DEPARTMENT *of*
PRIMARY INDUSTRIES,
WATER *and* ENVIRONMENT

Tasmania

Aquatic Ecology Of Rivers In the Great Forester Catchment

A Report Forming Part of The Requirements for State of Rivers Reporting

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Report Series WRA 99/07
June 1999.

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Glossary

anadromous	refers to fishes which migrate from saltwater to freshwater to spawn
diadromous	refers to fishes that migrate freely between freshwater and saltwater in either direction.
macroinvertebrate	animals without a backbone which can be seen with the naked eye. In rivers, common macroinvertebrates include insects crustaceans, worms and snails.
riparian	of or on the river bank

1. Introduction

This chapter deals with aspects of the aquatic ecology of the Great Forester River and associated tributaries. The section provides a brief overview of the aquatic fauna found in the catchment and provides some detail of the habitat requirements and potential threats to some of the more vulnerable and endangered species found in the Great Forester catchment. Another section deals specifically with endangered species found in the catchment and covers potential threats to the distribution of each species. The main focus of the chapter details work carried out in the Great Forester catchment under the Monitoring Riverine Health Initiative (MRHI), a national program aimed at the development of models to assess riverine health using macroinvertebrates as a bio-indicators. These models are comprehensive in their development and allow a relatively rapid assessment of riverine health of specific sites along the river and surrounding tributaries. Finally, algal community composition at selected sites in the Great Forester catchment is examined in respect to potential impacts. Algae were sampled concurrently with macroinvertebrates under the MRHI program in spring and autumn of 1997.

2. Aquatic Fauna

At least five different species of frogs are found in the Great Forester catchment. The Northeast region has been identified as a significant region for frogs due to extensive coastal wetlands which form excellent frog habitat (Brown, 1996). It is especially significant to the species *Litoria raniformis*, which is classified as 'vulnerable' in the State. Preservation of wetlands is seen as vital to the long term preservation of frog species diversity in the Northeast.

There are 18 freshwater fish species found in northeast Tasmania, three of which are introduced species (Chilcott and Humphries, 1995). Most of these species are diadromous and have a Tasmania wide distribution. Three of the native fish species are confined entirely to freshwater areas (Table 1), and all three have the most limited natural distributions of species occurring in the northeast (Fulton, 1990).

Of the species listed below, the dwarf galaxias, *Galaxiella pusilla* Mack (dwarf galaxiid), is the only species having a conservation status of 'rare' in Tasmania. This species is also considered 'vulnerable' on mainland Australia, with causes of decline being seen as drainage of wetlands, river channelisation, removal of riparian vegetation and interactions with introduced fish (Koehn, 1990a; Koehn, 1990b). The only other species currently requiring conservation attention is *Prototroctes maraena* Gunther (Australian grayling), which is considered 'vulnerable'. Two other species, *Galaxias cleaveri* Scott (Tasmanian mudfish) and *Lovettia sealli* Johnston (Tasmanian whitebait) although quite common (Fulton, 1990), are subject to various pressures that may limit their abundance and distribution on a local scale. The juvenile *G. cleaveri*, together with other galaxiid juveniles form part of the whitebait runs on their return from the sea in spring and they take up residence in the lower part of coastal streams (Fulton,1990).

The usual habitat of *G. cleaveri* is swampy areas near the coast and the species is found mostly in still waters, heavily vegetated mud bottomed swamps and drains (McDowall, 1996; Fulton, 1996). Mudfish are regarded as widespread and common around Tasmania (Fulton, 1990), although its habitat is under continual threat from drainage of swamps and reclamation of estuarine marshes.

These activities have been common in the past in the lower reaches of the Great Forester River. In the 1920's, the Great Forester River was diverted by excavating a drain known as Adam's Cut. This reduced the rivers length by more than 7 km and enabled 325ha of land to be reclaimed.

The true whitebait *L. sealli* exhibit an anadromous lifestyle migrating into freshwater to breed. Spawning occurs during spring and early summer when large schools of year old adults migrate into freshwater. Eggs are attached in clusters to submerged logs, stones or plants and hatching occurs in 2-3 weeks. The larvae are then washed down into the sea. In the past, this species was the basis of an important commercial fishery, however since the 1940's populations have declined to the point where the fishery was closed from 1973 to 1990. The fishery has since been opened on a restricted basis.

Table 1: Freshwater Fish of northeast Tasmania

Life History: M = migrates to and from sea or estuary, F = freshwater only
Habitat: R = rivers, L = lake, W = wetlands

Common Name	**Scientific Name**	**Life History**	**Habitat**
Native Fish			
short-headed lamprey	*Mordacia mordax*	M	R
pouched lamprey	*Geotria australis*	M	R
short-finned eel	*Anguilla australis*	M	R/L/W
long-finned eel	*Anguilla reinhardtii*	M	R/L/W
jollytail	*Galaxias maculatus*	M	R/L
spotted galaxias	*G. truttaceus*	M	R/L
climbing galaxias	*G. brevipinnus*	M	R
Tasmanian mudfish	*G. cleaveri*	M	R/W
dwarf galaxias	*Galaxiella pusilla*	F	R/W
Tasmanian whitebait	*Lovettia sealii*	M	R
Australian grayling	*Prototroctes maraena*	M	R
Tasmanian smelt	*Retropinna tasmanica*	M	R
river blackfish	*Gadopsis marmoratus*	F	R/L
southern pygmy perch	*Nannoperca australis*	F	R/W
sandy flathead	*Pseudaphritis urvillii*	M	R
Introduced Fish			
brown Trout	*Salmo trutta*	M	R/L
Atlantic salmon	*Salmo salar*	M	R/L
rainbow trout	*Oncorhynchus mykiss*	M	R/L

Taken from Chilcott and Humphries (1995)

There are two major genera of freshwater crayfish found in the northeast region, *Astacopsis* (including the Giant Freshwater Crayfish, *Astacopsis gouldi*) and *Engaeus* (a smaller burrowing crayfish) which consist of about eight species in northeast Tasmania (Horwitz, 1996). Both *Astacopsis gouldi*, Clark and *Astacopsis franklinii*, Gray are found in the Great Forester catchment (Hamr, 1992), while at least three species of *Engaeus* are also known to occur. The most threatened of these is the Scottsdale burrowing crayfish (*Engaeus spinicaudatus*). It is presently registered as 'vulnerable' due to its very restricted distribution and disturbance of its habitat. *Astacopsis gouldi* is also registered as a 'vulnerable' species and is now protected under the Rare and Threatened Species Act and will be discussed in the next section.

3. Endangered Species

A species is regarded as endangered if it is in danger of extinction because long term survival is unlikely while the factors causing them to be endangered continue operating. Approximately 4 endangered aquatic species are listed that have distributions in the Great Forester catchment. The best known of these is *Astacopsis gouldi* (the Giant Freshwater Crayfish). *A. gouldi* is listed as "vulnerable" under Tasmanian *Threatened Species Protection Act* 1995. At the beginning of 1998 *A. gouldi* was declared a "protected fish" under the *Inland Fisheries Act* 1995 ending recreational fishing for the species.

Astacopsis gouldi has been the subject of numerous scientific studies (Hamr, 1990; Horwitz, 1994; Growns, 1995) and a draft recovery plan currently exists for the species (Bluhdorn, 1997). *A. gouldi* is a lowland wet forest/rainforest species with a preferred habitat in heavily forested stream and creeks. Distribution is limited between sea level and around 400m altitude although most animals are found below 200m (Horwitz, 1994). *A. gouldi* requires streams with high quality water (low nutrients and sedimentation), a stable thermal regime of relatively low water temperature, and habitat cover in the form of woody debris, undercut banks and ample canopy cover (Growns, 1995; Bluhdorn, 1997). Large scale habitat disturbance from agricultural and urban landuse, forestry activity and fishing pressure has reduced both the species abundance and viability of some populations. Localised extinction's or large depletion's of stocks are thought to have occurred in the Great Forester River as well as many other northeastern rivers (Bryant, 1998a).

(Bryant, 1998b) listed key issues associated with the protection of the habitat of *A. gouldi* as follows:

- Protection of stream side vegetation
- Appropriate willow removal and retention of stumps and rehabilitation of native riparian vegetation
- Retention of large woody debris
- Management of stock access
- Appropriate use of fertilisers and chemicals

The Scottsdale burrowing crayfish (*Engaeus spinicaudatus*) is restricted in Surveyors Creek and the Great Forester River valley just northeast of Scottsdale. It requires organic (peaty) , permanently saturated surface soils and is found in buttongrass and heathy plains, the floodplains and riparian areas of streams, and wet pastures. Threats to *E. spinicaudatus* include drainage of swamps, conversion to pasture, siltation of streams and swamps and pesticide contamination of water (Jackson & Munks, 1998).

Two aquatic hydrobiid snails are also listed as endangered (Jackson & Munks, 1998). *Beddomia briansmithi* has been sampled from the Fern Creek and *Beddomia minima* from a small unnamed stream near Scottsdale. Both of these waterways are tributaries of the Great Forester River. The family Beddomia displays a high level of local endemicity with over 62 Tasmanian species in this group (Davies, 1995). The survival of hydrobiid snail populations primarily depend on the retention of native riparian vegetation and maintenance of good water quality. Ponder (1988) also suggests that landuse impacts and competition with introduced species such as *Potamopyrgus antipodarium* are also having a deleterious effect on snail populations and these impacts are primarily in lowland rural and urban streams (Davies, 1995).

Galaxiella pusilla (Dwarf Galaxiid) is found in northeastern lowland rivers and inhabits still or slow flowing waters such as swamps and backwaters of creeks, frequently amongst marginal vegetation (Humphries, 1986; Jackson and Munks, 1998). Spawning occurs from August to October. Eggs are usually deposited on macrophytes or leaf litter. The current status of the species is rare due to a limited distribution at unprotected sites. Important management considerations include retention of riparian vegetation, maintenance of water quality and flow regime and decrease in sediment input from roads and drainage of swamps.

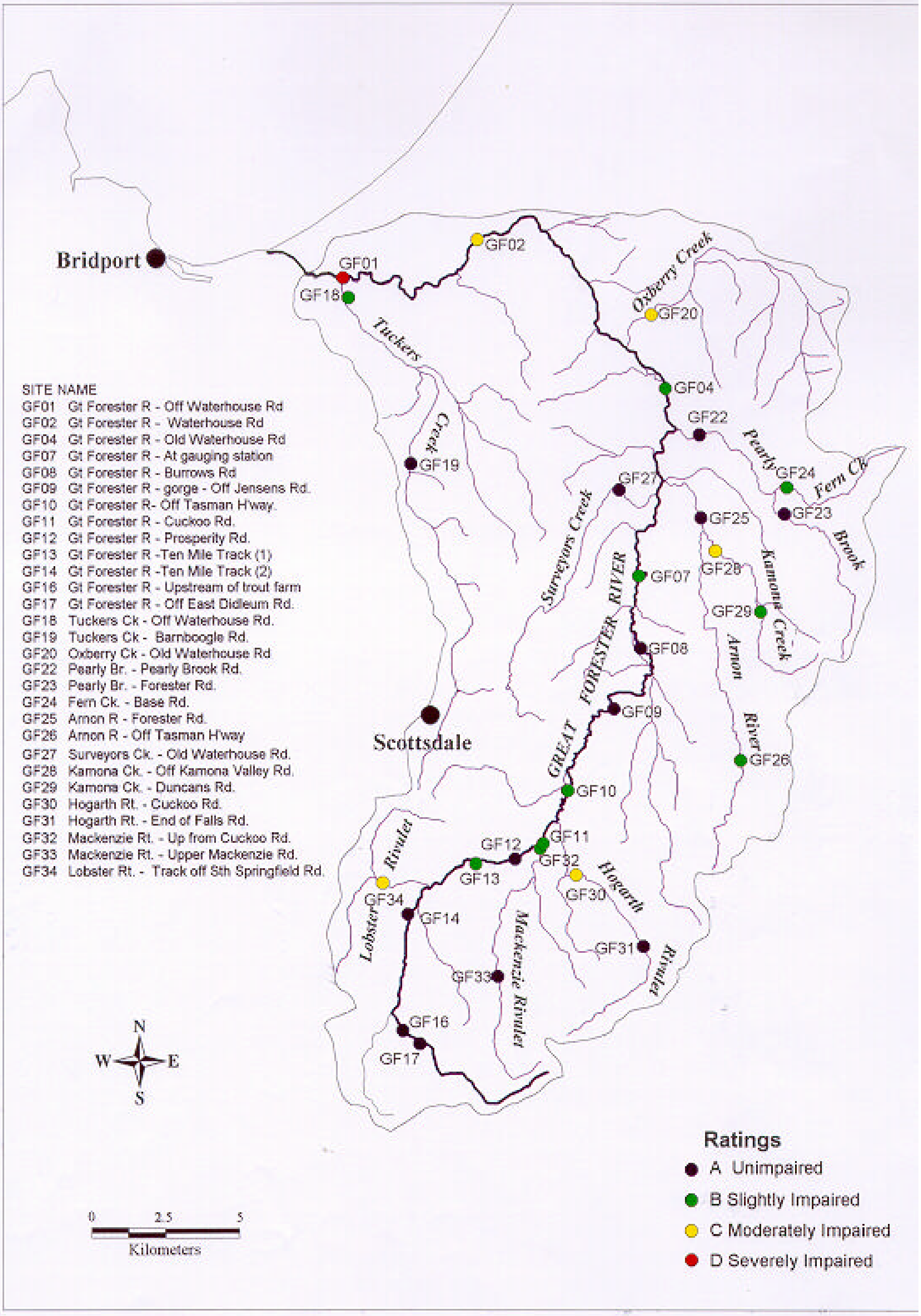
Prototroctes maraena (Australian Grayling) lives in coastal streams and rivers around the Tasmanian coast and occurs most commonly in clear gravelly streams with a moderate flow. Its need to migrate to and from the sea makes it vulnerable to depletion in rivers that prevent fish passage as a result of barriers to upstream and downstream migration (McDowall, 1986). Spawning takes place in autumn and once larvae have hatched, they are swept downstream towards the sea. Larval life is marine and juveniles return to rivers from the sea during spring and the rest of their life is spent in rivers. The current status of this species is vulnerable due to a decline in its population resulting in decreased numbers across much of its former range.

In summary, many of these species are affected by habitat degradation. Management prescriptions in the form of retention and rehabilitation of native riparian vegetation and minimal disturbance to instream habitat particularly in the lower reaches of the Great Forester River will increase the chances of recovery for many of these species.

4. Macroinvertebrates

The National River Health Program was formed in 1993 by the Federal Government to provide a means of assessing the ecological condition of Australia’s river systems. MRHI in Tasmania commenced in 1994 and the programs primary objectives were to develop predictive models to allow assessment of river health using macroinvertebrates as biological indicators. Over 120 sites in Northern Tasmania were sampled in order to build the bioassessment models. As part of this sampling, five sites were sampled at various times from spring 1994 to spring 1997 in the Great Forester catchment. Reference sites are defined as sites that are least disturbed and are suitable for use in the construction of predictive models. Test sites are those sites defined to be of importance in assessing the condition of a river known or thought to be experiencing an impact from water quality or habitat degradation. One reference site (Great Forester at Prosperity Rd.) and one test site (Great Forester at Tasman Hwy) were sampled on four occasions (spring 1994 and 1995 and autumn 1995 and 1996). A further 4 test sites (Arnon at Forester Rd., Great Forester at Ten Mile Track, Tuckers Creek at Barnbougle Rd., and Kamona Ck. at Kamona Valley Rd.) were sampled in autumn and spring 1997 (see Table 3, Fig. 1). Because the selection of sites in the Great Forester catchment was primarily aimed at the development and testing of the river health model, the overall coverage of the catchment was not extensive. However, an additional 29 sites were sampled under the Index of River Condition (IRC) study undertaken in autumn 1998, ranging from small tributaries in both the upper and lower catchment as well as the mainstream channel of the Great Forester River (see Fig. 1).

Figure 2: AusRivAS River Health ratings for sites sampled under the Index of River condition Study



As a comprehensive description of sampling protocols is given in CEPA(1994) and Oldmeadow (1998), a detailed description of these procedures will not be given here. The biological monitoring package AusRivAS (Australian River Assessment System) was used to provide a broad scale picture of the health of previously sampled sites in the Great Forester catchment at different times.

The AusRivAS model essentially predicts the aquatic macroinvertebrate fauna that would be expected to occur at a site in the absence of environmental stress such as pollution or habitat degradation. The first step of the model building process is classifying reference sites into groups which have similar invertebrate composition, based on family level presence/absence data. This is done using the agglomerative clustering technique, flexible unweighted pair-group arithmetic averaging (UPGMA). The reference site groups from the classification are entered into the reference habitat data set and a stepwise multiple discriminant function analysis (MDFA) is used to select the predictor variables used in a model. This procedure selects a subset of habitat variables which best discriminate between the groups of sites formed from the faunal classifications. The subset of habitat variables obtained from the stepwise MDFA are used as predictor variables for the AusRivAS model being constructed. The predictor variables and the reference site invertebrate classification form the foundation of AusRivAS, allowing predictions of which taxa should be found at new sites to be made. A comparison of the invertebrates predicted to occur at the test sites with those actually collected, provides a measure of biological impairment at the tested sites.

Each site is classified into four categories based on the ratio of macroinvertebrates "Observed" (or sampled) to the macroinvertebrates "Expected". This ratio is known as the observed / expected score or "OE". Table 2 presents the categories used and the OE ratio ranges for each cut off. The O/E ratio represents the percentage of taxa sampled at a site. From the table below, a site with less than 41 percent of the taxa expected to be present at the site is considered to be severely impaired. The advantages of these river health models is that not only the presence of an impact but also the magnitude can be determined for a specific site.

Table 2: River Health categories and Associated OE scores

Site Status	OE
Unimpaired	> 0.89
Slightly impaired	0.70-0.89
Impaired	0.41-0.69
Severely impaired	<0.41

Another biotic index is incorporated into the model output to provide an insight into the nature of the disturbance or impact at a site (see Fig. 2). (SIGNAL, Stream Invertebrate Grade Number Average Level, (Chessman, 1995) is a ratio of the observed (sampled) SIGNAL score to the expected signal score. The index is based on the sensitivity of macroinvertebrates to pollution. Each family of macroinvertebrates is assigned a grade according to their tolerance where a grade of 10 represents a high sensitivity to pollution and a grade of 1 represents a high tolerance to pollution. The "observed" SIGNAL score is the sum of the grades divided by the number of taxa collected and the "expected" score is the sum of the grades divided by the number of taxa expected.

O/E is sensitive to a wide variety of disturbances provided these result in the loss of families of macroinvertebrates from the habitats sampled at a site. Thus this index should detect not only loss of families due to deteriorated water quality, but also loss because of physical habitat degradation. O/E SIGNAL weights the families by their sensitivity to water pollution. Accordingly, O/E SIGNAL can detect situations where water pollution has resulted in the loss of only a few, but very sensitive, families of macroinvertebrates.

The model used to analyse the data collected under the Index of River Condition study was the regional autumn riffle model developed in 1996. The predictor variables for this model are catchment area, conductivity, latitude and alkalinity (mg $CaCO_3$/l). However alkalinity was measured at only 9 of the 29 index of river condition sites. This posed a problem because multivariate analyses used in AusRivAS models do not permit missing data. However Simpson *et al.*(1996) suggest that extrapolations using data from similar sites or means from previous years can be used to fill missing data. On closer examination, the concentration of calcium carbonate was uniformly low in the catchment ranging from 17mg/l at Great Forester off Tasman Highway (GF10) to 42mg/l at Tuckers Creek at Barnbougle Rd. (GF19) (see water quality section). Given the low variability, sites with missing data were given an average alkalinity score of 23mg/l. While this was not ideal, it was done to prevent the exclusion of the majority of the sites from the analysis and should not compromise the banding scores.

All macroinvertebrates were identified to family level except in the following cases: Chironomidae (midges) were identified to sub-family level Oligochaeta (worms), Hirudinea (leeches), Acarina (mites) and Turbellaria (flatworms) were identified to order and class level. A total of 48 families were identified from edgewater habitats and 31 families from riffle habitats. These taxa represented all the major taxonomic groups typical of freshwater streams. Insects were the most dominant, representing around 84% of the total number of taxa collected and accounting for 95% of the total number of individuals collected. In the edgewater habitat, the most dominant families both in terms of distribution and abundance were Leptoceridae (Caddisflies), Chironomidae (Midges) and Leptophlebiidae (mayflies). The two most dominant families in riffle habitats were Leptophlebiidae (Mayflies) and Elmidae (riffle beetles).

Table 3 presents the river health categories for riffle and edgewater habitats at sites visited under the MRHI program from 1994 to 1997 as well as results from the Index of River Condition study carried out in autumn 1998. Only riffle habitats were sampled in the IRC study.

Figure 2 is a plot of the O/E scores against the OESIGNAL scores for the riffle habitat for sites collected under the Index of River Condition study. The majority of impacted sites indicate the usefulness of including OESIGNAL for interpretation and diagnosis. All the impacted sites except GF21 and GF24 indicate that the lower health ratings are due to a potential impact other than water quality. For example Kamona Creek at Kamona Valley Rd. has an OE value of 0.52 indicating a substantial loss of taxa (48%) relative to the reference sites, whereas OESIGNAL (1.07) shows that the taxa collected were mostly sensitive taxa. Inspection of the diagnostic data shows that taxa that were expected but not found at this site included Psephenidae (water pennies), Simuliidae (black fly larvae), Baetidae (mayflies), Eustheniidae (stoneflies), Hydrobiosidae, and Hydropsychidae (caddisflies). All of these taxa are adapted to life in fast flowing water either by having a streamlined shape and/or some means of attachment to such as claws, suckers or hooks. These taxa are generally found under cobbles or boulders or submerged objects such as coarse woody debris. However most of the impacted sites are dominated by a sand/ silt substrate, in some cases approaching 90%. Boulder and cobbles at these sites tend to be completely surrounded by the finer sediment , thus restricting the available habitat for the aforementioned taxa. The lack of substrate diversity, in addition to clearance of riparian vegetation may be the primary factors in determining the lower river health ratings observed at many of these sites.

Site	Code	Spring 94		Autumn 95		Spring 95		Autumn 96		Autumn 97		Spring 97		IRC Autumn 98	
		Riffle	Edge	Riffle	Edge	Riffle	Edge	Riffle	Edge	Riffle	Edge	Riffle	Edge	Riffle	
Gt Forester R - Prosperity Rd.	D24	A	A	**B**	A	**C**	A	**B**	X						
Gt Forester R - Off Tasman H'way	DMon4	**B**	A	A	X	**C**	A	**C**	A						
Arnon R. - Forester Rd	DT01									A	**B**	A	X		
Gt Forester R - Ten mile track (2)	DT06									A	X	A	X		
Kamona Ck - Off Kamona Valley Rd	DT07									NS	A	NS	A		
Tuckers Ck./ Barnbougle Rd.	DT14									NS	A	NS	A		
Gt Forester R - Off Waterhouse Rd.	GF01													**D**	
Gt Forester R - Waterhouse Rd.	GF02													**C**	
Gt Forester R - Old Waterhouse Rd.	GF04													**B**	
Gt Forester R - At gauging station	GF07													**B**	
Gt Forester R - Burrows Rd.	GF08													A	
Gt Forester R - gorge - Off Jensens Rd.	GF09													A	
Gt Forester R - Off Tasman H'way	GF10													**B**	
Gt Forester R - Cuckoo Rd.	GF11													**B**	
Gt Forester R - Prosperity Rd.	GF12													A	
Gt Forester R - Ten mile track (1)	GF13													**B**	
Gt Forester R - Ten mile track (2)	GF14													A	
Gt Forester R - Upstream of trout farm	GF16													A	
Gt Forester R - Off East Didleum Rd.	GF17													A	
Tuckers ck - Off Waterhouse Rd.	GF18													**B**	
Tuckers Ck - Barnboogle Rd.	GF19													A	
Oxberry Ck - Old Waterhouse Rd.	GF20													**C**	
Pearly Br. - Pearly Brook Rd.	GF22													A	
Pearly Br. - Forester Rd	GF23													A	
Fern Ck - Base Rd.	GF24													**B**	
Arnon R. - Forester Rd	GF25													A	
Arnon R. - Off Tasman H'way	GF26													**B**	
Surveyors Ck - Old Waterhouse Rd	GF27													A	
Kamona Ck - Off Kamona Valley Rd	GF28													**C**	
Kamona Ck - Duncans Rd.	GF29													**B**	
Hogarth Rt. - Cuckoo Rd.	GF30													**C**	
Hogarth Rt. - End of Falls Rd track.	GF31													A	
Mackenzie R - Up from Cuckoo Rd.	GF32													**B**	
Mackenzie R - Upper Mackenzie Rd.	GF33													A	
Lobster Rt. - Farm track off Sth Springfield Rd.	GF34													**C**	

Table 3: River Health Categories for Riffle and Edgewater Habitats at sites visited under the Monitoring River Health Initiative 1994-1997 and the Index of River Condition study in Autumn 1998. Ratings are as follows:

Category X - Above Reference Condition (Biodiverse Sites)
A - Unimpaired
B - Slightly Impaired
C - Impaired
D - Severely Impaired
NS - Not Sampled

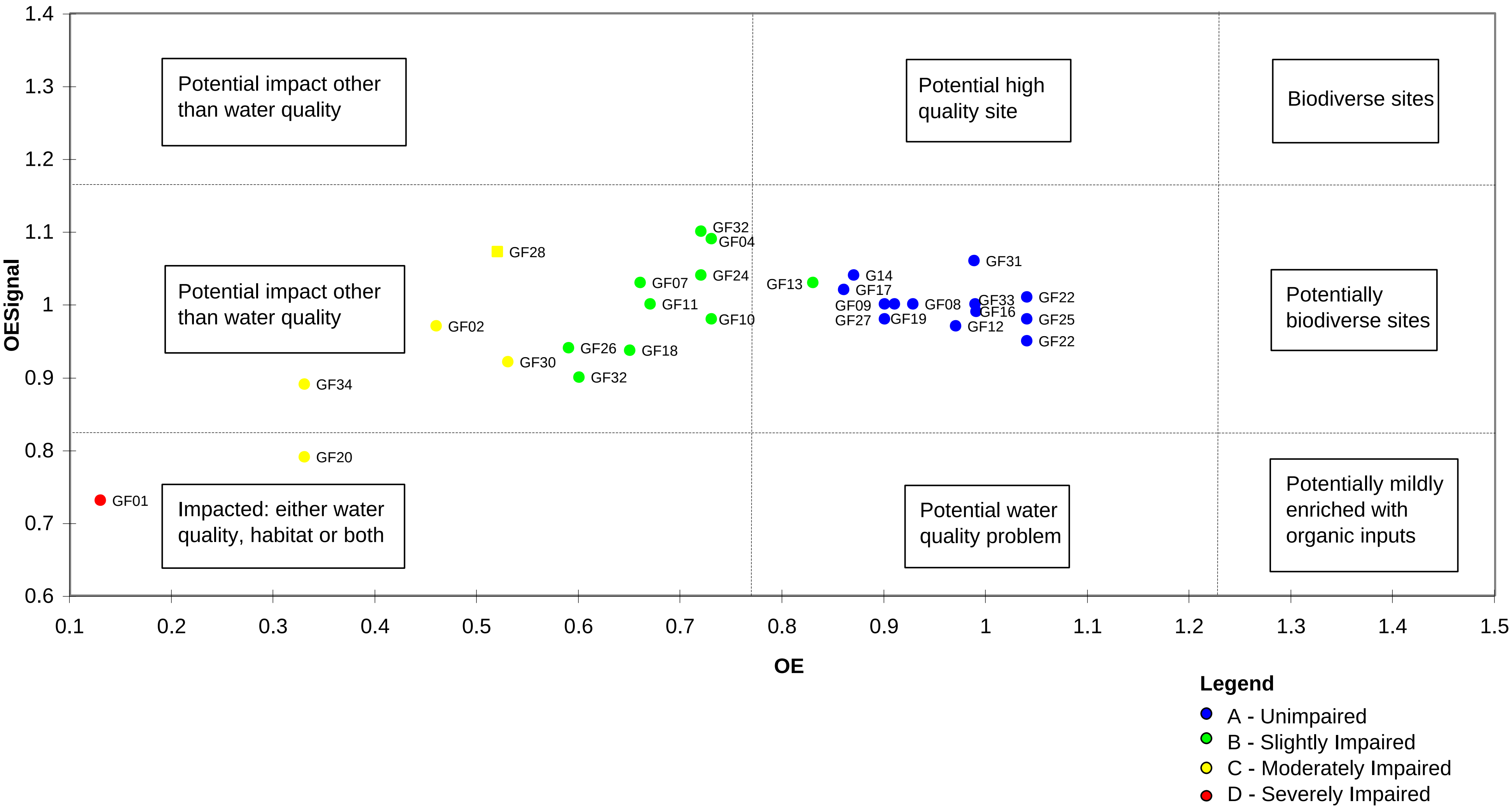


Figure 2. Plot of OE vs OE signal for riffle habitats at each site sampled under the Index of River Condition study and possible interpretations for situations where the two indices place sites in different bands. The vertical and horizontal dashed lines indicate the upper and lower bounds for unimaired (A) high quality sites

Great Forester River

Thirteen sites were sampled on the Great Forester mainstream. These were spread throughout the catchment. Figure 1 illustrates that the health of the Great Forester River gradually deteriorates longitudinally down the catchment. Sites from the top of the catchment (Great Forester off East Diddleum Rd. down to Great Forester at Old Waterhouse Rd. had faunal assemblages indicative of unimpaired or slightly impaired rivers. From Old Waterhouse Rd. there is a marked reduction in OE scores culminating at the lowest site at Waterhouse Rd. which is rated as severely impaired. At this site only two of the predicted eighteen taxa were collected. This site plots in the lower left hand corner of the OE vs OESIGNAL plot indicating that the impact is water quality and/or habitat related. The main trend is a reduction in OE scores down the catchment. In contrast, OESIGNAL scores remain high which suggests an impact other than water quality.

The two sites on the Great Forester River which were also sampled under the MRHI program (Great Forester off Tasman Highway and Great Forester at Prosperity Rd.) have shown slight to moderate impairment on a number of occasions (Table 3). However OESIGNAL scores again suggest that the impairment is due to other factors other than water quality. However it is worth noting that the herbicide simazine was detected in the water at both of these sites in spring 1994. The concentration was 1µg/l at Prosperity Rd. and 0.7µg/l at Tasman Highway. Davies *et al.* (1994) reported that the aquatic fauna of Tasmanian streams may suffer minor short term disturbances if frequently exposed to triazine herbicides such as simazine. They found that concentrations between 1 and 20µg/l had no major impact on the aquatic fauna even when exposed for several weeks, but that concentrations above 100µg/l were regarded as having short term lethal effects. The concentrations found at the two sites were unlikely to cause any adverse impact on the aquatic fauna. However, because the sites were sampled only once, it is impossible to determine when or where the impact occurred, nor the peak concentration of simazine in the water.

Tributaries

All the tributaries of the Great Forester River are influenced to some extent by forestry activities. The predominantly pine plantations (*Pinus radiata*) supply two major pine board mills located in the Scottsdale area. Mining activity in the Great Forester catchment is restricted to a few small tin mines to the northeast of Mt. Stronach on the Arnon River. Tributaries, particularly in the lower part of the catchment are influenced by agricultural activities and have been subjected to erosion through land clearing and unrestricted stock access.

Edgewater habitats sampled from the tributaries of the Great Forester River have consistently been found to have an unimpaired river health rating on each sampling occasion. The one exception is the slightly impaired (B) rating obtained for the Arnon River at Forester Rd. in autumn 1997. However this sample was collected and picked in adverse conditions of poor light and heavy rain which may have biased the taxa which were found at this site and hence affected the quality of the data. Re-sampling and reassessment of the site in spring 1997 shows a return to an unimpaired health rating.

The Arnon River at Forester Rd. was the only tributary from which a riffle sample was obtained under the MRHI program. On each occasion it obtained an unimpaired rating. The other two sites Kamona Creek at Kamona Valley Rd. and Tuckers Creek at Barnbougle Rd. were deemed not to have a suitable riffle habitats for the purposes of model development.

Riffle habitats of the tributaries in the IRC study obtained river health ratings ranging from moderately impaired (C) to unimpaired (A). Where two sites were sampled on a tributary, i.e. Tuckers Creek, Pearly Brook, Kamona Creek, Arnon River, Hogarth Rivulet, and Mackenzie Rivulet, invariably the higher site received a better rating, usually unimpaired, than the corresponding lower site. The only exception was the pair of sites on the Arnon River where the trend was reversed. The higher site is influenced by intensive agriculture (dairy). The combination of riparian vegetation clearance in addition to unrestricted stock access have probably contributed to bankside erosion. These factors, along with elevated nutrient levels, are likely to have contributed to the lower river health rating at this site. The site at Forester Rd. shows a recovery from the significant impacts further up in the Arnon catchment.

Pearly Brook received an unimpaired rating at both sites. This catchment is perhaps the least impacted of the tributaries. There is some forestry activity within the catchment, however this is isolated to the upper reaches of the catchment. Compared with other sites in the Great Forester catchment, the native vegetation of Pearly Brook is relatively intact. No water quality problems have been identified and there is a diverse cobble/ boulder substrate, particularly at Forester Rd., which promotes species diversity (Minshall, 1984)

Hogarth Rivulet follows the trend of an unimpaired rating higher in the catchment, deteriorating to a moderately impaired rating at Cuckoo Rd. Hogarth Rivulet is influenced by forestry and agricultural activities (hops). Riparian vegetation at the Cuckoo Rd. site is severely reduced and restricted to exotic species. Although nutrient and faecal coliform levels were low, high amounts of aluminium were found at this site. Aluminium is one of the more toxic of the trace metals and has been shown to decrease diversity in riverine habitats and also influences growth rates and survival of many aquatic invertebrates (Dallas & Day, 1993).

There is evidence to suggest that the Great Forester River undergoes periodic episodes of impairment due to temporary decreases in water quality. The most dramatic of these was a major spill of pyrethrum in Hogarth Rivulet in April 1994. This resulted in the destruction of aquatic fauna within Hogarth Rivulet and the Great Forester River with dead fish and the endemic freshwater crayfish *Astacopsis gouldi* being found up to 15 km downstream from the spill. The Department of Primary Industries, Water and Environment undertook a program to study the effects of such a major pollution event as well as to investigate and monitor the aquatic ecosystem recovery processes in the Great Forester River and the relative roles of tributary recolonisation in comparison with lateral movement of organisms within the main channel. Maxwell *et al* (1997) found that the invertebrate communities had recovered from the initial impact of the spill within a relatively short period of time. Within two months of the spill, over half of the taxa found at the control sites were found at the impacted sites. After 10 months, the invertebrates had established community structures similar in numbers and composition to the control sites. The species of most concern is the giant freshwater crayfish *Astacopsis gouldi*. Because of its low fecundity and territorial nature, it has a low rate of dispersal and it was hypothesized that recolonisation of the lower section of the Great Forester River could take a number of years.

A second fish kill was reported in Hogarth Rivulet and the Great Forester River on the 23rd January 1999. The causes were unknown as the water quality tests proved to be inconclusive.

Summary

In general the Great Forester River and tributaries are in good health, particularly in the upper to mid catchment. In the main channel all sites down to Old Waterhouse Rd. received an unimpaired to slightly impaired rating. The lower part of the main channel is in poorer health with sites either moderately or severely impaired. The majority of tributaries are unimpaired or slightly impaired. The majority of impaired sites are impacted by habitat degradation or factors other than water quality (Fig.2) although there is evidence to suggest periodic deterioration of water quality. Edgewater habitats, in general, are in better condition than riffle habitats sampled at the same time. This again suggests that potential impacts are due to habitat related factors. Sites that have been sampled on more than one occasion have shown fluctuation in river health ratings (Table 3). Although this may be due to operator efficiency, it is more likely a response of the macroinvertebrate communities to periodic deterioration in water quality. This may be further exacerbated by periods of low flow and elevated nutrient inputs into reaches in the form of runoff from agricultural land practices upstream or stock access evidenced at impaired sites such as the Lobster Rivulet (GF34).

5. Algae

Algae are simple plants that vary considerably in size, shape and colour, and are found in a range of habitats. They are a natural part of the surface water ecosystem and are encountered in every water body that is exposed to sunlight. While a few algae are found in soils and in surfaces exposed to air, the great majority are truly aquatic and grow submerged in ponds, lakes, water supply storages, streams, estuaries and oceans. In water storages the phytoplankton, or floating microscopic plants, are of major importance, and are the basic food source of small aquatic animals. There are four main types of freshwater algae: Green Algae (Chlorophyceae), of which the threadlike filamentous form is the most common, Blue-green Algae (Cyanophyceae), Diatoms (Bacillariophyceae) and Euglenoids (Euglenieae). Excessive growth of algae can cause numerous problems in waterways. Blooms can severely reduce the oxygen content of the water and cause the death of fish and other aquatic animals. Mats of filamentous algae can clog irrigation channels and pipes and severely reduce flow and certain blue-green algal blooms (in particular *Anacystis cyanea*) are toxic and have been known to kill live stock, including cattle, sheep, horses and domestic fowl.

Algae has many advantages over traditional indicators of water quality particularly in an urban setting (Round, 1991). Unlike macroinvertebrates, algae are a ubiquitous component of a water environment and are even found in concrete drains (common in urban environments). Algae have particular advantages as bio-indicators over other animals such as fish and macroinvertebrates in that they are often present before and after pollution incidents, reflect nutrient composition of the water more closely than animals and are often different to macroinvertebrates in their sensitivity to toxic materials (Whitton & Kelly, 1995).

In many Australian states, algae have been used on small spatial scales for bio-monitoring (Chessman, 1986; Sonnerman & Breen, 1997). There have been investigations into the feasibility of using algal taxa to assess river health and many researchers have suggested various protocols for bioassessment of rivers using algae as indicators (Hotzel & Croome, 1998). The development of river health models such as AusRivAS, the current platform for using macroinvertebrates to assess river health, has prompted various workers to develop similar models using algae as the indicator taxa.

In this vein, DPIWE has been sampling algae at sites where macroinvertebrates have been sampled for the Monitoring Riverine Health Initiative (MRHI) and the First National Assessment of River Health (FNARH) since late 1996 with the long term plan to develop bioassessment models for algae similar to those currently being developed for macroinvertebrates. To date, over 247 genera have been identified from over 350 sites around Tasmania.

As part of this program algal samples were collected from 4 sites in the Great Forester catchment in autumn and spring 1997. These sites were located on the Great Forester mainstream and associated tributaries. Samples were taken from both riffle and edgewater habitats by scraping the top surface of a cobble. They were preserved in 5% formalin and identified to genus level under a compound microscope in the laboratory.

Sixty eight genera of algae were identified from the Great Forester catchment, including Diatoms, Green algae, Blue-green algae and Euglenoids. These species are common throughout Tasmania and as such pose no public risk.

The number of genera of algae recorded per site ranged from 12 to 45 (see Fig. 3). Low numbers in algal taxa are most likely due to nutrient limitation, and hence likely to be recorded from relatively undisturbed sites such as the Arnon River (DT01) and Kamona Creek (DT 07). Conversely, high algae taxa numbers correspond to rivers with high Total
Nitrogen and bacterial levels i.e. Great Forester at Ten Mile Track (DT06) and Tuckers Ck. at Barnbougle Rd. (DT14). The Arnon River recorded a sharp increase in taxa numbers in spring. This may be due to the higher than expected nutrient levels at this site (see Water Quality section) and may reflect the impact of agricultural activities higher up in the catchment. Despite this, the types of algae encountered at all sites in this study such as *Cymbella*, *Fragilaria*, *Gomphonema*, *Navicula* and *Synedra* are generally characteristic of healthy unimpacted streams (Chessman, 1986) and contain a high diversity of algal groups with the exception of blue green algae. The most likely reason for the reduction of blue green algal taxa is the low pH of the water. Dallas(1993) reviewed studies that generally found low pH conditions are responsible for reductions in the types and number of blue green algae present.

To make further comments on the composition of algal communities and how these relate to specific water quality impacts or habitat degradation in the Great Forester catchment would be inappropriate as too few sites were sampled in 1997 for a rigourous analysis. However the brief survey carried out at this time indicates that algal communities at all sites are diverse and indicative of good river health. Some sites with high numbers of algae are possibly responding to elevated nutrient levels and sites with low numbers of algal taxa are commonly in undisturbed low nutrient streams and tributaries of the Great Forester River.

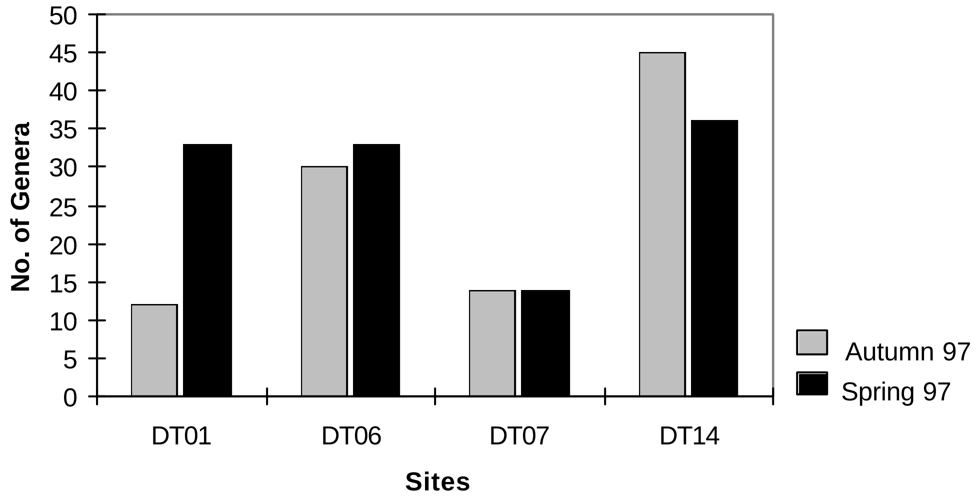


Figure 3: Number of algal genera sampled at each site in the Great Forester catchment in autumn 1997 and spring 1997: Site codes for the following sites are as follows

DT01 - Arnon R. - Forester Rd.
DT06 - Gt. Forester R. - Ten Mile Track (2)
DT07 - Kamona Ck. - Off Kamona Valley Rd.
DT14 - Tuckers Ck. - Barnbougle Rd.

6. References

Bluhdorn, D.R. (1997) Recovery plan for the Tasmanian Giant Freshwater Lobster *Astacopsis gouldi* Clark. Inland Fisheries Commission, Hobart. 21pp.

Brown, P.B. (1996) The frogs of northeast Tasmania. *Biogeography of northeast Tasmania*. Edited by Robert Mesibov, Queen Victoria Museum and Art Gallery, Launceston, pp.139-144.

Bryant, S. (1998a). Tasmania's Giant Freshwater Lobster *Astacopsis gouldi* (Part one). Inland Fisheries Commission Newsletter. Vol. 27 p. 3.

Bryant, S. (1998b). Tasmania's Giant Freshwater Lobster *Astacopsis gouldi* (Part Two). Inland Fisheries Commission Newsletter. Vol. 27 pp. 3-8.

CEPA (1994) National River and Management program Monitoring River Health Initiative: River Bio-assessment Manual. Commonwealth Environmental Protection Agency, Canberra.

Chessman, B.C. (1986) Diatom flora of an Australian river system: spatial patterns and environmental relationships. *Freshwater Biology,* Vol. 16, pp. 805-819.

Chessman, B.C. (1995) Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat -specific sampling, family level identification and a biotic index. *Australian Journal of Ecology,* Vol. 33**,** pp.122-129.

Chilcott, S.J.& Humphries, P. (1995). Freshwater fish of northeast Tasmania with notes on the Dwarf Galaxias. *Biogeography of northeast Tasmania*, Edited by Robert Mesibov, Queen Victoria Museum and Art Gallery, Launceston. pp.145-150.

Dallas, H.F. & Day, J.A. (1993) The effect of water quality variables on riverine ecosystems: a review. Water Research Commission, Pretoria. Report TT 61/93.

Davies, P.E. (1995) Effect of logging operations on hydrobiid snails in Tasmanian streams: a before versus after study. Freshwater Systems, Hobart. pp.1-15.

Davies, P.E., Cook, L. S. J., and Barton, J. L. (1994). Triazine herbicide contamination of Tasmanian streams: sources, concentrations and effects on biota. *Aust. J Mar, Freshw. Res*. **45**, 209-226

Fulton, W. (1990) *Tasmanian Freshwater Fishes*. Edited by Alistair Richardson, University of Tasmania, Hobart First edition. pp. 1-80.

Growns, I.O. (1995) *Astacopsis gouldi* Clark in streams of the Gog range, Northern Tasmania: the effects of catchment disturbance. *Papers and Proceeedings of the Royal Society of Tasmania,* Vol. 129, pp. 1-6.

Hamr, P. (1990). Comparative Reproductive Biology of the Tasmanian Freshwater Crayfishes *Astacopsis gouldi* Clark, *Astacopsis franklinii* Gray and *Parastacoides tasmanicus* Clark (Decapoda: Parastacidae). PhD thesis, Zoology Department, University of Tasmania. 153pp.

Hamr, P. (1992) A revision of the Tasmanian Freshwater Crayfish Genus *Astacopsis* Huxley (Decapoda:Parastacidae). *Papers and Proceedings of the Royal Society of Tasmania,* Vol. 126, pp. 91-94.

Horwitz, P. (1996) Biogeographical affinities of macrocrustacean groups in northeast Tasmania. *Biogeography of northeast Tasmania*. Edited by Robert Mesibov, Queen Victoria Museum and Art Gallery, Launceston. pp.171-178.

Horwitz, P.H.J. (1994) Distribution and conservation status of the Tasmanian giant freshwater lobster *Astacopsis gouldi* (Decapoda: Parastacidae). *Biological Conservation,* Vol 69, pp.199-206.

Hotzel, G. & Croome, R. (1998) A phytoplankton methods manual for Australian rivers. Land and Water Resources Research and Development Corporation, Canberra. Occasional paper No. 18/98.

Humphries, P. (1986) Observations on the ecology of *Galaxiella pusilla* (Mack) (Salmoniformes:Galaxiidae) in Diamond Creek, Victoria. *Proceedings of the Royal Society of Victoria,* Vol. 98, pp.133-137.

Jackson, J. & Munks, S. (1998) *Threatened fauna manual for production forests in Tasmania* (revised version) Forest Practices Board, Hobart.

Koehn, J.D. (1990a) Threats to Victoria native freshwater fish. *Victorian Naturalist,* Vol. 107, pp.5 - 12.

Koehn, J.D. (1990b) A review of the conservation status of native freshwater fish in Victoria. *Victorian Naturalist,* Vol. 107, pp.13 - 25.

Maxwell, H., Nelson, M. and Fuller, D. (1997): Ecological Recovery of the Great Forester River(1994-1996) Department of Primary Industry and Fisheries, Hobart. Technical Report No. WRA97/01.

McDowall, R.M. (1996) Southern graylings. *Freshwater Fishes of southeastern Australia*. Edited by R.M. McDowall , Reed, Sydney. 2nd edition pp. 96-98.

McDowall, R.M. & Fulton, W. (1996) Galaxiids. *Freshwater Fishes of south- eastern Australia*. Edited by R.M.Mcdowall Reed, Sydney. 2nd edition pp 52-77.

Minshall, G. W. (1984) Aquatic Insect Substrate Relationships. *Ecology of Aquatic Insects*. Edited by V. H. Resh and A. M. Rosenberg. Praeger. pp358-400

Oldmeadow, D., Krasnicki, T. & Fuller, D. (1998) Monitoring River Health Initiative. Department of Primary Industry and Fisheries, Hobart. Technical Report No. WRA 98/03

Ponder, W.F. (1988) *Potamopyrgus antipodarum*-a molluscan coloniser of Europe and Australia. *Journal of Molluscan Studies,* Vol. 54, pp.271-285.

Round, F.E. (1991) Diatoms in river water monitoring studies. *Journal of Applied Phycology,* Vol. 3, pp.129-145.

Simpson, J., Norris, R., Barmuta, L., and Blackman, P. (1996) AusRivAS- National River Health Program - User Manual. CRC for Freshwater Ecology, University of Canberra.

Sonnerman, J. and Breen, P. (1997). *Factors influencing benthic diatom community patterns in urban and non-urban streams.* Australian Society for Limnology Annual Congress, Albury/Woodonga, Australian Society for Limnology.

Whitton, B.A. & Kelly, M.G. (1995) Use of Algae and other plants for monitoring rivers. *Australian Journal of Ecology,* Vol. 20, pp. 45-56.