dawson Valley) 147 regional ecosystems are recognised. Of these 21 are endangered, 19 vulnerable, and 30 of concern. This high number of ecosystems under some conservation concern is probably a reflection of the extent to which the brigalow belt has been developed for agriculture. No detailed maps of the location of the regional ecosystems are provided and currently their location must be constructed from the land systems reports. The philosophy behind the report and indications of how it may be used are outlined in Hoy *et al.* (1992).

Detailed maps are, however, being prepared by the Queensland Department of Environment and Heritage (Herbarium-Ecology Branch) which is currently mapping Queensland forests. The "Comprehensive regional assessment of Queensland's native forests" is part of the Queensland Government policy on "Greater Planning Certainty for Queensland's wood products industry". The mapping is being undertaken on a priority basis with South East Queensland having highest priority. The Dawson Valley falls outside the South East Queensland priority area and will be waiting at least two years for mapping to start (Stanley pers. com.). According to Leverington (QDEH) data on terrestrial vegetation, fauna and aspects of culture are being analysed to facilitate Queensland Government decisions related to logging and associated conservation issues. Eventually the Brigalow Belt biogeographic region (including the Nathan Dam site) will be mapped. The vegetation mapping will involve field teams and will be undertaken at a scale of 1:100,000. Vegetation structural classes will be defined according to Walker and Hopkins (1990). These maps should update the land system reports of Perry (1968) and the vegetation structural classifications of Gunn and Nix (1977).

5.2.2 The vegetation

5.2.2.1 Vegetation structure

The bottom of the Dawson Valley represents the main channel of the Dawson River. For most of its course the river flows through recent sediments (Quaternary alluvium) forming a complex of meandering and anastomosing channels and levees. This is flooded alluvial country largely dominated by coolibah (*Eucalyptus coolibah*). These lands correspond to the Coolibah land system of Perry (1968). Seven land units make up this land system but the predominant vegetation type is a grassy woodland dominated by *E. coolibah* with some *E. tessellaris*, *E. polycarpa* and some *E. tereticornis*. This vegetation type is equivalent to the *Eucalyptus* grassy woodland of Gunn and Nix (1977). Johnson (1992) describes this vegetation as *E. coolibah* (coolibah) woodland which is dominated by *E. coolibah* with *E. tereticornis* and *E. tessellaris* (or *E. populnea*). He describes the understorey as including *Acacia spp.* such as *Acacia salicina* as well as *Eremophila bignoniiflora* and *Lysiphyllum hookeri*. The grassy understorey includes *Dichanthium sericeum, Paspalidium spp., Thellungia advena, Sporobolus mitchellii* and *Cyperus bifax*. The Nathan Dam site will flood this vegetation community within the Coolibah land system in the vicinity of Taroom.

Between Taroom and Theodore the river traverses a complex of land systems. These include *Narran, Mundell, Woleebee, Dakenba, Nathan* and *Carborough* land systems (Perry 1968). The *Narran, Mundell, Woleebee, Dakenba* land systems are potentially effected by the Nathan Dam proposal. Downstream of the dam the *Nathan* and *Carborough* land systems are unlikely to be directly affected. These six land systems are briefly discussed below.

The *Narran* land system consists of tablelands and slopes supporting softwood scrub, eucalypt woodlands and brigalow. It consists of ten land units most of which are on hills and slopes above the proposed inundation level of the dam. However, some lower land units consisting of *E. populnea* grassy woodlands and stream fringing open forests, primarily of *E. tereticornis* and *E. coolibah*, are likely to be inundated. These stream fringing forests may have a mid storey of *Acacia spp., Callistemon sp.* and a number of softwood scrub species, with vines and creepers.

Like the *Narran* land system, the *Mundell* land system consists of softwood scrubs and brigalow on tablelands and slopes and is composed of nine land units. The dominant vegetation is softwood scrubs, brigalow and occasionally bauhinia (*Lysiphyllum spp.*). These are unlikely to be affected by the dam, in contrast to the lower slopes and valley floor where four communities are likely to be affected. These are brigalow scrubs with wilga (*Geijera parviflora*) and sandalwood (*Eremophila mitchellii*) on colluvial slopes, bluegrass grasslands on the lower slopes and *E. populnea* grassy woodlands and fringing *E. tereticornis* open forests on the valley floor and along stream channels.

The *Woleebee* land system is comprised of eucalypt woodlands and some brigalow on undulating plains. The river channel is fringed by *E. tereticornis* open forest and associated vegetation as in the *Narran* land system above. The valley floor on the older alluvium away from the river channel supports dense brigalow (*A. harpophylla*) with a tall *Geijera parviflora* and *Eremophila mitchelii* shrub layer. There is a well developed low shrub layer of *Carissa ovata* and *Heterodendrum sp.* in places on the valley floor. The majority of the valley floor is dominated by *E. populnea* grassy woodland with scattered *E. orgadophila* and *Callitris columellaris*. This land system appears to the authors to be the most extensively occurring land system within the flood zone of the proposed Nathan dam.

The *Dakenba* land system consists of brigalow country on alluvium associated with the Dawson River. Again the main stream channel is fringed with *E. tereticornis* open forest while the valley floor consists primarily of brigalow associated communities with some *E. populnea* grassy woodland. On the frequently flooded slopes *E. coolibah* seedlings may be quite abundant. The lower facets of this land system along the Dawson River and adjoining Cockatoo Creek will probably be inundated by the proposed Nathan Dam.

Both the *Carborough* and *Nathan* land systems are comprised of rugged sandstone country supporting eucalypt forests. Through these systems the Dawson Valley floor supports tall eucalypt forests and woodlands which fringe the river channel and occur on the adjacent lower slopes. These systems are below the proposed Nathan Dam site.

The Dawson Valley floor may also be described using the vegetation structural classification of Gunn and Nix (1977). It consists predominantly of *Eucalyptus* open-forest (associated with hilly, mountainous terrain), *Eucalyptus* grassy woodland (woodlands on alluvium and gentle to moderate slopes dominated by *E. tereticornis, E. populnea, E. orgadophylla* or *E. melanophloia* depending on the topography and soils), Eucalyptus shrub woodlands (primarily *E. populnea* with a shrubby mid storey of *Geijera parviflora, Ventilago viminalis, Eremophila mitchelii* and *Carissa ovata*), and *Acacia* open-forest (dominated by *A. harpophylla* on clay soils in broad lowlands and gently undulating soils) depending on soils and topography.

Three of these vegetation structures, *Eucalyptus* open-forest, *Eucalyptus* grassy woodland, *Acacia* open-forest, and a fourth, much smaller unit, low closed forest occur within the flood zone of the proposed dam. Low closed forest representing "dry rainforests" is found on plains and undulating terrain over texture-contrast and brown and grey-brown soils. These vegetation structural types form components of the *Narran*, *Mundell*, *Woleebee*, *Dakenba* land systems discussed earlier.

None of these vegetation and land classification systems take account of the changes that have occurred with land clearing and altered land management practices since the 1960's. There is colloquial information that suggests that remnant communities have altered in floristic composition and structure over the last few decades at least. The draft report on the conservation status of bioregional ecosystems (QDEH 1995) takes some account of land development in its assessment of conservation status for each bioregional ecosystem. Within the Taroom Province (Provinces are described as "areas with similar patterns of local climate, vegetation geology and landform in the report") 17 ecosystems are recognised. Of these, six are classed as endangered, three vulnerable, and four of concern. These ecosystems are listed below.

CONSERVATION STATUS	REGIONAL ECOSYSTEM
Endangered	softwood scrub on colluvials
	brigalow-belah yellowwood woodland on basalt lowlands
	brigalow - Dawson gum open-forest on shales
	brigalow open-forest on shale
	belah open-forest on shale
	Queensland bluegrass-brigalow patchy plain on shales
Vulnerable	brigalow open-forest on colluvials
	softwood scrub on shales
	bonewood scrub on shales
Of concern	coolibah woodland on alluvials
	forest red gum/river red gum-roughbarked apple woodland on alluvials
	softwood scrub on basalt ranges
	Queensland bluegrass-Mitchell grass grasslands and low open woodlands on shales.

Many of these ecosystems are similar to brigalow associated communities likely to be found within the land systems occurring on the Nathan Dam site, and it is probable that a detailed vegetation survey will identify some of them within the flood zone.

5.2.2.2 Species composition

It is clear from the discussion above that the occurrence of terrestrial plant species within the Dawson Valley can generally be predicted from the land system or vegetation structure occurring at the site of interest in conjunction with a knowledge of the distribution and habitat requirements of Queensland's plant species. This information is derived largely from field collections and floristic records held by the Queensland Herbarium. These records are computerised and species distribution and habitat data can be obtained for specific locations throughout Queensland. Two data bases are available. CORVEG (Vegetation and flora database for Queensland: Vegetation site attributes) was developed by W.J.F. McDonald and H.A. Dillewaard at the Queensland Herbarium. Vegetation records and site attributes for plants collected throughout Queensland, including sampling methodology and habitat characteristics, are stored in this database. The second system, HERBRECS, provides data on location of collection point, conservation status, habitat and additional data as well as a map of national or state distribution. There is a charge for HERBRECS data. The charges are $0.10/ record and $5.00 for a distribution map of each species. There is a minimum charge of $20.00.

As a trial of the system the authors sought HERBRECS data on the lands within 25° 05', 150° 15' and 25° 45', 149° 42' - encompassing the Dawson Valley around the Taroom region. This search identified 308 species and subspecies, of which two were classed as vulnerable, one as poorly known and 14 as rare.

The poorly known species *Boronia sp.* (Nathan Gorge N. H. Speck 1925) and the rare species *Macarthuria ephedroides* and *Leucopogon grandiflorus* have been collected on the Dawson River from Nathan Gorge. Other rare species *Wahlenbergia islensis*, and *Calytrix islensis* have been collected from the surrounding region in habitat similar to that of the Nathan Gorge and its surrounds. It is possible that plants of these species may occur on the rocky walls of the Dawson River at the site of, or just upstream of, one proposed dam wall construction site.

Another rare species *Livistona sp.* (Taroom R.W. Johnson 2764) has been collected on the Dawson River, downstream of the dam site, on Robinson Creek and the adjacent Lake Murphy. Not unexpectedly Phillips (1995) found this species on the Dawson River and its tributaries within the flood zone of the dam.

A recent collection of the flora associated with the mound springs (boggomosses) on the Dawson River near Taroom was undertaken by Bruce Wilson (QDEH - South-Western). Although the taxonomy is not complete 162 species were collected including the grass *Arthraxon hispidus* and the fern *Thelyptensis conflicens*. *Arthraxon hispidus* is classed as vulnerable under the Queensland Nature Conservation Act (1992) (schedule 3 of the Nature Conservation (Wildlife) Regulations (1994)) and endangered under the Commonwealth Endangered Species Protection Act (1992) (schedule 1). The fern *Thelyptensis conflicens* is known from only four locations and will be listed under the Queensland Nature Conservation Act in the future. Three other plants (two mosses and a bladderwort) are probably new species. These "boggomoss" communities will be directly affected by the Nathan Dam flooding.

This "boggomoss" collection represents a small diverse community which will almost certainly be considered of high conservation value. The detailed floristic descriptions derived from collections such as this cannot be extrapolated from regional descriptions or mapping programs and require a local and intensive survey. The proposed Nathan Dam site includes the Narran and Mundell land systems both of which support softwood scrubs. These are vegetation communities of high conservation significance due to their high species diversity, the rare plant species they support and their restricted distribution (Gunn and Nix 1977, Forster *et al.* 1991, QDEH 1995). Although it is likely that most of these communities will be above inundation by the dam, softwood scrub species occur as part of the stream fringing open-forests on the valley floor (Speck 1968) and a detailed vegetation survey may find these stream fringing communities to be of relatively high species diversity. In addition, given the extent of regional land development (Melzer pers. obs.) these communities may be of high local conservation significance.

5.3 Terrestrial Fauna of the Dawson Valley

5.3.1 Literature

The only detailed terrestrial fauna survey to be undertaken in the Taroom Shire is that of Crossman and Reimer (1986). This survey of mammals, birds, reptiles and amphibians was undertaken from 1977 to 1979. Earlier work includes the diary of Gilbert (1844,) who accompanied Leichhardt's expedition; Finlayson's (1931,1934) records of mammals, and Crossman's (1974) survey of vertebrate fauna in Robinson Gorge National Park.

In recent times, interest in the artesian springs of the Dawson Valley has sparked some initial investigations of their fauna. Artesian springs support a rich array of smaller aquatic and less mobile fauna classes (Wilson 1995). A number of rare and threatened species have been recorded only from 'mound springs', and these unusual environments support a particularly high number of endemic species. Wilson (1995) lists the mound springs of the Taroom area, locally known as "Boggomosses", as a priority area for systematic survey.

The Queensland Museum undertook a limited field study of the Boggomosses over 3 days in mid-May 1995. Publications in progress following the trip are Ingram's paper on isopods of the Dawson Valley mound springs (Ingram pers. com.) and Stanisic's paper covering the snails on and near Boggomosses of Mt Rose station. Both papers will appear in the *Memoirs of the Qld Museum* (Stanisic pers. com.).

5.3.2 The fauna

The Queensland Museum holds records of fauna for Queensland and they may be searched in various ways. A search for listed species in a defined geographic area costs 40 cents per record with a minimum charge of $ 48.00. The Museum does not hold extensive records for the study area due to the paucity of detailed surveys in the area.

5.3.2.1 Vertebrates

The Dawson Valley is part of the biogeogrphic region known as the Brigalow Belt, in which a diversity of habitat types exist. These include softwood and brigalow scrubs, eucalypt woodland and open forest, riverine and rocky cliff vegetation and open grassland (see section 5.2).

Crossman and Reimer (1986) concluded that while the brigalow and softwood scrubs had been extensively cleared by 1979, the impact on the vertebrate fauna had been limited. These scrubs are not considered faunistically unique and should not be treated in isolation but rather as part of an association with eucalypt communities.

A complete list of the vertebrate species recorded in the Taroom Shire (a total of 328 species) is given in Crossman and Reimer (1986). All of the broad habitat types identified by these authors occur in the study area and hence the species listed are expected to occur there also.

Mammals

Forty-eight species of mammal were recorded, including eight introduced species. Crossman and Reimer (1986) found established feral populations, but numbers were apparently low and stable, posing no significant threat to the survival of native populations.

Gordon (1984) notes that few mammals of the brigalow belt are specific to a single vegetation type. The brigalow mammal fauna is more accurately derived from and shared with the fauna of eucalypt woodland and open forest communities. Gordon (1992) acknowledges minor associations of mammals with softwood scrubs and states that it is possible to find endemism in the lower vertebrates and invertebrates of the Dawson Valley. Stanisic (in press) has found assemblages of invertebrate fauna confined to very moist habitats.

Habitats associated with the sandstone ranges of the Central Highlands permit some open forest mammals of the humid coastal areas to extend their ranges into this region for example *Pseudocheirus peregrinus* (Common ringtail possum), *Petaurus australis* (Yellow-bellied glider), *Macropus parryi* (Whiptail wallaby) and *Melomys cervinipes* (Fawn-footed melomys) (Gordon 1984).

Pseudocheirus peregrinus (Common ringtail possum) and *Petaurus norfolcensis* (Squirrel Glider) were not recorded by Crossman and Reimer (1986), although both were noted by Finlayson (1934) as having low population densities in the area, and both could be expected to occur. Much of the brigalow belt has been cleared, leaving only remnant areas of intact vegetation and Gordon (1984) notes that small and medium sized ground mammals are scarce or extinct in such areas.

Birds

Two hundred and nine species of birds were recorded by Crossman and Reimer (1986), reflecting the diversity of habitat and the geographic location of the Taroom area. Some migratory species are absent from the list and some species with low abundance may also have been missed.

The Paradise parrot (*Psephotus pulcherrimus*) was noted by Gilbert (1844) and a sighting was made in 1922, but sightings since then have been unconfirmed and they remained unverified (Crossman and Reimer 1986).

The Valley floor does not posses any extensive habitat for marsh and waterbirds and this is reflected in a paucity of these species along the river. The construction of a permanent water body can be expected to alter this avifauna complement.

Reptiles

Fifty-two reptile species were found in the 1977 to 1979 survey with only 50% of the reptiles expected by Crossman reflecting the difficulties in adequately surveying this diverse group of animals. Detailed searching should reveal more species, with attention to the hitherto little surveyed sandstone cliffs and gorges.

Phillips (1995) writes that the *Paradelma orientalis* (Brigalow scale foot), a vulnerable species, has been recorded from Nathan Gorge, although the original reference is unclear.

Amphibians

Of the nineteen species of amphibians listed by Crossman and Reimer (1986) the Long-thumbed frog (*Limnodynastes fletcheri*) is of note as it was found at the northern limit of its distribution. In 1979 the Cane toad (*Bufo marinus*) was a recent arrival in the Shire (Crossman and Reimer 1986) and the possibility that it may have substantially influenced the populations of native amphibians in the intervening years should be considered (Melzer pers. com.). Additional frog species may be found with further investigation of the Boggomoss communities.

5.3.2.2 Invertebrates

The invertebrate class has generally been ignored in fauna surveys. There are some records for the general region (Queensland Museum) and recently, Lambkin and New (1994) described a new species of lace wing, *Theristria taroom,* from the Dawson Valley.

In contrast to the vertebrate fauna, the invertebrates exhibit habitat specialisation, particularly those surviving in moist refuges protected from the generally dry conditions.

Snails require a moist environment and this is found in four habitats of the Dawson Valley: vine thickets and brigalow on well drained soil, vine thickets on rocky outcrops, vine thicket/ rainforest (dominated by *Livistona sp*) on the edges of drainage lines, and Boggomosses (John Stanisic pers. com.).

Of these, the Boggomosses are the only habitat type in which invertebrates have been sampled. The Queensland Museum researchers found localised assemblages of invertebrates within the moist environment of individual springs. The Boggomosses are wet refugia for the moisture loving invertebrates and they play an important role in the dispersal of these species. Fauna may be shifted between springs, along drainage lines, by floodwaters (John Stanisic pers. com.).

Stanisic (in press) found two new species of snail for the area, not endemic species but extremely restricted in range and vulnerable to extinction. The species from the Charopidae is a new *Eesothera* species, related to a large, rare South Australian snail, and the species from the Camaenidae will be a new species within a new genus and a northern outlier, with the nearest relatives in New South Wales and Victoria.

5.3.2.3 Rare and endangered fauna

The paucity of significant species recorded by the Queensland Museum's database reflects the lack of fauna surveys undertaken in the area (Phillips 1995).

The following species recorded by Crossman and Reimer (1986) are also listed by Phillips (1995) as having a significant conservation status

Species	**Common name**	**Conservation Status**
REPTILES		
Diplodactylus taenicauda	Golden-tailed gecko	rare or insuff. known
Egernia rugosa	Yakka Skink	rare or insuff. known
Glyphodon dunmalli	Dunmalls snake	vulnerable
Vermicella annulata	Bandy Bandy	rare or insuff. known
BIRDS		
Calyptorhynchus lathami	Glossy Black Cockatoo	rare
Ninox strenua	Powerful Owl	insufficiently known
MAMMALS		
Chalinolobus dwyeri	Large Pied Bat	rare, scattered
Chalinolobus picatus	Little Pied Bat	uncommon, limited habitat
Ornithorhynchus anatinus	Platypus	vulnerable
Petaurus australis	Yellow-bellied Glider	vulnerable
Planigale tenuirostris	Narrow-nosed Planigale	sparse distribution
Sminthopsis macroura	Stripe-faced Dunnart	sparse distribution
Sminthopsis murina	Common Dunnart	limited distribution
Taphozous flaviventris	Yellow-bellied Sheath-tail Bat	rare in widespread habitat

Phillips (1995) lists the following species with significant conservation status, as likely to occur, based on distributional records and habitat type :

Species	Common name	Conservation Status
Petaurus norfolcensis	Squirrel glider	rare
Poephila cincta cincta	Black throated finch	rare
Lophoictinia isura	Square tailed kite	vulnerable
Erythrothiorchis radiatus	Red Goshawk	vulnerable
Paradelma orientalis	Brigalow scale foot	vulnerable
Ramphotyphlops broomi	Burrowing Snake	rare or insufficiently known
Anomalopus brevicollis	Burrowing Skink	vulnerable
Acanthophis antarcticus	Common Death Adder	rare or insufficiently known
Denisonia maculata	Ornamental snake	vulnerable

Patrick Cooper (pers. com.) is preparing a report to the Australian Nature Conservation Agency (ANCA), titled a *Review of rare and endangered animals in the Brigalow belt.* This report is not specific to the Taroom area as field sites concentrate around Emerald and the southern Darling Downs.

5.3.3 Terrestrial Fauna Conservation issues

In 1976, Gasteen (cited in Crossman and Reimer 1986) noted the importance of the Dawson Valley area to nature conservation in the Central Highlands. This zone of overlap, where the arid west meets the moist east and where animals travel north-south with the Rivers, exhibits high biodiversity (Gasteen 1976, Gordon 1992).

Stanton and Morgan (1977) gave twelve natural regions in Queensland a broad priority ranking, the Brigalow Belt rated second, after South-east Queensland. Cummings (1987) studied the key natural areas of the Central Highlands, and recommended the Palm Grove / Nathan Gorge area be incorporated in a Central Highlands Watershed / biological reserve plan.

This region has undergone significant development for coal, timber, pasture and agriculture, prior to Crossman and Reimer's (1986) fauna study and since. Crossman and Reimer's study found that there was no significant loss of species attributable to the pre-1980's development phase. It is likely, however, that there have been changes in the last sixteen years and the relative conservation value of the fauna and associated communities on the Nathan Dam site may have changed.

National Parks and State Forests contain the only large undeveloped areas representing remnants of the original distribution of many vegetation types. Brigalow and softwood scrubs are inadequately protected within these reserves (Cummings 1987, Gordon 1992). Gordon (1992) concludes the survival of fauna to date has relied on the areas of eucalypt woodlands and open forest remaining on freehold land. With an upsurge in clearing and development of these habitats, many local declines and extinctions among the fauna can be expected.

Outside reserves, the remaining riparian vegetation may have become a significant conservation area. This significance lies in the provision of a corridor for fauna, an insurance against complete fragmentation and isolation of fauna populations (Frank Carter pers. com.). The Department of Environment and Heritage (Taroom) has begun work on a community remnant vegetation survey. The Nathan Dam site falls within the scope of this survey. As part of this study a draft *Remnant Vegetation Assessment Manual* has been produced (Leahy and Carter 1995).

Artesian springs are probably an important source of water for some terrestrial fauna in extended dry periods at the Nathan Dam site. They are of critical importance to invertebrate fauna assemblages which cannot adapt to conditions outside these moist refuge sites (Stanisic pers. com.). Most springs (Boggomosses) are outside current reserves (Wilson pers. com.) and will be inundated by the dam.

Much of the uncertainty about contemporary faunal distribution and associated questions about conservation issues may be addressed within the *Greater Planning Certainty* (GPC) process discussed in section 5.2.1. The following discussion was derived from McFarland (QDEH). Apart from mapping vegetation the QDEH - GPC section will report on the terrestrial fauna of south-eastern Queensland and subsequently five biogeographic regions including the Brigalow Belt (encompassing the Nathan Dam site). This work is at a preliminary stage. Currently all Australian museum records, the Royal Australian Ornithological Union (RAOU) bird atlas data base and other data bases as well as the results of a comprehensive literature search are being compiled. This compilation will concentrate on vertebrate fauna and will include only those invertebrate fauna listed under the Queensland Nature Conservation Act (1992) or its regulations. Subsequently, systematic terrestrial vertebrate fauna surveys will be conducted using a survey methodology currently being developed by CSIRO Division of Wildlife and Ecology under Australian Nature Conservation Agency funding. Invertebrate surveys will be undertaken separately (probably by the Queensland Museum). It is expected that survey work on the Brigalow Belt biogeographic region would not start for two years.

5.4 CONCLUSION

The floristic and structural characteristics of the terrestrial vegetation within the region encompassing the Dawson Valley are well described and mapped. The resolution of the descriptions is, however, not sufficiently fine to adequately describe the flora of any particular site on the Dawson River unless by chance the site was intensively surveyed for a particular purpose. As the recent (and as yet unpublished) survey of the mound springs near Taroom has demonstrated, intensive surveys are needed to fully resolve the vegetation community components and adequately address the conservation values of the proposed dam site. The Taroom region is almost fully developed (in land clearing terms) and, as the draft QDEH report on the conservation status of regional ecosystems highlights, it is the extent of this development which has increased the scientific and conservation value of remnant vegetation patches. In this light it is recommended that a thorough survey of the Nathan Dam site and adjacent land systems be undertaken, and that the plant communities be mapped and fully described so that their regional significance can be adequately addressed within the context of the resources identified in this report. It is further recommended that, as a part of this process, discussions be held with QDEH - Herbarium to raise the priority of the mapping of the Taroom 1: 100,000 map sheet.

The understanding of the fauna of the Dawson Valley is similar to that of the flora. Regional data on terrestrial fauna is available, and Crossman and Reimer (1986) provides some site specific data, however, the lack of information on the Boggomosses again illustrates the need for detailed site specific fauna studies. In addition the extent of land development and the consolidation of the cane toad in the Taroom region since Crossman and Reimer's surveys in conjunction with the ongoing effects of feral animals may have significantly affected the fauna assemblage in the vicinity of the proposed dam. This reinforces the need for an intensive local fauna collection. Data on the invertebrate fauna of the Dawson Valley were scarce (apart from the boggomoss collections in early 1995). Collections of this fauna will be needed to complete the picture of the faunal assemblages likely to be affected by the dam. The collection will need comparison with other regional studies to ascertain the conservation significance of individual species and communities. Again it is recommended that a thorough survey of the terrestrial vertebrate and invertebrate fauna be undertaken at the site of the proposed Nathan Dam and that, if possible, the priority of the surveys proposed under the GPC process be increased.

There are differences in detail between the significant flora and fauna species listed by Phillips (1995) and those discussed within this report. These differences reflect differences in the scope of the respective reports as well as differing interpretations of the resource material as to likely species occurrence within the Nathan Dam site. These differences are unlikely to be resolved without a detailed onsite inspection.

6.0 SUMMARY AND DISCUSSION

From the previous chapters it is clear that a substantial amount of information is available on the aquatic and terrestrial flora and fauna of the Dawson River system. Much is also known of the climate, geology, geography and land and water resources of the area in general (cf. papers in Duivenvoorden *et al.* 1992 and Appendix I). This information is valuable as a basis from which decisions can be made about the the types of studies that are required to determine the potential environmental effects of the proposed Nathan dam as well as the studies that are required to determine the environmental flow requirements of the area downstream of the dam.

The information available for various components of the biota of the Dawson system varies in detail and generally very little is known about the specific area that will be inundated. In the section of this report on aquatic macrophytes the large number of sites that have been studied in the Dawson river system was illustrated, but none of these was in the area to be inundated. The results of the studies did show, however, that the aquatic plant communities are very dynamic (with a large proportion of the species changing from year to year) and that the effects of environmental variables such as droughts or floods need to be considered in planning any of the studies required. **Hence for these species it is important to provide, where possible, opportunity for study of seasonal variation in the plant communities so that the aquatic flora of the area can be adequately assessed in terms of its conservation value.**

The information provided on the phytoplankton of the Dawson River system highlighted that algal blooms do occur in the area, though these organisms appear to be limited to some extent by the highly turbid water of the system. To the author's knowledge blooms of blue-green algae have not previously been reported from the Taroom area, but sampling of the site at Baroondah indicates that bloom forming algae do occur upstream of the proposed dam. For this reason there is a potential for these blooms to occur in the new water storage and their significance and/or prevalence will largely be determined by the light and nutrient conditions that will prevail in the storage. **Studies of the phytoplankton in the area to be inundated have not been made and are recommended (along with studies of basic physical/chemical parameters) if a more accurate assessment of the potential for algal blooms in the new storage is to be made.** Noble *et al.* (Appendix I) provides information on nutrient levels in the Dawson river system and it was suggested that further attention be given to determining the factors that limit algal growth since the availability of nutrients is probably not limiting for many sites.

In the section on aquatic invertebrates the variability in the abundance and diversity (richness) of these organisms between years and between sites was stressed. They are, however, still very useful as biological indicators of changes in water quality and so it would be valuable to obtain data on these types of organisms currently inhabiting the area in the vicinity and downstream of the proposed dam. This data could then be used (in conjunction with other biological data) to help assess the possible effects of alterations in the flow regime resulting from the construction of the dam. Such information could also be used to modify/refine the flow regime of the river once the dam is in place such that it adequately provides for the aquatic biota downstream. For this process to occur, long term studies of the aquatic invertebrates are required, particularly in the area downstream of the proposed dam. "Once off" surveys will provide data on the water quality of an area and may provide information about the conservational significance of the area (particularly for communities such as the Boggomosses), but the full advantage of this monitoring technique can only be achieved by surveys over a longer time period.

In the last chapter information available on the terrestrial flora and fauna was summarised and the conservation issues for both components discussed. Of significance were the flora and fauna of the Boggomoss communities and the flora of softwood scrubs which may fringe the Dawson River in places. The resolution of the vegetation descriptions available for the study area is not considered to be fine enough to adequately describe the flora of any particular site on the Dawson River and emphasises the need for detailed site specific studies of the proposed dam site area. Only in this way can an accurate assessment of the conservational status of the area be made.

Techniques that may be used to determine the environmental flow requirements of streams are many and varied and were recently the subject of a workshop attended by the author on June 22, 1995 in Cooma, NSW. The techniques include desk-top type studies using a fixed proportion of flow based on historical discharge methods (Gippel, 1995); studies dealing with Instream Flow Incremental Methodology where the effect of stream flow on habitats is considered along with the habitat preferences of particular species (Jowett, 1995); hydraulic rating methods that relate stream flow to habitat variables (Stalnaker, 1980); the holistic approach based on the concept of the need for a natural flow regime (or at least having all the important elements of one) (Arthington *et al.* 1992; 1995) and of course the expert panel approach, based on the opinions of several experts usually consisting of scientists from a range of fields (Harris *et al.* 1995). The latter approach is relatively inexpensive, but all of these methods should be examined for their usefulness with regard to the Dawson River system.

The methods used for each river system may vary depending on many factors such as the nature and size of the water storage, the proportion of the river that is regulated (Cross *et al.* 1995), the relative positions of major feeder streams (Duivenvoorden, 1995c), the location of the water storage in the catchment and whether the stream is ephemeral or permanent. The holistic approach of Arthington *et al.* (1992; 1995) is particularly relevant to the current study in that it was used recently for determining the environmental flow requirements of a water storage on the Barker- Barambah Creek system, which lies between the Dawson system and the coast.

7.0 REFERENCES

Arthington, A.H., Cornick, D.L. and Bycroft, B.M. (1992) Environmental Study: Barker-Barambah Creek, Volumes 1, 2 and 3. Queensland Government, Water Resources Commission, Depart. of Primary Industries.

Arthington, A.H., Pusey, B., Bludhorn, D., Bunn, S. and King, J. (1995) An holistic approach for assessing environmental flow requirements of riverine ecosystems: origins, theory, applications and new developments. Abstract of seminar presented at Environmental Flow Assessment Techniques Seminar, Cooma, NSW 22 June.

Baxter, K.E. (1992) Water Resources of the Fitzroy Basin. In *Fitzroy Catchment Symposium Proceedings*, 12-13 November, University of Central Queensland, Rockhampton, Australia.

Beadle N.C.W. and Costin A.B. (1952) Ecological classification and nomenclature. *P. Linn. Soc. N.S.W. 77*, 61-82.

Boucant, W.R.P. and Moye, D.G.(1965) Report on preliminary investigations into Upper Dawson River Dam sites.

Bowling, L. C. (1992) *The cyanobacterial (blue-green algal) bloom in the Darling/Barwon River System, November-December 1991.* Technical Services Division, NSW Department of Water Resources. Report No. T.S. 92.074.

Christian C.S. and Stewart G.A. (1953) General Report on survey of Katherine - Darwin region, 1946. CSIRO *Aust. Land Res. Ser. 1.*

Cooper, P. (in progress) Report to ANCA Feb 96 Review of Rare and endangered animals in the Brigalow belt (raw data only at present)

Connell, D.W., Bycroft, B.M., Miller, G.J. and Lather, P. (1981) Effects of a barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland. *Australian Journal of Marine and Freshwater Research*, **32**, 57-63.

Cross, H., Shaw, J., Ardill, S. and Cooney, T. (1995) The expert panel approach to environmental flow determination in Barwon-Darling River. Abstract of seminar presented at Environmental Flow Assessment Techniques Seminar, Cooma, NSW 22 June.

Crossman and Reimer (1986) Mammals, birds, reptiles and amphibians of the Taroom Shire, central Queensland In *Q. J. Ag and Animal Sc 43* (1), 55-72. ,QDPI.

Crossman, D. (1974) *Interim Report Fauna survey Robinson Gorge National Park.* Qld National Parks Internal report.

Cummings, B. (ed) (1987) *The Central Queensland Study - A compendium of Key Natural areas in Central Queensland and their current conservation status.* Capricorn Conservation Council, Rockhampton Qld .

Duivenvoorden, L.J. (1989) Aquatic macrophytes and heavy metal pollution in the Fitzroy River, Central Queensland. *Proceedings of The State of Our rivers Conference, September 29-30.* Australian National University. Canberra.

Duivenvoorden, L.J. (1990) Aquatic macrophytes of the Fitzroy River System, Central Queensland. Australasian Society for Phycology and Aquatic Botany Conference, 21-22 Jan. Palmerston North, New Zealand

Duivenvoorden, L.J. (1992a) The River Dee: Aquatic Flora and Acid Mine Discharge. In Yezdani, H (Editor) *Water Weeds Management in Queensland: Workshop Proceedings.* Queensland University of Technology, Brisbane. pp.187-200.

Duivenvoorden, L. J. (1992b). Aquatic macrophytes of the Fitzroy River catchment. *Proceedings of the Fitzroy Catchment Symposium*, 15-16 November, Rockhampton, Queensland.

Duivenvoorden, L.J., (1995a) *Biological Assessment of the Dee River, Central Queensland. III. Biological status of the Dee River in relation to acid mine drainage.* Consultancy report for Queensalnd Department of Minerals and Energy.

Duivenvoorden, L.J., (1995b) Biological Assessment of the Fitzroy River System: Aquatic Macrophytes. Abstract only In *Proceedings of a National Conference on Downstream Effects of Land Use.* 26-28 April, Central Queensland University , Rockhampton, Australia.

Duivenvoorden, L.J. (1995c) *Mt Rawdon Project:Aquatic biological investigation of proposed water storage sites on the Perry River, South East Queensland.* Consultancy report for Placer Pacific Ltd., Sydney, Australia.

Duivenvoorden, L.J., Roberts, D.T. and Holmes, P.M. (1995) Biological Assessment of the Fitzroy River System: Aquatic Invertebrates. Abstract only In *Proceedings of a National Conference on Downstream Effects of Land Use.* 26-28 April, Central Queensland University , Rockhampton, Australia.

Fabbro L. D., Duivenvoorden, L. (1992a) Water quality aspects of the Fitzroy River: a look at the blue-green algae problem. *Proceedings, Central Region Engineering Conference*, Sept 25-27, Rockhampton, Queensland. pp. 155-163.

Fabbro, L.D. and Duivenvoorden, L.J. (1992b). Physical and chemical parameters of river waters above and below the Fitzroy River Barrage, Rockhampton, Central Queensland. In *Fitzroy Catchment Symposium Proceedings*, 12-13 November, University of Central Queensland, Rockhampton, Australia.

Fabbro, L.D. and Duivenvoorden, L.J. (1993) *A Photographic guide to Common Cyanobacteria of Central Queensland.* River and Wetland Ecology Group, Central Queensland University, Rockhampton, Australia. ISBN 0 9081 40 83 5.

Fabbro, L.D. and Duivenvoorden, L.J. (1995) Biological Assessment of the Fitzroy River System: Phytoplankton. Abstract only In *Proceedings of a National Conference on Downstream Effects of Land Use.* 26-28 April, Central Queensland University, Rockhampton, Australia.

Foged, N. (1978) Diatoms in Eastern Australia. *Bibliotheca Phycologica*, J.Cramer, Band 41. A.R. Gartner Verlag, Vaduz, Germany

Forster P.I., Bostock P.D., Bird L.H. & Bean A.R. (1991) *Distribution atlas and conservation status of vineforest plants in South-East Queensland, Australia.* World Wide Fund for Nature.

Finlayson, H.H (1931) On Mammals from the Dawson Valley, Queensland Part I in *Proc. Roy. Soc. S. Aust. 55*, pp 67-89.

Finlayson, H.H (1934) On Mammals from the Dawson and Fitzroy Valleys; Central Coastal Queensland - Part II in *Proc. Roy. Soc. S. Aust.* 58, pp 218-231.

Gasteen W.J. (1976) *Survey of the Central and Eastern Central Highlands of Queensland.* Unpublished report to the Queensland Conservation Council under the National estate Grant Programme 1975.

Gilbert, J (1844) Unpublished diary of the journey of exploration of Ludwig Leichhardt and party from Jimbour to Port Essington (1844-45).

Gippel, C.J. (1995) Environmental flow assessment approaches based on flow records.. Abstract of seminar presented at Environmental Flow Assessment Techniques Seminar, Cooma, NSW 22 June.

Gordon, G. (1984) Fauna of the Brigalow belt In Bailey, A (ed) *The Brigalow belt of Australia : the proceedings of a symposium held at the John Kindler Memorial Theatre QIT* 23 Oct 1982, QDPI for RSQ, Brisbane. pp 61-70.

Gordon, G. (1992) Terrestrial Fauna of the Fitzroy Catchment, In Duivenvoorden, L.J, Yule, D.F., Fairweather, L.E. and Lawrie, A. G.. (eds.) *Proceedings Fitzroy Catchment Symposium* 12-13 Nov 1992, University of Central Queensland, Rockhampton.

Gunn R.H. and Nix H.A. (1977) *Land units of the Fitzroy Region, Queensland.* Land Research Series 39, CSIRO, Australia.

Harris, J.H., Swales, S. Johnson, H.T. and Cross, H. (1995). The expert panel approach to environmental flow assessment. Abstract of seminar presented at Environmental Flow Assessment Techniques Seminar, Cooma, NSW 22 June.

Hoy, N.T., Barry, S. and Kershaw, N. (1992) An Overview of nature conservation in the Fitzroy Catchment- protected areas, management principles and rare and threatened plants, In: *Proceedings of the Fitzroy Catchment Symposium* (eds L. J. Duivenvoorden, D.F. Yule, L.E. Fairweather & A.G. Lawrie), University of Central Queensland Rockhampton, Queensland.

Ingram, G. (in press) Isopods of Dawson Valley mound springs, to be published *in Memoirs of the Qld Museum* end of 1995.

Isbell R.F. (1962) *Soils and vegetation of the brigalow lands, Eastern Australia.* Soils and Land Use Series 43, CSIRO, Australia.

Johnson R.W. (1984) Flora and vegetation of the brigalow belt. In: *The brigalow belt of Australia* (ed. A. Bailey), The Royal Society of Queensland, Brisbane.

Johnson R.W. (1992) Vegetation of the Fitzroy River catchment. In: *Proceedings of the Fitzroy Catchment Symposium* (eds L. J. Duivenvoorden, D.F. Yule, L.E. Fairweather & A.G. Lawrie), University of Central Queensland Rockhampton, Queensland.

Johnstone, P., Fabbro, L., Blake, T., Robinson, D., Noble, R., Rummenie, S. and Duivenvoorden, L. (1995) Land use, water use and blue-green algae. *Proceedings of a National Conference on Downstream Effects of Land Use*, 26-28 April, Central Queenslannd University, Rockhampton, Australia.

Jowett, I. (1995). IFIM - Biological justification and pitfalls. Abstract of seminar presented at Environmental Flow Assessment Techniques Seminar, Cooma, NSW 22 June.

Lambkin, K.J. & New, T.R. (1994) Australian Mantispidae (Neuroptera): Supplementary Notes 2, J. *Aust. Ent. Soc. 33*: 117-121.

Leahy, A. and Carter, F. (1995) *Remnant Vegetation Assessment Manual* (Draft) Qld Department of Environment and Heritage -Taroom.

Lee, C.L. and Fielder, D.R. (1979) A mass migration of the freshwater prawn, *Macrobrachium australiense* Holthuis, 1950 (Decapoda, Palaeomonidae) *Crustaceana* 37(2), pp 219-222.

Leggett, R. (1986) Krombit Tops - 9th-19th December Creek Survey. *Queensland Nat.* 27 (1-4) 60.

Mackey, A. P., (1988) The Biota of the River Dee (Central Queensland, Australia) in relation to the effects of acid mine drainage. *Proc. R. Soc. Qld.* 99, 9-19.

Noble, R.M., Rummenie, S.K., Long, P.E., Duivenvoorden, L.J. and Fabbro, L.D. (1995) Downstream Effects of Land Use in the Fitzroy River Catchment. Abstract only In *Proceedings of a National Conference on Downstream Effects* *of Land Use*. 26-28 April, Central Queensland University, Rockhampton, Australia.

Pearce, B.R. (1982) Fractured Rock Aquifers in Central Queensland. In *Papers of the Groundwater in Fractured Rock Conferance*. Australian Water Resources Council Conference Series No. 5.

Perry R.A. (ed.) (1968) *Lands of the Dawson-Fitzroy area, Queensland.* Land Research Series 21, CSIRO, Melbourne.

Phillips, N. (1995) Report on Nathan dam Environmental, Cultural and Social Issues. For Queensland Department of Primary Industries, Water Resources.

QDEH. (1995) *Conservation status of Queensland's bioregional ecosystems*: Draft report. Queensland Department of Environment and Heritage, Brisbane.

Ryan, L. (1992) Fitzroy Catchment: Resource Endowment and Utilisation. In *Fitzroy Catchment Symposium Proceedings*, 12-13 November, University of Central Queensland, Rockhampton, Australia.

Specht R.L. (1970) Vegetation. In *The Australian Environment*, ed. G.W. Leeper. CSIRO, Melbourne University Press.

Specht R.L., Specht A., Whelan, M.B. and Hegarty E.E. (in press) *Conservation atlas of plant communities in Australia.* Centre for Coastal Management, Southern Cross University Press.

Speck N.H. (1968) Vegetation of the Dawson -Fitzroy Area. In: *Lands of the Dawson - Fitzroy Area, Queensland*, Land Research Series 21, pp. 157-173, CSIRO, Melbourne.

Stanisic, J (in press) New land snails from the Boggomoss environment of Dawson Valley, South East Queensland (Euplmonata : Charopidae and Camaenidae), to be published in *Memoirs of the Qld Museum.*

Stanton, J.P and Morgan, M.G. (1977) *The Rapid Selection and Appraisal of Key and Endangered Sites : The Queensland Case Study,* Report to the Dept Environ, Housing & Community Dev., School of Natural Resources University of New England Armidale NSW.

Walker J. and Hopkins M.S. (1990) Vegetation. In *Australian soil and land survey*, 2nd edition, Inkata Press, Melbourne.

Webb L.J. (1959) A physiognomic classification of Australian rain forests. *J. Ecol. 47*, 551-570.

Wilson I.B. (1968) Introduction to the Dawson - Fitzroy Area. In: *Lands of the Dawson - Fitzroy Area, Queensland,* Land Research Series 21, pp. 7-10, CSIRO, Melbourne.

Wilson, B. A. (1995) *Artesian Springs of the Great Artesian Basin in Queensland*, Department of Environment & Heritage Toowoomba.

Wood J.G. and Williams R.J. (1960) Vegetation. In: *The Australian Environment*, 3rd ed. pp. 67-84, CSIRO, Aust. Melb. Uni. V. Press, Melbourne.

Appendix I

Downstream Effects of Land Use in the Fitzroy Catchment

Bob Noble and project team.

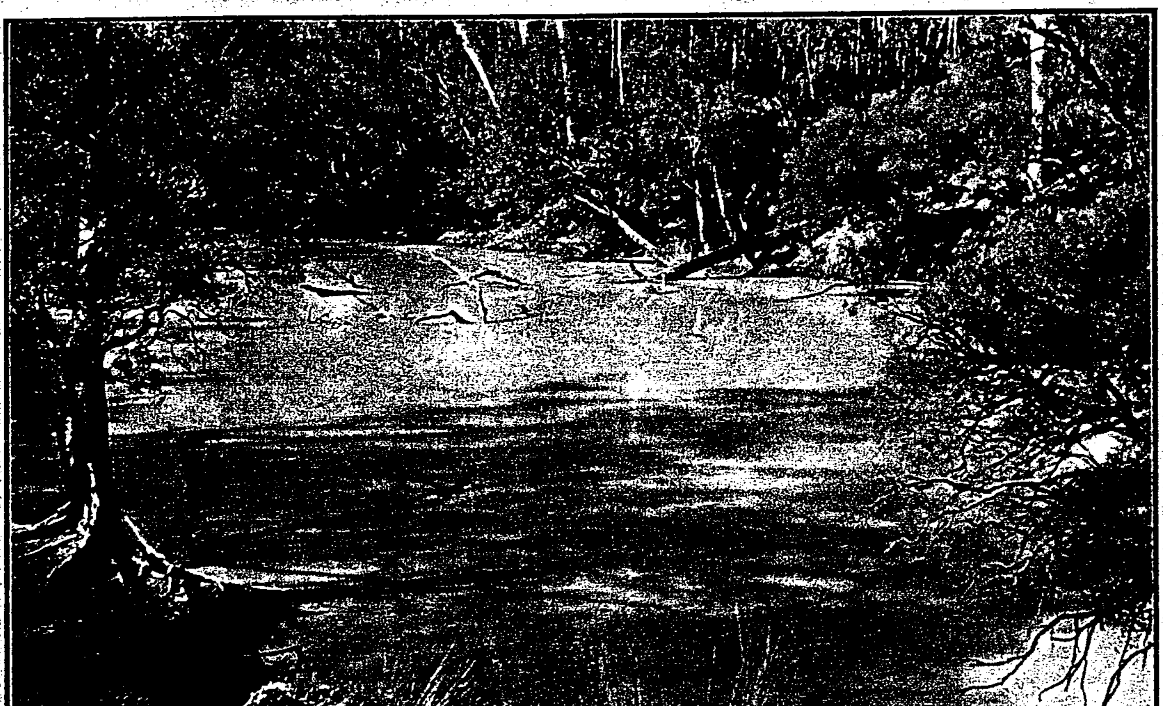
SUMMARY

of

WATER QUALITY

DAWSON RIVER and COMET RIVER

1994 - 1995



August, 1995

DOWNSTREAM EFFECTS OF LAND USE

IN THE

FITZROY CATCHMENT

A project jointly funded by the Queensland Department of Primary Industries and the National Landcare Program whose support is gratefully acknowledged. Assistance from the Land and Water Resources Research and Development Corporation and the Cotton Research and Development Corporation in some collaborative studies is greatly appreciated.

Bob Noble and Project Team

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
BILOELA RESEARCH STATION

and

CENTRAL QUEENSLAND UNIVERSITY
ROCKHAMPTON

Cover: A small summer flow in the lower Dawson River near Baralaba.

INTRODUCTION

A project with a multidisciplinary ecological approach was set up to assess the "state of health" of steams in the Fitzroy catchment. Main collaborators are the Queensland Department of Primary Industries and the Central Queensland University with funding support from the National Landcare Program for 1993 - 1996. This document summarises water quality parameters measured for the Dawson River and Comet River during 1994/95 from this NLP "DELU - Fitzroy" project.

METHODS

Sampling Strategies

Eleven monitoring sites (sites 1 to 11) were established to represent the major sub-basins of the Fitzroy system. Included were a site on the lower Comet River (site 9), a site on the upper (site 8) and lower (site 7) Dawson River (see attached map). As well, four additional sites were selected on the Dawson River for more frequent sampling (sites 12 to 15). Sites 1 to 11 were sampled three times (May - June, 1994; October, 1994 and May, 1995), under base (background) flow conditions for a range of physico-chemical, chemical and biological parameters. The four additional Dawson River sites were sampled every two months from August, 1994 for physico-chemical and chemical parameters. As well, any flows during 1994/95 in the major sub-basins were sampled for chemical parameters.

Sampling Protocols

Strict sampling protocols and post-sampling preservation techniques were used to ensure representative sampling and sample integrity. Physico-chemical parameters were measured *in situ*, nutrient and pesticide samples collected in appropriate containers, refrigerated and sent by air to the Resource Management Institute laboratories, Brisbane.

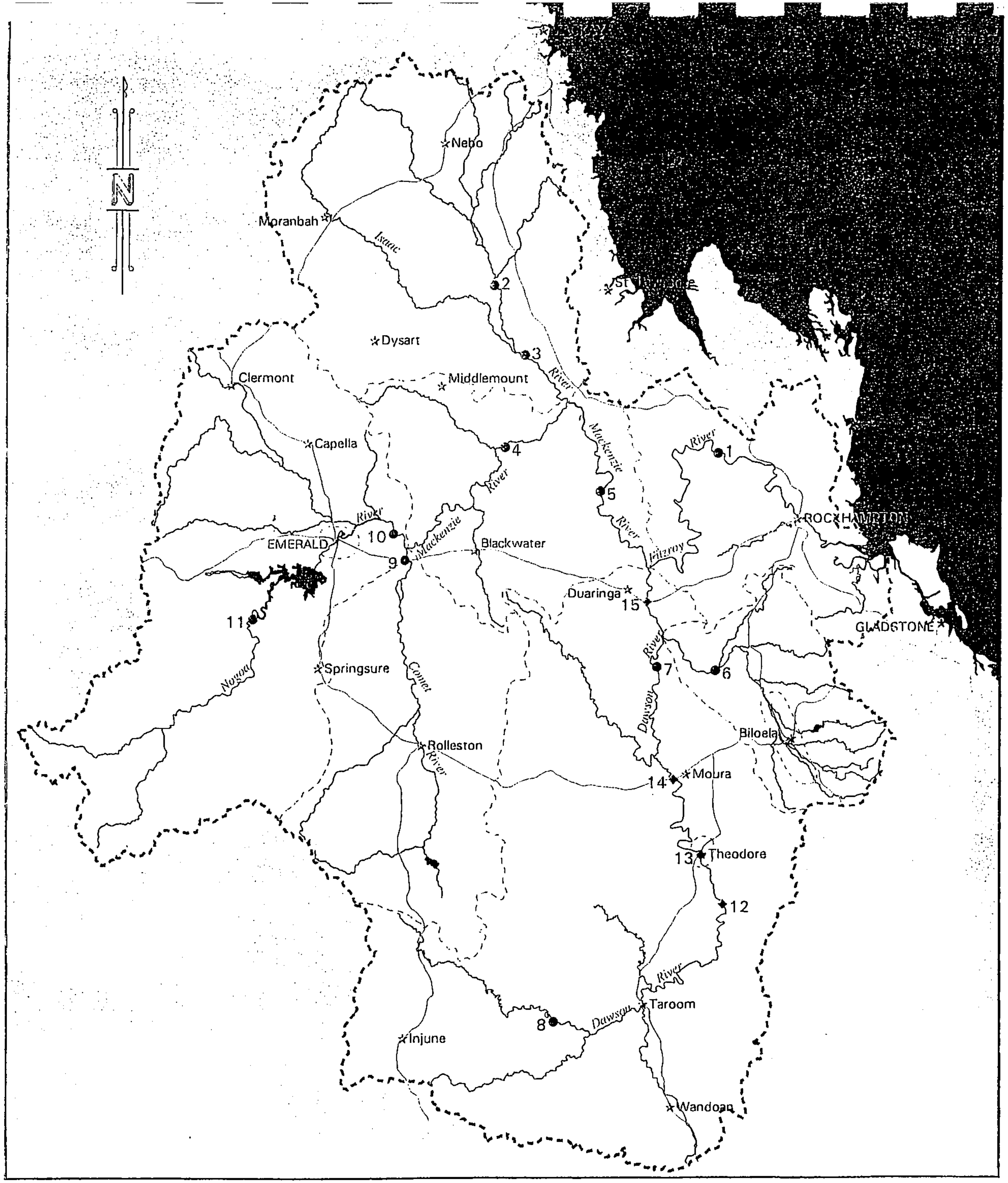
Results for chemical parameters were evaluated against Australian guidelines (1, 2) or overseas guidelines where Australian guidelines are not presently available.

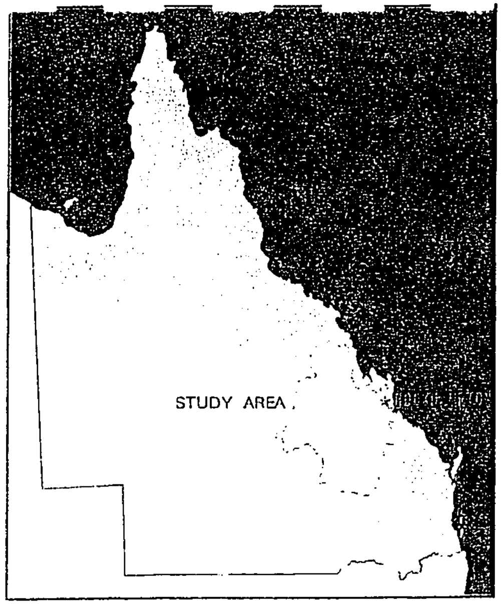
RESULTS AND DISCUSSION

Physico-chemical parameters

Fig. 1 summarises electrical conductivity (EC) and pH data for the Dawson River under base (background) flow and flow conditions during 1994/95. Irrespective of flow, both parameters remained within environmental, irrigation and drinking water guidelines (1, 2). Elevated flows lowered both EC and pH values. There were no large differences in these parameters for water samples from the upper, mid or lower Dawson River.

Table 1 shows physico-chemical parameters for a more limited data set of site 9 on the lower Comet River.





LOCALITY PLAN

LEGEND:

- Fitzroy Catchment Monitoring Sites
- Dawson River Monitoring Sites
- Major Towns
- Study Area
- Groundwater Observation Areas
- Major Rivers
- Major Roads
- Sub-Catchment Boundaries

KILOMETRES

0 100

NATIONAL LANDCARE PROGRAM

DPI DEPARTMENT OF PRIMARY INDUSTRIES
QUEENSLAND WATER RESOURCES

NATIONAL LANDCARE PROJECT
MONITORING SITES
FITZROY CATCHMENT

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Table 1. Physico-chemical parameters for site 9 on the Comet River.

	Sediment (gm/L)	Electrical Conductivity (μS/cm)	pH
Mean	**0.168**	**317**	7.75
S.D.	0.18	138	0.12
Range	(0.013 - 0.500)	(137 - 530)	(7.5 - 7.9)
No. of Samples	10	10	10

All values were within environmental, irrigation and drinking water guidelines (1, 2).

Pesticides

The herbicide atrazine was the most commonly detected and widely distributed pesticide in the Fitzroy system (Fig. 2 & Fig. 3). A flow of about 200, 000 megalitres down the Dawson River from rainfall in the Taroom - Wandoan area in February, 1995, carried with it a considerable quantity of atrazine. Detectable atrazine residues, which were monitored in the Dawson and at Riverslea on the upper Fitzroy, persisted for at least three months after the flow event (Fig. 2). Atrazine was also detected (1.2 μg/L) at the Comet River monitoring site in the May, 1995 sampling (Fig. 3).

"Cotton" chemicals were commonly detected at sites on the Dawson and Nogoa Rivers downstream from the irrigated cotton areas at Theodore and Emerald during the 1994/95 season (Fig. 4) but not in the winter of 1994. Except for endosulphan, concentrations were in general, below both environmental and drinking water guidelines. Endosulphan levels were below drinking water guidelines but well above the environmental level of 0.01 μg/L (1, 2). To our knowledge, no fish kills were attributed to the detected levels of endosulphan in the Dawson and Nogoa Rivers.

Nutrients (nitrogen and phosphorus)

Fig. 7 and Fig. 8 present summarised data for nitrogen (N), phosphorus (P) and sediment (suspended solids) concentrations for the upper, mid and lower Dawson River sites during 1994/95. In Fig.7, these parameters are compared for base (background) flow and flow conditions. Upper limits for environmental guidelines (1) are included.

Under base flow conditions, total N and total P values were within the guidelines for upper and lower but not mid Dawson River sites. Total N and total P concentrations at Theodore and Moura exceeded the upper guideline levels of 0.75 mg/L for N and 0.1 mg/L for P (1).

During flow conditions, N and P concentrations rose dramatically and exceeded guideline limits at all sampling sites on the river.

N and P concentrations were highest for the mid Dawson during both base flow and flow conditions. This probably arises from the intensive agricultural activities in the area, although any inputs from the urban areas of Theodore and Moura were not evaluated.

Table 2 summarises a more limited data set for the Comet River (site 9). Data presented are means for base flow and some flow samplings.

Table 2. Total nitrogen and total phosphorus concentrations for the Comet River (site 9).

	Total N (mg/L)	Total P (mg/L)
Mean	**1.12**	**0.29**
S.D.	0.46	0.19
Range	(0.65 - 1.94)	(0.09 - 0.56)
No. of samples	10	10

The mean values for total N and total P clearly exceed the upper environmental guideline limits (1), although values for some individual samplings do not. Site 9 is at the downstream end of the Comet River sub-basin which is dominated by grazing and cropping activities. As no major urban areas abut the Comet River, the nutrients presumably arise by runoff from rural lands. For comparison, a single sample from a "pristine" area, high in the sub-basin (Carnarvon Creek) gave values of total N - 0.36 mg/L and total P - 0.05 mg/L.

Fig. 5 shows averages for N and P concentrations across all of the Fitzroy system sites for base flow and flow conditions. The markedly increased concentrations during flows are again evident. Fig. 6 illustrates the high concentrations of N and P that can be produced in farm runoff from intensive activities such as irrigated cotton production and also the significant benefit of delaying the passage of the runoff back into the riverine system.

The quite high nutrient concentrations and low TN / TP ratios in sections of the Fitzroy system, including the mid Dawson, are some factors predisposing towards problems with algal blooms. This will be discussed more fully elsewhere.

CONCLUSIONS

Notwithstanding the current dry conditions and resulting limited ground cover, moderate flows in the Dawson and Comet sub-basins carried quite high sediment and nutrient loads. When climatic conditions improve, further efforts should be made to retain soil within the sub-basins using suitable strategies on farm and in the riparian zone.

Nutrient levels higher than current environmental guideline recommendations were recorded for flows in the Dawson and Comet Rivers and for the mid Dawson under base flow conditions. Algal blooms with cyanobacterial dominance were evident in the mid Dawson during the summer of 1994/95. For future developments to be ecologically sustainable, strategies should be developed to minimise any increased input of nitrogen and phosphorus to the riverine system. Greater efforts should be made to understand other factors limiting algal growth, for availability of nutrients is probably not limiting for many sites in the Fitzroy system.

Biological monitoring in the present project was designed to detect significant pollution. No adverse biological effects from the low concentrations of pesticides which sporadically moved down the Dawson River and to lesser extent the Comet River, have been detected in the current work. Longer term and more focused studies will be needed however, to detect the impact, if any, of these residues on the riverine biota.

REFERENCES

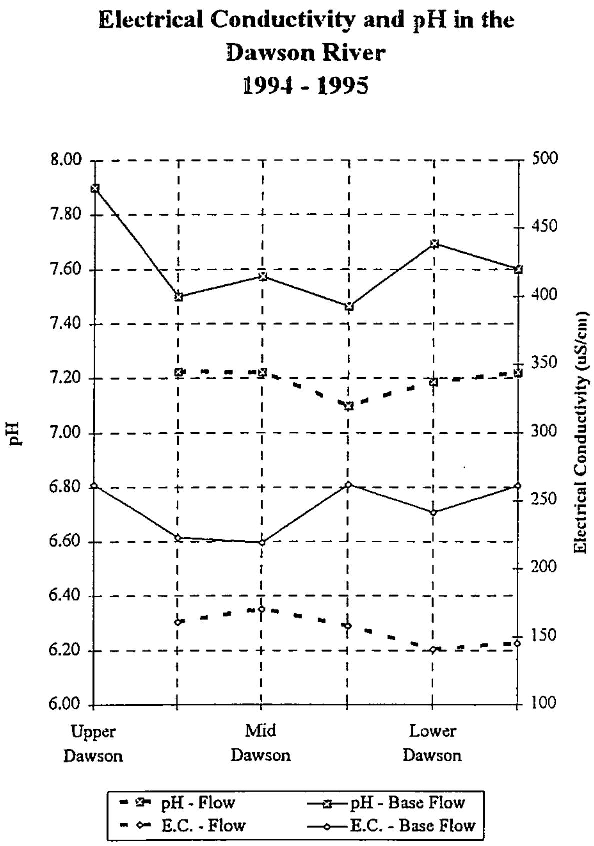
1. ANZECC (1992). Australian Water Quality Guidelines for Fresh and Marine Waters. Australian and New Zealand Environmental and Conservation Council.

2. NHMRC / ARMCANZ (1994). Draft Australian Drinking Water Guidelines. National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra.

Contact Details

Bob Noble, Project Leader, Biloela Research Station, QDPI, P.O. Box 201, BILOELA 4715.
Phone (079) 92 9114. Fax (079) 92 3468.

Figure 1.



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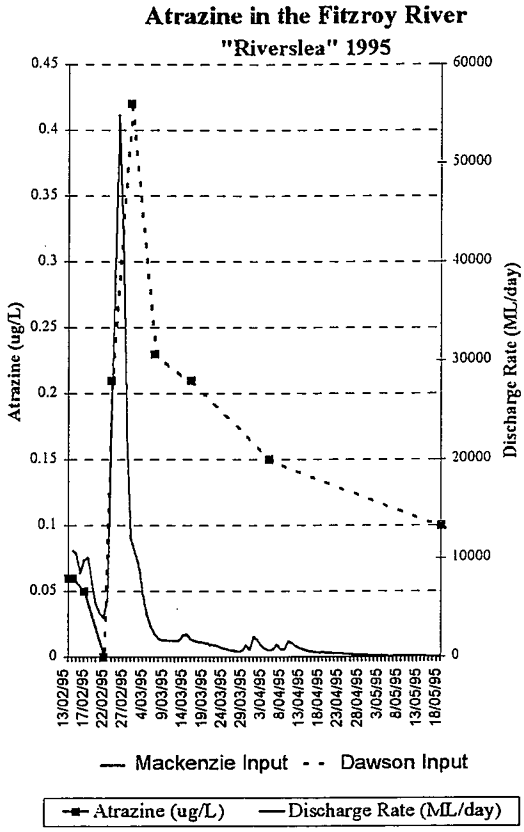

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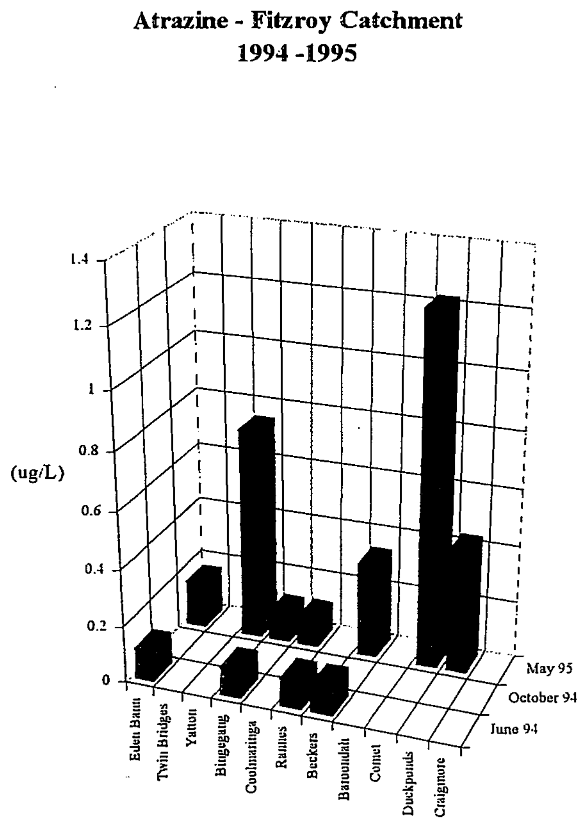

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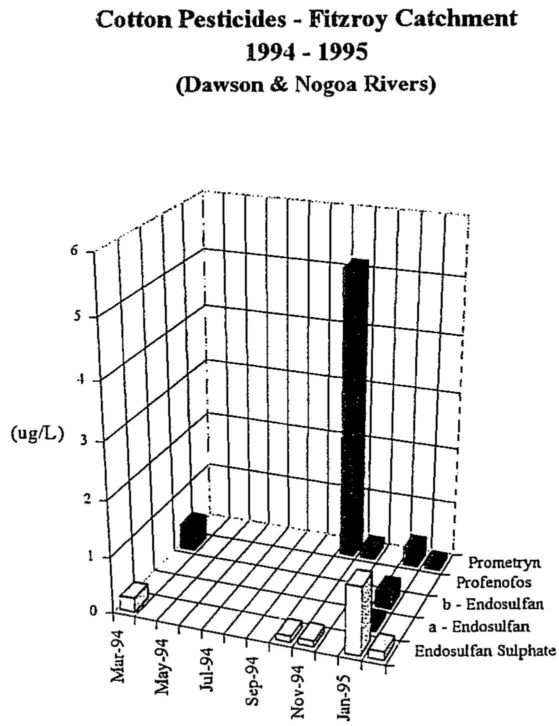

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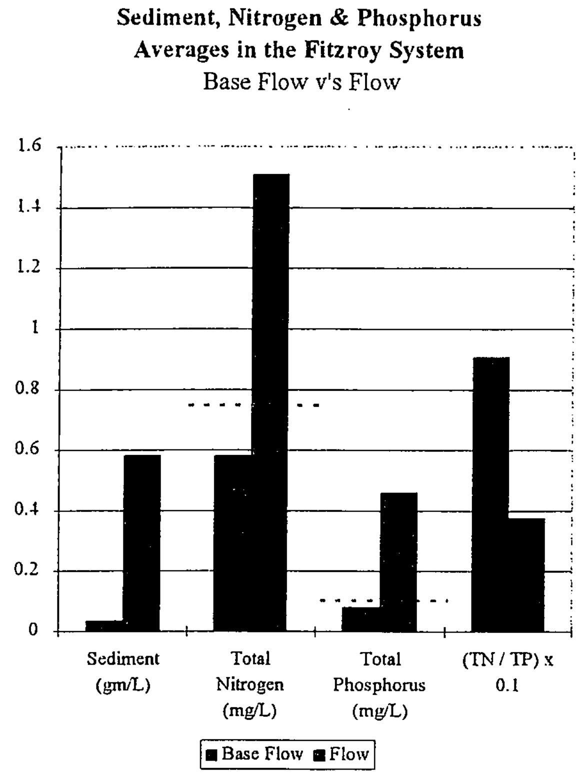

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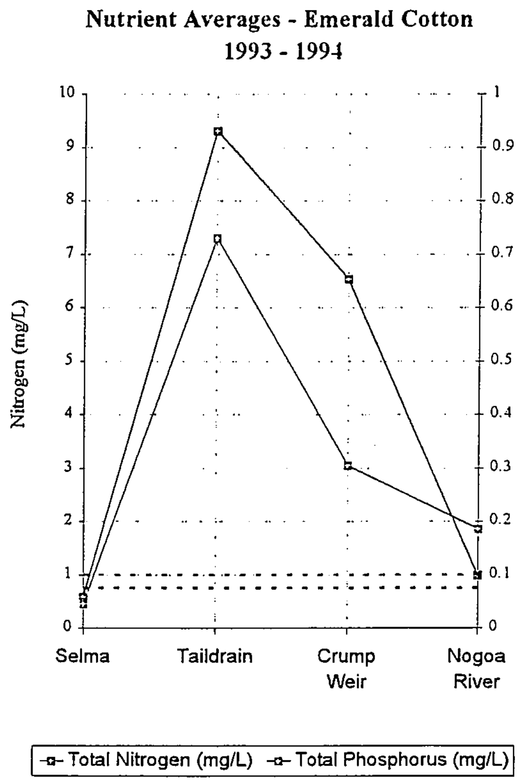


ANZECC Upper Guidelines for Total Nitrogen (0.75 mg/L)

ANZECC Upper Guidelines for Total Phosphorus (0.1 mg/L)

Figure 7.

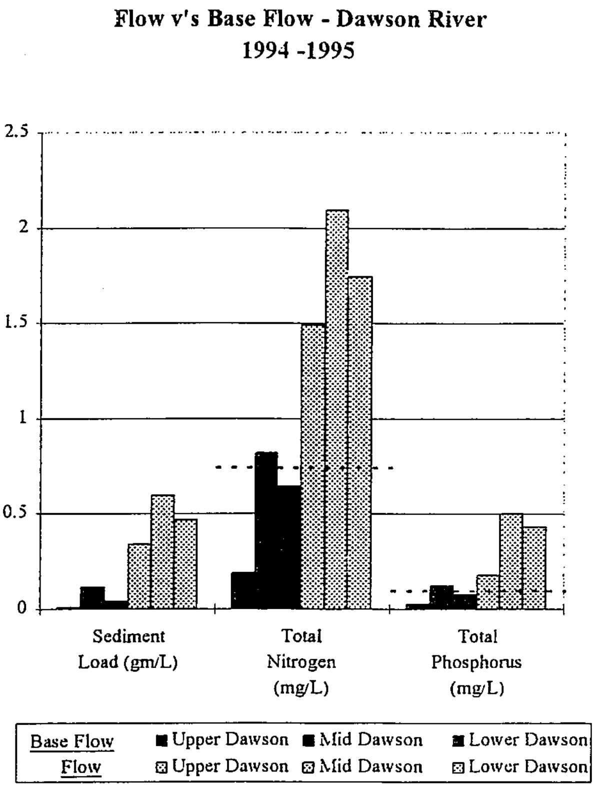
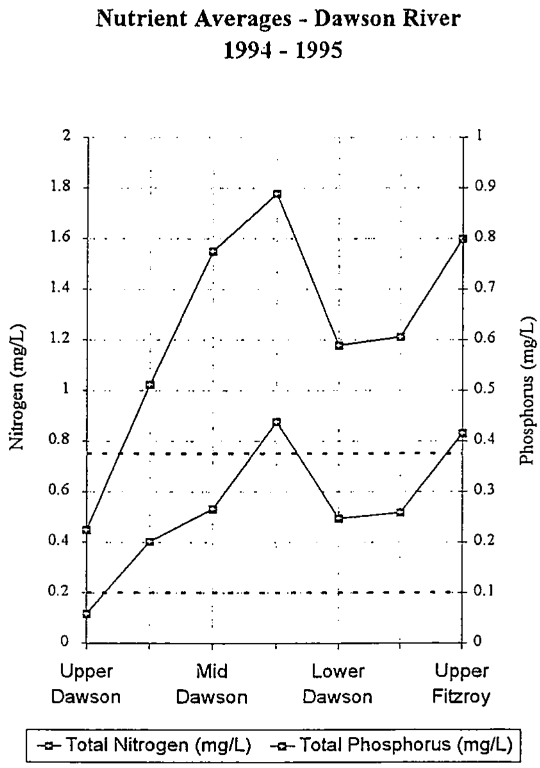


Figure 8.



ANZECC Upper Guidelines for Total Nitrogen (0.75 mg/L)

ANZECC Upper Guidelines for Total Phosphorus (0.1 mg/L)

Appendix II

Location of sites surveyed for aquatic macrophytes by Duivenvoorden (1992) in the Dawson River sub-catchment.

Site No.	Zone	East	North	Site No.	Zone	East	North
1	56	245650	7343750	21	55	767000	7271400
2	56	236150	7347050	22	55	739550	7276200
3	56	223350	7344050	23	55	752400	7322950
4	56	257950	7302400	24	55	748100	7311200
5	56	242650	7296750	25	55	741250	7297350
6	56	208900	7289850	26	55	738600	7293600
7	56	212950	7252300	29	55	683700	7205200
8	56	203700	7238550	30	55	684000	7179600
9	56	199200	7214000	31	55	666200	7151600
10	55	793000	7112900	32	55	670600	7168200
11	55	795800	7107000	33	55	665400	7194800
12	55	790100	7140800	70	55	710700	7366850
13	55	780100	7160800	71	55	714300	7370550
14	55	778600	7175000	88	55	781350	7366050
15	55	764000	720000	89	56	209700	7384000
16	55	758600	7209800	91	56	234300	7382650
17	55	756500	7253100	92	56	230050	7368250
18	55	747500	7267500	98	55	729150	7346250
19	55	793850	7277100	99	56	207300	7332450
20	55	782400	7273650				