Internal Report

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

PRELIMINARY INVESTIGATION OF THE FRESHWATER MACROINVERTEBRATES IN THE SALT RIVER, IN RELATION TO THE PROPOSED STOCKING OF TROUT INTO THE UPPER SALT RIVER, FARM 236, THE CRAGS

Helen M. Barber-James

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1. INTRODUCTION

The rivers that originate in the fold mountain belts of the southern and western Cape are characterised by having slightly acid (pH 6.0-6.9) to strongly acid (pH 5.0-5.9) waters (Harrison & Agnew, 1962). They carry a low suspended solid load and are generally clear or stained brown by humic acids. Rainfall in the southern Cape is year round with perennial coastal south-flowing rivers and some of the smaller streams in the rain shadow of the mountains becoming seasonal.

Surveys of the macroinvertebrates of the rivers of the southern Cape fold mountain region by Harrison and Agnew (1962), Stuckenberg 1962 and Brundin 1966 revealed that this region of South Africa had a unique and diverse fauna. Surveys of invertebrates in rivers of the Baviaanskloof Wilderness have uncovered further additions to this unique, largely endemic aquatic macroinvertebrate fauna (de Moor, 1988, 1991, 1992, 1993, 1998, 1999; Scott & de Moor, 1993; Perkins & Balfour-Browne, 1993; Cambray, de Moor & Barber-James, 1995; Picker and Stevens, 1997, 1999; Stevens and Picker, 1995, 1999; McCafferty and Wang, 1997). A number of workshops, popular articles and other scientific publications have also presented information on the diverse and unique fauna of this region. In addition, the Albany Museum holds collections of aquatic invertebrates made in the region, some of which have been only partially sorted and identified. Several "new" species collected await proper scientific description and further study.

The Cape fold mountain regions are rich in insect species in a number of orders. Aquatic and semi-aquatic insect groups include taxa from the orders Odonata, Ephemeroptera, Plecoptera, Hemiptera, Trichoptera, Diptera and Coleoptera. The montane regions of the southern and southwestern Cape offer a diversity of complex and finely partitioned ecosystems within one geographical area, thus over time, with fluctuations in temperature and rainfall patterns, creating restrictive conditions for various life forms (Perkins & Balfour-Browne, 1993). The mountains form a geographical area isolated by the sea (in the South) and dry plateau areas (in the North and East) over a very long geological time. The region has suffered no catastrophic events such as glaciation, total aridity, flooding by epicontinental seas or meteor impacts since the middle Cretaceous time (ca. 100 million years bp), and thus has a very long biogeographic history. The Cape fold mountains, having remained geographically in a more temperate climate, form the oldest linkage with the former temperate Gondwanaland and have important geographical and biological links with South America, Australia and New-Zealand (Brundin 1966). The region therefore has high evolutionary and natural history value. It must be considered as one of the evolutionary and species diversity hotspots on the globe, not only in its rich plant diversity, but also in the diverse insect fauna, both terrestrial and aquatic. In contrast, the freshwater fish of this area are very species poor.

Some of the uniqueness of the aquatic invertebrate fauna in the southern Cape is due to the acidity of the water. This is in contrast to studies on Californian Alpine lakes, which are also naturally acidic, but where the macroinvertebrate species richness was shown to decrease with decreasing pH (Bradford *et al.* 1998). It is the biogeographic history of the southern Cape rivers and particularly the radiation of Trichoptera which has lead to the unusually high species diversity in the acid waters of the southern Cape. Mayflies follow the general pattern of reduced species diversity in more acid conditions, and only the endemic species that have evolved with these conditions thrive in the southern Cape (Wang and McCafferty, 1997).

Aquatic macroinvertebrates are important processors of organic matter. They serve a vital function in purifying water and also provide a valuable food resource for larger animals within, and even outside the system. In order to continue functioning optimally, the component species in a river system require regular inputs of nutrients, sediments and water flow. Specific river systems evolve particular assemblages of species forming functional communities within reaches. These communities are optimally adapted to the prevailing conditions such as substrate composition, water temperature, sediment transport, pH and nutrient flows. The aquatic macroinvertebrate fauna of the southern Cape rivers is unique when compared with the rest of Africa, the fauna being adapted to the cool, low nutrient, fast flowing acidic waters. The rivers in this area are all headwater streams, plunging straight from the mountainous catchments to the sea, without the slow meandering attributes characteristic of lower reaches of most of the other South African rivers. Hence the high proportion of montane macroinvertebrate species.

The survey of the macroinvertebrates of the Salt (Sout) River in the Southern Cape was undertaken jointly with a survey of the fish fauna of this river. The details of the background to this survey are covered separately in the report by Bok (2000). This report focuses on the macroinvertebrate findings and the implications posed by the proposed stocking of trout.

A reduction or increase in flow, sediment transport or nutrient loads, or the introduction of unnatural predators may lead to changes in community structures through loss of certain species and increases in others. Where the Salt River flows through farm 236, it is in a healthy state with largely natural riparian vegetation, although the encroachment of alien vegetation is apparent (Plate 1). The biggest extant threat to this river, and many of the others in this area, is the massive invasion of the Australian black wattle, *Acacia mearnsi.* It is well know that massive invasions of acacias can cause considerable reduction in stream flow, increased sedimentation, river bank collapse, shading of naturally unforested areas (resulting in reduced algal production and hence reduced food source for invertebrates) and obstruction with woody litter. Their bark, which is very acid, flakes off, which leads to decreased pH of the soil and the water since the substrate of this area, Table Mountain sandstone, is unbuffered. The decreased soil acidity prevents the growth of natural riparian vegetation. This leaves wattle as the only riparian vegetation, and during dry years the trees invade the water courses. Since they have shallow roots, they are easily washed out during floods, converting a deep channeled river to a shallow, sediment-laden river, choked with woody debris, thus creating less suitable habitat for aquatic insects, resulting in reduction of species diversity. The Hol River, a tributary of the Salt River, has already suffered this fate (Plate 2).

2. DATA COLLECTION

The Salt River system as well as the adjacent Groot and Buffels rivers (with the various sample sites indicated) are shown in Figure 1.

Survey of the Aquatic Macroinvertebrates

A survey of the aquatic macroinvertebrates in the Salt River was undertaken from 11 to 13 August, 2000 by Helen Barber-James of the Albany Museum, Grahamstown, with Nikki Köhly as field assistant.

Sampling Methods

Collecting of aquatic macroinvertebrates was done using fine-meshed hand nets. The fine mesh ensures that small invertebrates species or young instars are not overlooked. As many aquatic biotopes as possible were sampled at each site. Light traps, to collect the adult stages of many aquatic insects, important to aid with species identification, could unfortunately not be used effectively because of the inaccessibility of sites and are also not very effective in winter because many species are not present in the adult stage at this time of year. Most sampling was done from stones-in-current, water flowing over hygropectirc regions, marginal and floating vegetation, and from pools to a lesser extent. The Salt and Wit River have many deep pools (Plate 3), which makes invertebrate sampling difficult.

Unsorted samples as well as selected animals collected were given a catalogue number for each site, date and biotope type. Samples were labelled and preserved in 80% ethanol. Samples were sorted in the laboratory by first picking out large animals and then passing each sample through a series of nets of different mesh sizes to separate large and small invertebrates. A final check of each sample with a dissecting microscope was conducted to remove any smaller animals that might have been missed in the coarse sorting.

Identification of animals was carried out using museum-voucher material for comparison and the library of taxonomic papers held by the Albany Museum. Certain groups will be sent away to specialists for species identification, and these details are not included in this report. All material collected is stored and curated in the Albany Museum under the Southern Cape Rivers catalogue (SCR).

3. RESULTS AND DISCUSSION

A summary of the invertebrates collected is given in Table 1. In order to compare the biota in the Salt River with adjacent systems, brief surveys in the Groot River (to the east) as well as the Buffels River (tributary of the Matjies River to the west) was undertaken.

Table 1. Summary of invertebrates collected from the Salt, Groot and Buffels rivers survey of 11 to 13 August 2000. * indicates a record at that site.

S1 – Salt River 2km above mouth

S2 – Salt River south of Fern Farm on farm 236.

S3 – Salt River just above confluence with Wit River

W – Wit River at waterfall barrier

G – Groot River upstream of old N2 road bridge

B – Buffels River on farm Kirbywood.

TAXA	RIVER SITES					
	S1	**S2**	**S3**	**W**	G	B
Platyhelminthes						
Planariidae						
Planaria sp.	*				*	*
Annelida						
Naididae	*	*			*	
Mollusca						
Ancylidae						
Burnupia sp.	*					
Crustacea						
Cladocera						
Gen. spp. indet	*					
Copepoda						
Gen. spp. indet	*	*				
Isopoda						
Sphaeromatidae						
Pseudosphaeroma barnardi	*					
Decapoda						
Potamonautidae						
Potamonautes ?parvispina	*					
Palaeomonidae						
Palaemon capensis					*	
Acari						
Hydracarina	*	*		*	*	*
Arachnida						
Tetragnathidae		*				
Collembola						
Poduridae		*			*	
Sminthuridae						*
INSECTA						
Ephemeroptera						
Baetidae						
Afroptilum sudafricanum						*
Baetis harrisoni	*	*			*	
Cloeodes sp. nov.		*		*		
Cloeon virgiliae	*	*				
Pseudocloeon vinosum	*	*			*	
Immature larvae				*		
Caenidae						
Caenis sp.					*	*
Heptageniidae						

Afronurus peringueyi	*	*				
Leptophlebiidae						
Adenophlebia peringueyella						*
Aprionyx pellucidulus		*	*			
Castanophlebia calida		*	*		*	
Choroterpes nigrescens	*	*		*	*	
Teloganodidae						
Ephemerellina barnardi	*	*		*		
Lestagella penicillata		*	*		*	
Lithogloea harrisoni		*				
Odonata						
Chlorolestidae						
Gen. sp. indet.		*				
Coenagrionidae						
Pseudagrion spp.	*	*				*
Gomphidae						
Notogomphus sp.					*	
Libellulidae						
Gen. sp. indet.		*				
Plecoptera						
Notonemouridae						
Aphanicerca capensis		*				
Aphanicerca sp.		*				
Apahnicercella sp.	*	*	*	*	*	
Aphanicercella ?cassida		*				
Aphanicercella ?nigra		*				
Hemiptera						
Naucoridae						
Laccocoris sp.		*				
Corixidae						
Micronecta sp.		*				
Notonectidae						
Anisops sp.				*		
Veliidae						
Microvelia sp.		*				
Rhagovelia sp.		*				
Hydrometridae						
Hydrometra sp.		*				
Mesoveliidae						
Mesovelia sp.						
Megaloptera						
Corydalidae						
Gen. sp. indet.	*	*		*	*	
Coleoptera						
Dytiscidae						

	1	2	3	W	B	G
Gen. spp. indet.	*	*				
Hydraenidae						
Gen. sp. indet.					*	
Hydrophilidae						
Gen. sp. indet.					*	
Helodidae						
Gen. sp. indet.	*	*		*	*	*
Haliplidae						
Gen. sp. indet.	*	*				
Psephenidae						
Gen. sp. indet.						
Elmidae						
Ctenelmis sp.		*		*	*	
Elpidelmis sp.		*				
Haplelmis sp.					*	
Leielmis sp.	*	*		*	*	
Stenelmis sp.	*		*			
Strina sp.		*				
Tropidelmis sp.	*					
Elmidae larvae (several spp.)	*	*	*	*	*	
? Salpingidae		*				
Trichoptera						
Barbarochthonidae						
Barbarochthon brunneum		*	*	*	*	
Ecnomidae						
Parecnomina resima		*				
Glossosomatidae						
Agapetus sp.		*		*		
Hydropsychidae						
Cheumatopsyche afra	*					
Cheumatopsyche maculata	*					
Sciadorus obtusus		*	*	*		
Hydroptilidae						
Hydroptila capensis		*				
Leptoceridae						
Athripsodes bergenisis group	*	*		*		
Athripsodes harrisoni					*	
Athripsodes schoenbates		*				
Athripsodes sp.			*		*	
Leptocerina sp.	*	*			*	
Leptecho sp. nov?	*	*		*	*	
Oecetis modesta	*	*			*	

Petrothrincidae						
Petrothrincus sp.		*				
Philopotamidae						
Chimarra sp.			*	*		
Pisuliidae						
Dyschimus sp.				*		
Sericostomatidae						
Rhoizema sp.				*		
Lepidoptera						
Pyralidae						
Petrophila sp.		*				
Diptera						
Tipulidae						
Gen. sp. indet.		*				*
Culicidae						
Culex sp.				*		
Ceratopogonidae						
Bezzia sp.	*	*			*	
Forcipomyiinae		*				
Chironomidae						
Chironominae						
Tanytarsini	*	*		*		*
Rheotanytarsus sp.		*			*	
Chironomini	*	*			*	*
Orthocladiinae	*	*		*	*	*
Corynoneura sp.	*	*		*	*	*
Thienemanniella sp.					*	
Tanypodinae	*	*	*	*	*	
Dolichopodidae						
Gen. sp. indet.		*				
Empididae						
Gen. sp. indet.	*		*			
Simuliidae						
Simulium nr. *dentulosum*		*				
Simulium nr. *medusaeforme*	*	*	*			
Simulium ?merops	*	*	*			
Simulium nigritarse	*				*	
Simulium (Metomphallus) gp.					*	
Simulium sp. nov.	*					
Athericidae						
Atherix sp.	*	*		*	*	
TOTAL TAXA PER SITE (97)	42	65	14	26	37	13

3.1 THE SALT RIVER

The Salt River has a rich and diverse invertebrate fauna (Table 1). Two species of invertebrates, hitherto unknown to science, have been collected. One is the pupa of a new species of *Simulium,* collected only from the lower-most site (S1). This is the first record of a new member of this important Dipteran family for over 30 years (de Moor, *pers. comm.*). The other is a member of the mayfly family Baetidae, a new species in the genus *Cloeodes*. This was found above the waterfall barrier on the Wit River (W1), and at the fern farm site (S2). The mayfly specimens were immature because of the season collected, and mature specimens should be collected in summer to confirm with certainty that these are a different species to the only described species to date, *Cloeodes inzingae*.

Like several other rivers in the southern Cape, the Salt River has no primary freshwater indigenous fish species in the freshwater reaches of the river. It is likely that the freshwater invertebrates in such rivers are more abundant and possibly more diverse than similar streams in the area which have a natural fish population. A study of invertebrates in the Wit River (Gamtoos river system), which has a population of indigenous fish (*Pseudobarbus afer)* below, but not above a barrier waterfall, showed a greater diversity and higher visible activity of invertebrates above the waterfall in the absence of the fish (de Moor, 1991).

Earlier studies on the invertebrate fauna of rivers of the southern and western Cape (Harrison and Agnew, 1962) indicated a number of endemic invertebrate families, several of which have been collected during this survey. However, although we know that there are several endemic families, the number of species has yet to be established, and further collecting of adult material is required to resolve this. Several of these endemic taxa were collected during this survey. These included the mayflies in the family Teloganodidae, many of the caddisflies (Trichoptera), Megaloptera, and the Isopod *Pseudosphaeroma barnardi.* There are also several species of the Plecoptera family Notonemouridae. Members of this family are confined to the cool waters of the western and southern Cape, with a few representatives extending through Lesotho to the mountainous regions of KwaZulu-Natal and Mpumalanga (Picker and Stevens, 1999). The Ephemeroptera (mayflies) are not as rich in species as in the rest of Africa, generally being found in less acid water, and the fauna is dominated by caddis. Some of the Trichoptera, especially the *Athriposodes bergensis* group, were abundant, with over 250 larvae being collected at site S2. The mayfly *Pseudocloeon vinosum* was also abundant at site S2 (over 150 nymphs), as were members of the Dipteran family Chironomidae (Orthocladiinae). The Isopod, *Pseudosphaeroma barnardi*, was also very abundant at the lowest site (S1), where over 400 specimens were collected from one biotope.

3.2 KNOWN EFFECTS OF ALIEN FISH ON AQUATIC INVERTEBRATES.

Detailed records on the abundance and diversity of aquatic insects prior to the introduction of exotic fish species in many rivers in South Africa are very limited. de Moor (1992) compares the diversity of caddisfly larvae in streams where trout were successfully introduced with streams where trout introductions did not succeed, and notes that the diversity was much higher in the absence of trout. He quotes an example where extensive sampling (over a three year period) of a section the Great Berg River (trout present for many years) produced only 9 caddis species, while a similar section of the Homtini River (only indigenous fish species present) produced 20 species in only a 20 minute search period).

de Moor (1988) suggests that trout may have little affect on the total biomass of benthic invertebrates, but that species composition may be affected. He indicates that active, visible invertebrate species may be replaced by more cryptic, reclusive species in the presence of trout or any other introduced predator.

Crass (1960) reports that in streams in KwaZulu-Natal, mayfly nymphs form an important component of trout food, but concludes that the numbers of mayfly nymphs present in streams without trout are not significantly more abundant than in streams with trout. Crass (1960) also quotes studies in Kenya and New Zealand that indicate that trout do not reduce the total quantity of bottom fauna. However, these studies fail to note the diversity at species level, so the results are misleading.

Many studies on the effect of predatory fish on aquatic invertebrate populations have been carried out in other parts of the world. In North America, Bradford *et al.* (1998) document the effect of trout introduced into alpine lakes in Sierra Nevada where there are historically no trout. They conclude that the trout reduce the species diversity in lakes where they have been introduced, especially larger, more mobile and conspicuous species. Macan (1997) found that in a river in England, rare and conspicuous invertebrate species were affected by trout predation, but more common and abundant species were not. Healey (1984) summarises a number of studies showing the change in composition of benthic macroinvertebrate communities due to fish predation. Both negative effects and no effects are recorded.

It must be remembered that the interactions between fish and invertebrates in different areas are unique and each case should be considered in its own context. There is no doubt that insects (both aquatic and terrestrial) and other invertebrates form an important component of the diet of predatory fish in any aquatic ecosystem.

Trout are well known as opportunistic feeders, and feed mainly by sight, requiring clear, well-lighted water (Bachman, 1985). In streams they often feed on aquatic invertebrates drifting downstream (Bachman, 1985, Fausch, 1991). Invertebrate drift has several patterns (constant drift, behavioural drift and catastrophic drift (Waters, 1972)). Behavioural drift generally begins at dusk and also has several patterns. It would be interesting to determine the type of drift patterns in the Salt and Wit Rivers to see whether the drift peaks at night or whether there are peaks at dusk and dawn. The invertebrates in these rivers are not accustomed to having predators present, and may not have developed predator avoidance tactics, such as peak drift occurring in the dark. This may affect the success of the trout's feeding, and may also change with time as the invertebrates adapt to having to coexist with predators.

3.3 THREATS TO THE CONTINUED EXISTENCE OF MONTANE AQUATIC INSECTS

Many factors have been identified which negatively affect rivers and the life in them. The introduction of alien fish is one such factor. Although they pose a threat to the invertebrate life in the rivers, trout have no effect on the catchment as a whole. Trout like clean water and do not do well in degraded streams. Where fish occur naturally in a system, the invertebrates have evolved to cope with predation. In some of the short rivers of the southern Cape where there are no fish populations, the invertebrates are very prone to predation by introduced fish. Furthermore, some of these rivers which have no fish may serve as refuges for restocking invertebrate populations in adjacent rivers which have fish populations, thus keeping a sufficiently large population of invertebrates present in both types of stream. The sections of rivers above the waterfall barriers would still serve as refuges for invertebrates, and since the southern Cape rivers are generally short and fast flowing, there is not much longitudinal change in invertebrate species composition.

The encroachment of alien vegetation is another major threat to aquatic life. The effect of alien vegetation in reducing the flow in streams is well known. For example, the flow of the Sabie River (Mpumalanga) has been reduced by one third by forestry plantations (Davies and Wishart 2000). The MAR of alien infested catchments in the Western Cape is estimated at having been reduced by between 30-60% through evapotranspiration (Davies and Wishart 2000). Van Wilgen *et al.* (1996) estimate that the entire fynbos biome will be replaced by exotic invasive vegetation within the next 50 years if left unchecked. This has direct bearing on the rivers in the region and is one of the biggest threats to the future survival of the invertebrate species in the rivers of the Southern and Western Cape.

Siltation is another factor which reduces the natural biodiversity of organisms in a river system. The major causes of siltation of rivers include:

1. Excessive overgrazing, leading to much loss of topsoil and visible erosion gulleys on slopes.

2. Agricultural or forestry development too close to the river bank, leaving very little natural riparian vegetation.

3. Exotic trees growing along the river banks. These exclude grass and other natural riparian vegetation and hence lead to a destabilization of the river bank. Excessive undercutting of the bank, where such trees were the only riparian vegetation, is often observed, resluting in siltation.

4. Roads next to and crossing over rivers. These act as additional inputs of sediment and are a major contributor unless well designed.

A survey of the aquatic macroinvertebrates of the rivers of the Ugie-Maclear district (de Moor and Barber-James, 1994) revealed that silting up of rivers was one of the major causes of a reduction in species. Despite the presence of trout, the upper reaches of the Tsitsa River, unimpacted by siltation, produced 27 species of Ephemeroptera, which declined to eight lower down where siltation was extensive. In the lower regions of the Tsitsa River where rejuvenation of the river occurred, exposing unsilted bedrock once more, there were 19 species of Ephemeroptera. Breeding populations of trout have been present since early last century in some of the North East Cape Rivers (de Moor and Bruton, 1988). It was noted that in the more degraded rivers in this area, trout were stunted and often parasitsed (Skelton and James, 1991), whereas in rivers which were still in a relatively undisturbed state, the trout were in a much healthier state. Of particular interest, in the Antelope Park Spruit, a river completely free of alien plant invasion and with natural riparian vegetation natural and undisturbed banks, the largest trout were collected (Skelton and James, 1991) while de Moor and Barber-James (1994) reported the highest diversity of aquatic macroinvertebrates of all the rivers sampled in the area. Although this river was sampled more intensively for invertebrates than some of the apparently more degraded streams in the area, the fact remains that trout were co-existing with a healthy population of macroinvertebrates in that river. This implies that exotic aquatic animals such as trout threaten the natural biodiversity of systems under stress more than in otherwise undisturbed systems

4. CONCLUSIONS

Although trout would undoubtedly have an effect on the taxon richness of the macroinvertebrate population in the section of the river proposed for stocking, these are not the only influence to consider. The encroachment of exotic vegetation which reduces the flow of water courses also has a severe effect. A study by Cambray, de Moor and Barber-James (1995) reports on the impact of alien vegetation on the flow regime of rivers in the Baviaanskloof, their fish and aquatic invertebrates. The importance of maintaining the natural flow regime of the rivers was emphasised. Leading on from this, the indigenous flora was identified as playing an essential role in keeping the rivers pristine and maintaining river bank stability. If alien invasive trees take hold of the area, the flow of water in these rivers will be reduced considerably, and river bank collapse will occur, resulting in siltation, and there will be a reduction in natural riparian vegetation.

Given the presence of the substantial waterfall barriers on both the Salt and the Wit rivers, there is a sancutary for the invertebrate community above these barriers. It is therefore recommended that the benefits for the catchment as a whole are considered before decisions are made regarding whether to stock trout or not.

Much work still needs to be done on the invertebrate fauna of the rivers in the southern Cape to determine exactly what species are present and to understand the complexities of species interactions. Studies need to be continued over several seasons, involving the use of light trapping to collect the adults which are needed to confirm specific identity. There are many streams, or sections of streams above waterfalls, without fish communities, and these require urgent studies to establish the geographic range of the invertebrates in the Southern Cape, and especially some of the unusual species collected from the Salt and Wit Rivers during this survey.

5. RECOMMENDATIONS

It is recommended that Cape Nature Conservation supports further studies of the rivers in the southern Cape to document invertebrate species diversity and the distribution of both indigenous and exotic fish species. Rivers without a natural fish population should be identified. Once more data is available, certain rivers should be set aside as sanctuaries so that the unique fauna of the area can be preserved in as near to pristine a state as possible.

If a decision is made to stock trout in the Salt River, close studies of their interactions with the invertebrate community should be carried out. Fishermen should be encouraged to preserve the contents of the guts of trout caught, and the developer should undertake to have these sent periodically to the Department of Freshwater Invertebrates at the Albany Museum, where they can be identified and documented.

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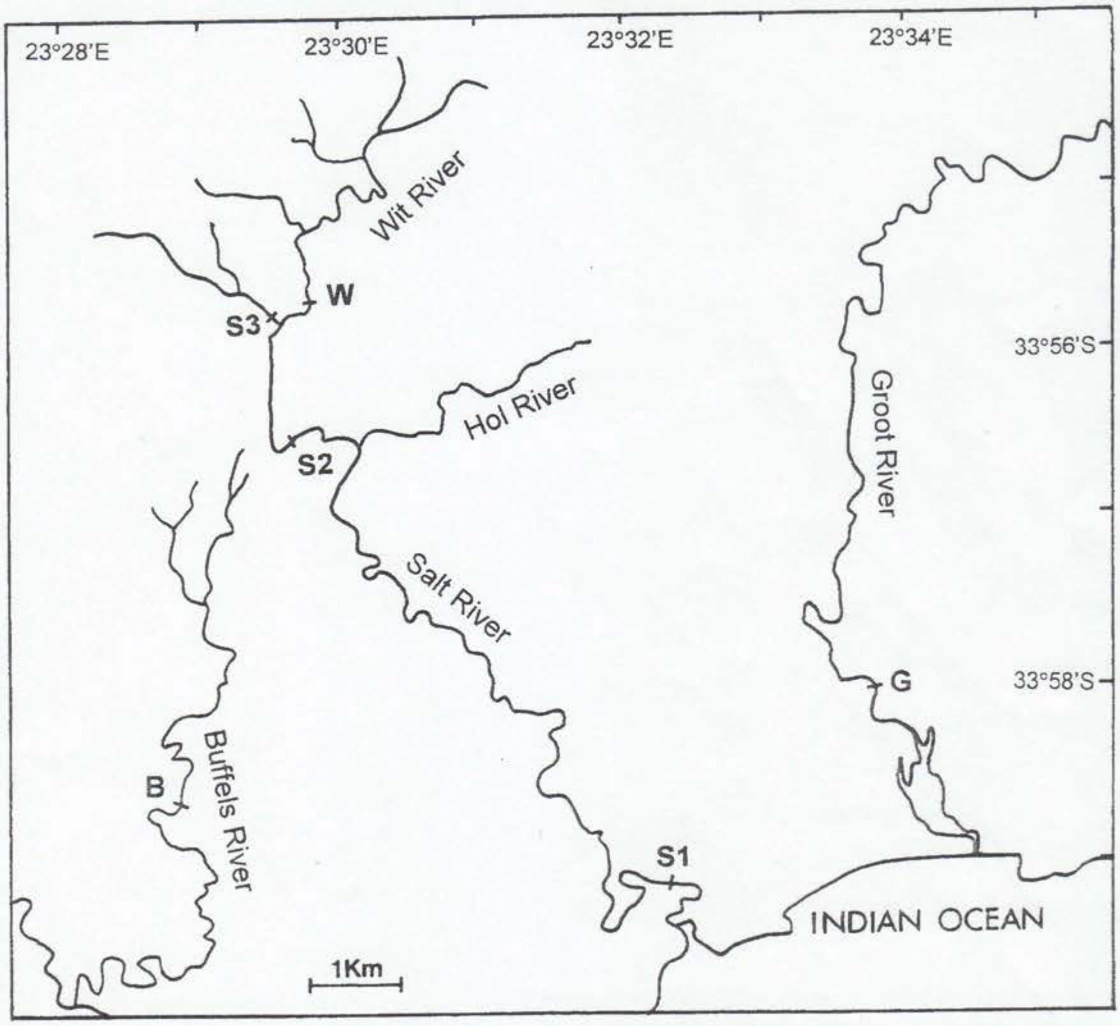

Figure 1. Map of rivers in the Crags area, showing collecting sites. Abbreviations used are indicated in Table 1.

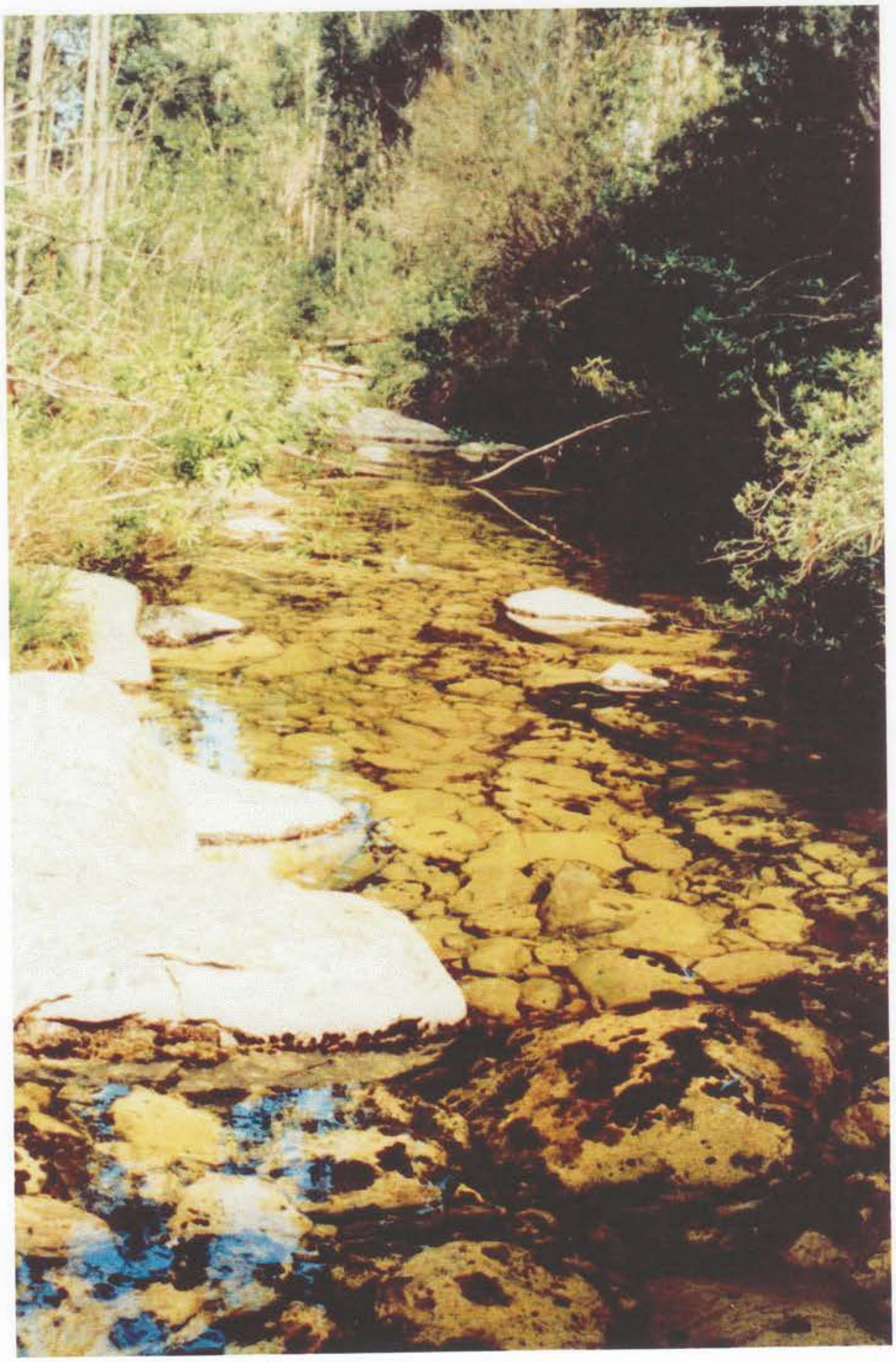

Plate 1. Salt River, showing encroaching exotic vegetation along its banks.

Plate 2. Hol River, showing the devastating effects of exotic vegetation.

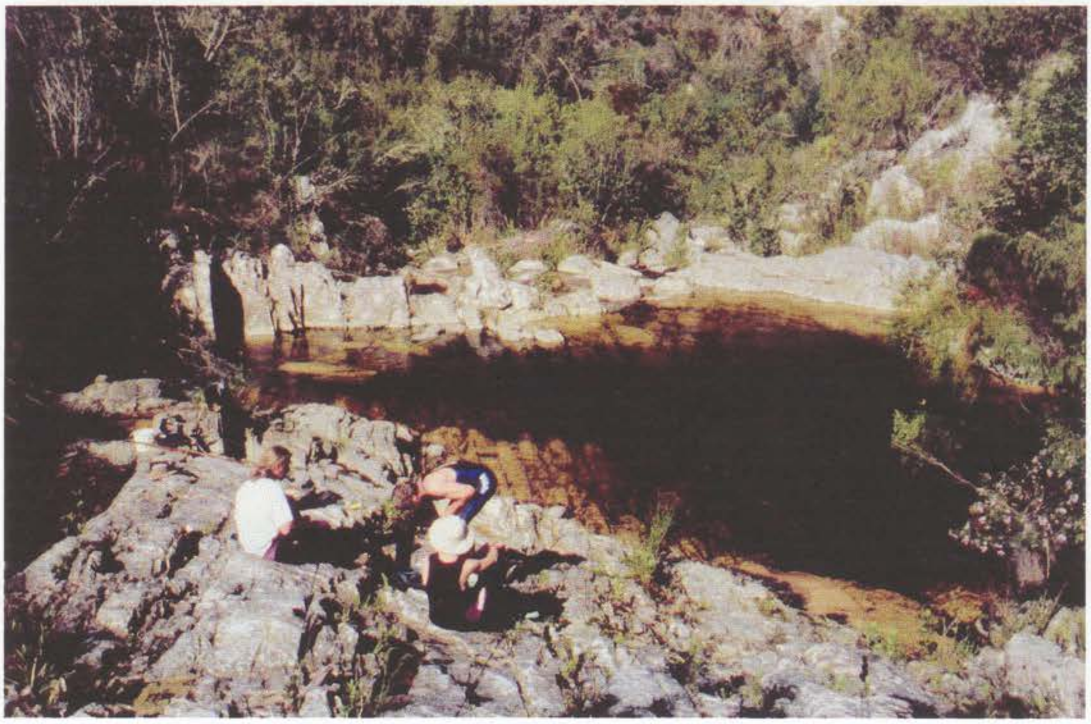

Plate 3. A typical pool in the Wit River.