An assessment of the current status of aquatic macroinvertebrate communities of the Diep River system, south-western Cape, using SASS4

H.F. Dallas
Southern Waters Ecological Research and Consulting cc
Freshwater Research Unit
Department of Zoology
University of Cape Town
Rondebosch 7700

AN ASSOCIATE OF
THE UNIVERSITY OF
CAPE TOWN

SOUTHERN WATERS
DALLAS

An assessment of the current status of aquatic macroinvertebrate communities of the Diep River system, south-western Cape, using SASS4

H.F. Dallas
Southern Waters Ecological Research and Consulting cc
Freshwater Research Unit
Department of Zoology
University of Cape Town
Rondebosch 7700

COMMISSIONED BY
Institute for Water Quality Studies
Department of Water Affairs and Forestry

December 1997

TABLE OF CONTENTS

PAGE

1. SCOPE OF THE STUDY

1.1 BACKGROUND INFORMATION

The Institute for Water Quality Studies (IWQS), Department of Water Affairs and Forestry (DWAF), is conducting a situational assessment of the water resource quality of the Diep River catchment. One component of the study involves the assessment of the aquatic ecosystem health of the system.

Southern Waters was requested by IWQS to undertake an assessment of the biological integrity of the Diep River catchment by assessing the health of the macroinvertebrate communities using South African Scoring System (SASS4, Version 4).

1.2 TERMS OF REFERENCE

The study had the following objectives:

1. To obtain an overall perspective of the catchment by reviewing video footage taken for the habitat integrity assessment;
2. To undertake a sampling survey of macroinvertebrates of the catchment in such a way as to tie sites in with the current water quality sampling network used by Regional DWAF;
3. To assess the current status of riverine macroinvertebrate communities within the catchment using SASS4;
4. To provide some indication of the possible causes, if any, of impairment to the river system.

1.2.1 Limitations of the study

The study is intended, in part, to be an initial assessment of the macroinvertebrate communities and was conducted within the time and financial constraints of a total of 5.5 working days, including three days for field data collection. SASS4 sampling was undertaken between 3 and 5 November (early summer) and the assessment is based on a single visit to each site. No data were collected, and none are available, on seasonal (or other) variations of macroinvertebrate communities within the Diep River catchment.

2. THE STUDY AREA

2.1 GENERAL DESCRIPTION OF THE STUDY AREA

2.1.1 The Diep River catchment

The Diep River rises in the Perdeberg and Riebeek-Kasteel mountains to the east and north of Malmesbury and flows in a south-easterly direction for approximately 65 km, broadening out near the coast to form an extensive vlei known as Rietvlei. The vlei is linked to the sea via a narrow, winding estuary known as the Milnerton Lagoon. Various tributaries join the Diep River including the Kleinrivier, the Groenrivier, the Soutrivier and the Mosselbankrivier, the latter draining the Durbanville/Kraaifontein area.

The Diep River catchment covers an area of some 1480 km^2 and receives a mean annual precipitation of approximately 500 mm (IWQS 1997). The mean annual runoff has been estimated at 40 million m^3, and during the summer months there is frequently no flow (IWQS 1997), i.e. the river is seasonal in character.

Urban areas in the catchment include Malmesbury, Kraaifontein, Durbanville and Milnerton. Landuse in the catchment is dominated by agriculture in the form of viticulture, and wheat and livestock farming, while, in the lower reaches residential and industrial landuse predominate. There are numerous quarries, mostly for sand, scattered within the catchment. Solid waste landfill sites are present at Vissershok and Malmesbury (IWQS 1997). The upper reaches of the river consist of a continuous series of farm dams, with virtually no unimpounded surface water flowing above Malmesbury (pers. obs.).

2.1.2 Geology of the catchment

The underlying geology of the Diep River catchment has a considerable influence on the natural water quality conditions of the system. In its uppermost reaches, the river drains an area consisting largely of hard resistant, quartzitic sandstones of the Table Mountain Series (TMS). Water flowing over such strata are characteristically acidic and low in nutrients and dissolved solids. In the vicinity of Malmesbury, the underlying formation is Malmesbury Shale which contains larger quantities of leachable ions. Water draining such shales usually has a higher concentration of total dissolved solids than that draining TMS, and hence natural or intrinsic salinity of the water is expected to be comparatively high in the middle and lower reaches.

2.2 SELECTION OF STUDY SITES

The focus of the study was an assessment of the current status of macroinvertebrate communities in the Diep River catchment, specifically at sites already incorporated in the regional DWAF water quality monitoring programme. In some instances, these sites were not suitable for SASS4 assessments or had already dried up. Additional sites were identified and sampled where deemed necessary (these sites have a suffix A in Table 2.1). Table 2.1 provides a description of each site sampled, in relation to the DWAF sites. Sites that were examined but which were not sampled are also included in the table and the reason(s) for exclusion are specified.

Table 2.1. Sites examined and/or sampled within the Diep River catchment.

RIVER	SITE CODE	DWAF CODE	DESCRIPTION
Sites sampled			
Diep	D02	2	Above roadbridge at Killarney
Diep	D03	3	Below N7
Diep	D04	4	Below R304, below confluence of Diep and Mosselbank rivers
Diep	D05	5	Above roadbridge, above confluence of Diep and Mosselbank rivers
Diep	D05A		At farm Nooitgedaght, midway between DWAF sites 5 and 6
Diep	D06	6	Downstream of the town Kalbaskraal
Diep	D07	7	At roadbridge leading to Abbotsdale
Diep	D08	8	Access via farm, below Malmesbury
Diep	D09	9	Near campground, above Malmesbury
Diep	D11A		At source, on farm Nooitgedacht at the top of the valley
Klapmuts	K15A		At roadbridge on R304, downstream of DWAF site 15
Mosselbank	M12	12	At farm off R304, above confluence of Diep and Mosselbank
Mosselbank	M13A		At farm Oortmanskloof, downstream of DWAF site 13
Mosselbank	M16	16	At roadbridge leading to Mellish
Sites visited but not sampled			
Riebeeks		10	Water stagnant, no flow
Diep		11	Water stagnant, no flow
Klapmuts		15	River canalised and dry, no flow
Mosselbank		13	Not suitable for SASS sampling (inaccessible, deep channel)
Tributary of Mosselbank		17	River canalised, no flow
Mosselbank		18	River dry, no flow
Mosselbank		19	River dry, no flow

3. CURRENT STATUS OF THE AQUATIC MACROINVERTEBRATE COMMUNTIES AND ASSOCIATED BIOTOPE AVAILABILITY

Aquatic macroinvertebrates form an important component of riverine ecosystems. In western Cape rivers they consist mostly of immature and/or adult stages of insects, in addition to worms, crustaceans and arachnids among others. They live in the water, either under or on the surfaces of stones, in soft sediments, or in instream and marginal vegetation. They have been used extensively in biological monitoring and "health" assessments of rivers, primarily because of their relative abundance, widespread distribution, largely non-mobile habits and their sensitivity to alterations in the aquatic environment. They act as continuous monitors of the water they inhabit (Hawkes 1979), enabling long-term analysis of the effects of both regular and intermittent flow, of variable concentrations of pollutants, and of single and multiple pollutants. Anthropogenic alterations in water quality, flow regimes or the physical characteristics of riverine environments, may lead to decreased abundances or even loss of sensitive species, with a concomitant increase in numbers of individuals of those species that can tolerate, or benefit from the altered conditions. The macroinvertebrate community at any particular site, therefore, reflects the immediate and long-term physical and chemical conditions in the water at that site.

3.1 SOUTH AFRICAN SCORING SYSTEM (SASS4) ASSESSMENTS

SASS4 (Chutter 1995) is a field-based, rapid bioassessment method that uses information on aquatic macroinvertebrates specifically to assess the impairment of water quality in rivers (Dallas *et al.* 1994), as well as providing a useful standard index of riverine health. The SASS4 method used in this study is the result of the latest modification of SASS (Chutter 1995), but is subject to continuous evaluation and updating. It can be used to assist in evaluating the present status of a riverine ecosystem and to help detect any impacts or the effects of deviations from the natural range of conditions on the riverine biota. It yields the following values for a site: SASS4 Score, Number of Taxa and Average Score Per Taxon (ASPT). The SASS4 Score is derived by summing the sensitivity/tolerance scores assigned to each invertebrate family or equivalent taxon. These scores range from 1 to 15 for any one taxon, with high scores being awarded to pollution-sensitive taxa and low scores to pollution-tolerant taxa (Chutter 1995). ASPT is a value calculated from SASS4 Score divided by the Number of Taxa present at the site. Since SASS is largely based on families of invertebrates, it provides an assessment of macroinvertebrate community changes in a river at a medium-to-coarse level and any effects at species level, therefore, will not be detected.

The SASS4 method was not designed to enable the exact nature of the impairment to the site to be ascertained, and it was intended that once an impairment had been established, it would be further assessed via intensive chemical and other studies (Dallas in press.). It is, however, possible to provide some indication of the type of impairment based on an examination of the macroinvertebrate taxa recorded.

3.2. BIOTOPE ASSESSMENTS

SASS4 Scores may be influenced by factors not directly related to water quality, such as the availability of biotopes or types of habitats in which aquatic invertebrates live (Dallas in press). In this study, two assessments were undertaken in conjunction with SASS4 at each site, namely Habitat Quality Evaluation (HABS1, Chutter 1995) and Habitat Assessment Matrix (HAM, Roux 1993). Details of each assessment method are outlined below.

3.2.1 Habitat Quality Evaluation (HABS1)

The number of available biotopes (such as stones-in-current, stones-out-of-current, marginal vegetation, aquatic vegetation, gravel, sand and mud) may influence SASS Scores. HABS1 scores, based on the number of biotopes, were therefore calculated for each site.

3.2.1 Habitat Assessment Matrix (HAM)

Physical degradation of habitat such as erosion, bank modification or removal of indigenous riparian vegetation, may indirectly affect SASS scores. A system adapted by Roux (1993) from that of Plafkin *et al.* (1989), the HAM, has been used to assess such effects. This scoring system relates to the physical habitat of the site, and includes information on bottom substrate/available cover, embeddedness, biotope diversity categories, velocity/depth categories, area of bottom affected by scouring and deposition, pool/riffle and run/bend ratios, bank erosion potential, bank vegetation stability and streamside cover (dominant vegetation).

3.3 RESULTS AND DISCUSSION

The Diep River is an atypical south-western Cape river in that it has a very low gradient and has been referred to as a "river of the plains" (Burman 1970). As a result, the high-velocity, erosive mountain-stream zone is reduced to a short section in the upper-most part of the catchment. Below this zone, the river rapidly resembles a typical transitional-zone river, with increasing sediment deposition, comparatively low flow and fine substrates interspersed with short sections of shales and/or cobbles. In the lower reaches the river widens and deepens to become a typical lowland river with slow flow.

3.3.1 SASS4 scores, ASPTs, number of taxa, HABS1 and HAM scores

SASS4 scores, ASPTs, number of taxa, HABS1 and HAM scores for 14 sites in the Diep River catchment are tabulated below (Table 3.1), and the biotopes sampled at each site are indicated by shading. The sites on the main river have been arranged in a longitudinal order to reflect changes in scores from the source to the sea. SASS4 scores, ASPTs, number of taxa are also indicated graphically in Figure 3.1 and HABS1 and HAM scores in Figure 3.2. A list of macroinvertebrate taxa recorded at each site is given in Table 3.2.

Table 3.1. SASS4 scores, ASPTs, number of taxa, HABS1 and HAM scores for 14 sites in the Diep River catchment. The biotopes sampled at each site are indicated by shading (SIC = stones-in-current; SOOC = stones-out-of-current; MV = marginal vegetation; AQV = aquatic vegetation; G = gravel; sand and mud). Site codes pertain to Table 2.1.

Site	SASS4 score	ASPT	No. Taxa	HABS1	HAM	SIC	SOOC	MV	AQV	G	SAND	MUD
D11A	98	7.54	13	80	89							
D09	62	4.43	14	45	30							
D08	41	3.42	12	90	63							
D07	52	4.00	13	85	86							
D06	67	4.47	15	85	73							
D05A	62	4.13	15	85	60							
D05	46	4.18	11	65	63							
D04	58	3.63	16	85	46							
D03	50	4.17	12	65	42							
D02	36	4.00	9	40	28							
K15A	76	4.75	16	70	52							
M16	42	4.20	10	45	35							
M13A	49	4.08	12	75	62							
M12	29	3.63	8	65	37							

3.3.2 Interpretation of water- and habitat quality

Site D11A, in the mountain-stream zone, had the highest SASS4 Score of 98 and an ASPT of 7.54. Three biotopes, namely stones-in-current, marginal vegetation and sand, were sampled, giving a HABS1 score of 80. The physical habitat as reflected in the HAM score (89) is largely undisturbed. The 13 macroinvertebrate taxa recorded at this site, are typical of south-western Cape mountain streams, with a number of sensitive taxa such as amphipods, athericid flies and cased-caddisflies present. Two families of beetle, namely Elmidae and Hydraenidae, both of which are reported as being common at reference or least-impacted sites in mountain stream and foothill zone sites (Dallas et al. In prep.), were recorded at Site D11A. The macroinvertebrate community at this site is, therefore, indicative of good water quality and suitable biotope availability, despite some abstraction of water above the sampling point (pers. obs.).

Site D09, immediately above Malmesbury, had a low SASS4 Score of 62 and an ASPT of 4.43. Availability of biotopes as habitat for colonisation by macroinvertebrates was low and only marginal vegetation, sand and mud were present. Soft sediments such as sand and mud are not "high quality" invertebrate habitats. As a result, both HABS1 and HAM scores were low at 45 and 30, respectively. Fourteen macroinvertebrate taxa were recorded nonetheless, two of which, worms (Oligochaeta) and leeches (Hirudinea), are indicative of severe water quality impairment. Many of the other taxa recorded are commonly associated with marginal vegetation such as corixid, gerrid, naucordid,

Figure 3.1. SASS4 scores, ASPTs and number of taxa for 14 sites in the Diep River catchment. The sites on the main river have been arranged in a longitudinal order to reflect changes in scores from source to sea.

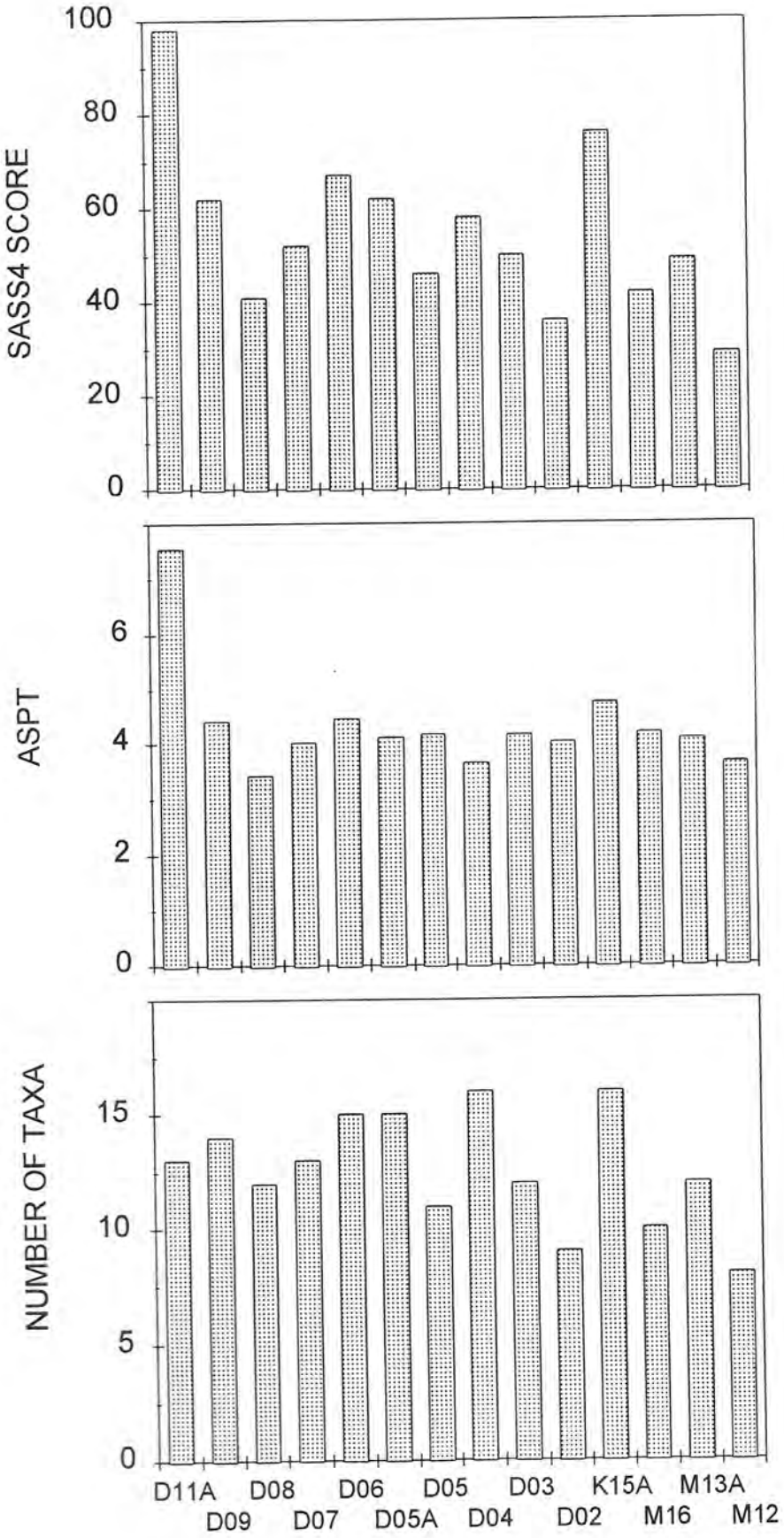

Figure 3.2. HABS1 and HAM scores for 14 sites in the Diep River. The sites on the main river have been arranged in a longitudinal order to reflect changes in scores from source to sea.

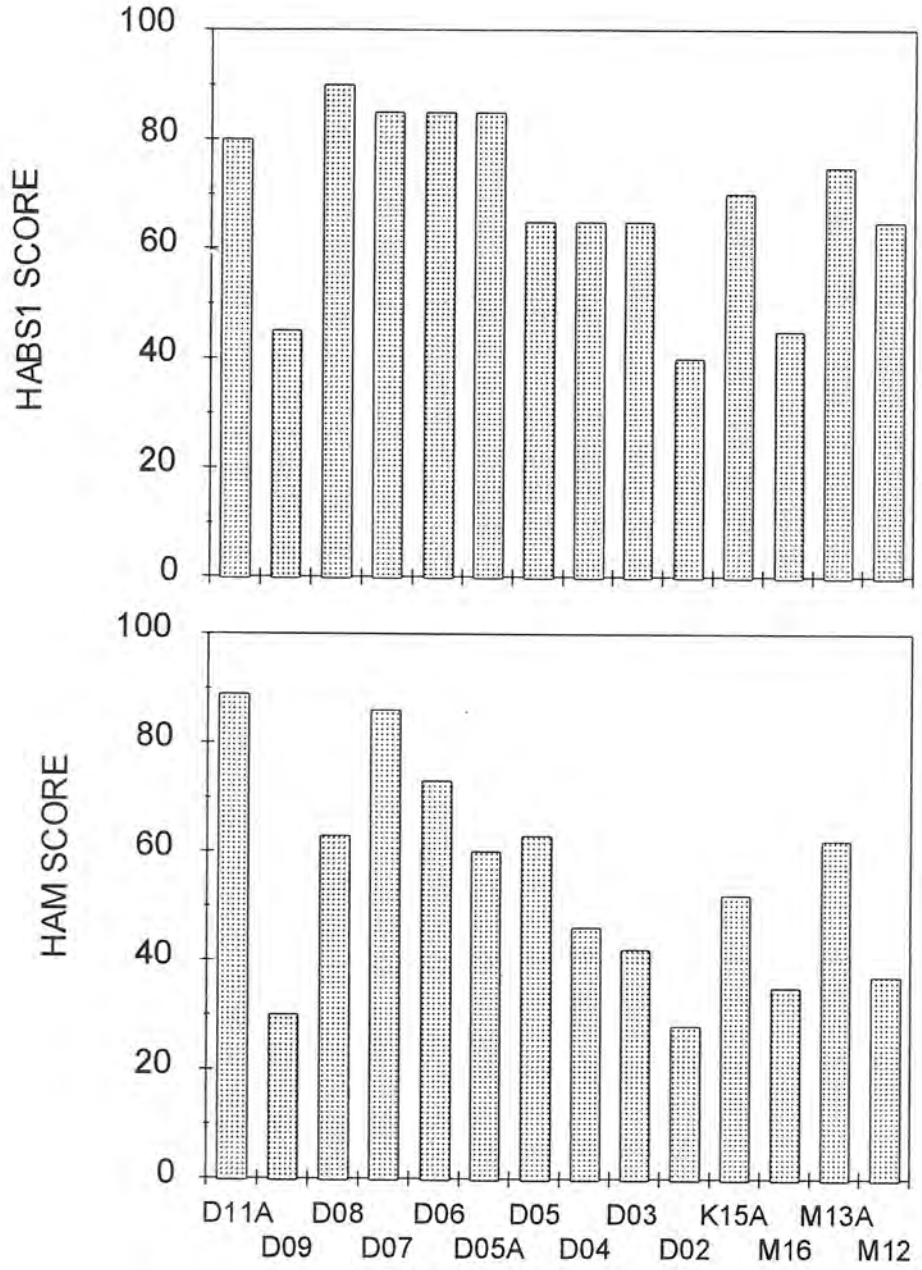

Table 3.2. Macroinvertebrate taxa recorded at mainstream sites in the Diep River catchment. The sites on the main river have been arranged in a longitudinal order to reflect changes in scores from source to sea.

TAXON	SITE	D11A	D09	D08	D07	D06	D05A	D05	D04	D03	D02
ANNELIDA	HIRUDINEA										
ANNELIDA	OLIGOCHAETA										
ARACHNIDA	HYDRACHNELLAE										
COLEOPTERA	DYTISCIDAE										
COLEOPTERA	ELMIDAE/DRYOPIDAE										
COLEOPTERA	GYRINIDAE										
COLEOPTERA	HYDRAENIDAE										
COLEOPTERA	HYDROPHILIDAE										
COLEOPTERA	LIMNICHIDAE										
CRUSTACEA	AMPHIPODA										
CRUSTACEA	BRACHYURA (CRABS)										
DIPTERA	ATHERICIDAE										
DIPTERA	CHIRONOMIDAE										
DIPTERA	CULICIDAE										
DIPTERA	EMPIDIDAE										
DIPTERA	MUSCIDAE										
DIPTERA	SIMULIIDAE										
EPHEMEROPTERA	BAETIDAE										
EPHEMEROPTERA	CAENIDAE										
GASTROPODA	ANCYLIDAE										
GASTROPODA	HYDROBIIDAE										
GASTROPODA	LYMNAEIDAE										
GASTROPODA	PHYSIDAE										
HEMIPTERA	BELASTOMATIDAE										
HEMIPTERA	CORIXIDAE										
HEMIPTERA	GERRIDAE										
HEMIPTERA	NAUCORIDAE										
HEMIPTERA	NEPIDAE										
HEMIPTERA	NOTONECTIDAE										
HEMIPTERA	PLEIDAE										
HEMIPTERA	VELIIDAE										
ODONATA	AESHNIDAE										
ODONATA	COENAGRIONIDAE										
ODONATA	CORDULIIDAE										
ODONATA	GOMPHIDAE										
ODONATA	ZYGOPTERA JUVENILES										
PLATYHELMINTHES	PLANARIIDAE										
TRICHOPTERA	ECNOMIDAE										
TRICHOPTERA	HYDROPSYCHIDAE										
TRICHOPTERA	CASED-CADDIS										

Table 3.2. cont. Macroinvertebrate taxa recorded at sites on the Klapmuts (K) and Mosselbank (M) tributaries in the Diep River catchment.

TAXON		K15A	M16	M13A	M12
ANNELIDA	HIRUDINEA				
ANNELIDA	OLIGOCHAETA				
ARACHNIDA	HYDRACHNELLAE				
COLEOPTERA	DYTISCIDAE				
COLEOPTERA	ELMIDAE/DRYOPIDAE				
COLEOPTERA	GYRINIDAE				
COLEOPTERA	HYDRAENIDAE				
COLEOPTERA	HYDROPHILIDAE				
COLEOPTERA	LIMNICHIDAE				
CRUSTACEA	AMPHIPODA				
CRUSTACEA	BRACHYURA (CRABS)				
DIPTERA	ATHERICIDAE				
DIPTERA	CHIRONOMIDAE				
DIPTERA	CULICIDAE				
DIPTERA	EMPIDIDAE				
DIPTERA	MUSCIDAE				
DIPTERA	SIMULIIDAE				
EPHEMEROPTERA	BAETIDAE				
EPHEMEROPTERA	CAENIDAE				
GASTROPODA	ANCYLIDAE				
GASTROPODA	HYDROBIIDAE				
GASTROPODA	LYMNAEIDAE				
GASTROPODA	PHYSIDAE				
HEMIPTERA	BELASTOMATIDAE				
HEMIPTERA	CORIXIDAE				
HEMIPTERA	GERRIDAE				
HEMIPTERA	NAUCORIDAE				
HEMIPTERA	NEPIDAE				
HEMIPTERA	NOTONECTIDAE				
HEMIPTERA	PLEIDAE				
HEMIPTERA	VELIIDAE				
ODONATA	AESHNIDAE				
ODONATA	COENAGRIONIDAE				
ODONATA	CORDULIIDAE				
ODONATA	GOMPHIDAE				
ODONATA	ZYGOPTERA JUVENILES				
PLATYHELMINTHES	PLANARIIDAE				
TRICHOPTERA	ECNOMIDAE				
TRICHOPTERA	HYDROPSYCHIDAE				
TRICHOPTERA	CASED-CADDIS				

notonectid and pleid bugs. They are air breathers and, therefore, better able to tolerate impaired water quality. The presence of a cordulid dragonfly is of interest in that this is the only site at which it was recorded. On the basis of the various scores recorded at this site, both water quality and habitat quality can be considered reduced from natural. The intense agricultural activities in this part of the catchment and associated nutrient enrichment, and water abstraction upstream of this site are most likely responsible for the reduced water- and habitat quality.

Site D08, downstream of Malmesbury, had a very low SASS4 Score of 41 and an ASPT of 3.42, despite a high availability of SASS biotopes; a HABS1score of 90 was recorded. Worms, leeches, *Chironomus* spp. and numerous mosquito larvae (Culicidae), all of which are indicative of extremely poor water quality, were recorded at this site. Ancylid snails, common in transitional and lowland rivers, were recorded and subsequently noted at all downstream sites. Although the HAM score was relatively low (63), biotopes were available for habitation by macroinvertebrates. It is, therefore, probable that the significantly reduced water quality is responsible for the low SASS scores. Point-source effluents arising in Malmesbury such as sewage effluent (organic enrichment), together with diffuse runoff from the surrounding agricultural land (nutrient enrichment) and livestock watering in the river, most likely contribute to the reduced water quality at this site.

Site D07, at Abbotsdale, showed a slight improvement in SASS4 Score (52) and ASPT (4.00) although both scores were very low in general terms. This was despite a high HABS1 of 85 and a HAM score of 86. The macroinvertebrate community was very similar to Site D08, with worms, leeches, *Chironomus* spp. and numerous mosquito larvae (Culicidae) recorded. Flatworms (Planariidae) were present and coenagrionid damselflies were recorded and subsequently noted at all downstream sites. Water quality is markedly impaired at this site, most probably the result of activities within the Malmesbury area leading to organic and nutrient enrichment of the receiving water body.

Site D06, downstream of the town Kalbaskraal, showed an improvement in SASS4 Score (67) and ASPT (4.47). HABS1 and HAM were 85 and 73, respectively. Worms and muscid fly larvae, both pollution-tolerant taxa, were recorded, as were those taxa commonly associated with marginal vegetation such as corixid, naucordid and vellid bugs and coenagrionid damselflies. Gomphid dragonflies, often found in sand, were present only at this site and the next one. The scores at this site were the highest relative to other sites in the same transitional river zone, suggesting a slight improvement in water quality. Habitat quality was adequate at this site.

Site D05A, at the farm Nooitgedaght, had a SASS4 Score of 62 and an ASPT of 4.13. HABS1 was high (85), although HAM decreased from Site D06 to 60. The macroinvertebrate community consisted of 15 taxa, most of which are considered moderately tolerant to water quality impairment. With the exception of muscid fly larvae, taxa such as worms, leeches and *Chironomus* spp. were absent, suggesting an reduction in organic loading to the system. Caenid mayfly nymphs were recorded for the first time. This group are often associated with elevated salinity levels (pers. obs.), indicating a possible increase in salinity in the system. Similarly, hydrobiid snails were noted for the first time, a group commonly found in brackish to very saline ponds and vleis (pers. obs., J. Day, Freshwater Research

Unit, University of Cape Town). Availability of biotope types for habitation by macroinvertebrates did not limit community composition, suggesting that water quality, in particular elevated salinity levels, was responsible for the observed communities. Large amounts of algae were also noted, suggesting enrichment of the water body by nutrients.

Site D05, above the confluence of Diep and Mosselbank rivers, had a SASS4 Score of 46 and an ASPT of 4.18. The HABS1 score decreased from that of Site D05A to 65, as a result of the loss of stones-in-current biotope. HAM was similar to that of Site D05A at 63. Only 11 taxa were recorded as a result of the reduced biotope availability, and of those recorded most were associated with marginal vegetation. The presence of hydrobiid snails again suggests elevated salinity levels.

Site D04, below the confluence of Diep and Mosselbank rivers, had a SASS4 Score of 58 and an ASPT of 3.63. Despite an increase in HABS1 score from 65 upstream to 85, and in the number of taxa from 11 to 16, water quality was reduced at this site. Worms, leeches and muscid fly larvae were recorded, as were caenid mayflies and hydrobiid snails. The presence of these taxa suggests that both organic (or oxygen-demanding) and nutrient enrichment, normally resulting from elevated concentrations of nitrate and phosphorus, is occurring, together with elevated salinity levels. General habitat quality was low (HAM=46) as a result of destruction of the adjacent land through removal of riparian vegetation and physical modification of the riverbed. Livestock grazing on the riverbanks and general farming activities, together with input of poor quality water from the Mosselbank River are responsible for the reduced water quality at this site.

Site D03, below the N7, had a SASS4 Score of 50 and an ASPT of 4.17. The river at this site is restricted to a predominantly sandbed channel with grasses providing some marginal vegetation. Both sand and marginal grasses represent poor invertebrate habitat. Both the HABS1 and HAM scores were comparatively low (65 and 42 respectively). Hemipterans and snails dominated the macroinvertebrate community. Both water quality and habitat quality and area are reduced at this site.

Site D02, above the roadbridge at Killarney, had a SASS4 Score of 36 and an ASPT of 4.00. The river at this site considerably wider than upstream but remains a sandbed channel with grasses providing some marginal vegetation. Both the HABS1 and HAM scores were very low (40 and 28, respectively). Only nine taxa were recorded at this site, and again hemipterans and snails dominated the macroinvertebrate community. Habitat availability is severely reduced at this site, which makes it difficult to interpret water quality conditions although it is likely that elevated salinity levels prevail.

Site K15A, on the Klapmuts River at the roadbridge on the R304, downstream of DWAF site 15, had a SASS4 Score of 76 and an ASPT of 4.75. The HABS1 score was reasonable high (70), although the stones-in-current biotope was unavailable because of relatively low flow conditions. The HAM score was 52. Most of the 16 taxa recorded were associated with the marginal vegetation, including seven families of hemipterans. Caenid mayflies were again recorded and the dragonfly family, Aeschnidae, was recorded for the first and only time. The river above this site was almost completely dry, and flow at the site was markedly reduced. The extent to which water abstraction has exacerbated seasonal flow

patterns is unknown, but reduced water quantity notably affects both water quality and habitat availability. Water quality is considered to be moderately impaired relative to sites on the main river.

Site M16, on the Mosselbank River at the roadbridge leading to Mellish, had a SASS4 Score of 42 and an ASPT of 4.20. Both the HABS1 and HAM scores were comparatively low (45 and 35, respectively). The macroinvertebrate community was dominated by leeches, *Chironomus* spp. and mosquito larvae, and both water and habitat quality were severely impaired. A sewage treatment works upstream of the site, together with extensive livestock watering at the site, are most likely responsible for the reduced water quality.

Site M13A, at farm Oortmanskloof, downstream of DWAF site 13, had a SASS4 Score of 49 and an ASPT of 4.08. Both the HABS1 and HAM scores increased from those of Site M16 to 75 and 62 respectively. The macroinvertebrate community was dominated by taxa commonly associated with marginal vegetation such as hemipteran bugs, coenagrionid damselflies, physid and ancylid snails. The comparatively pollution-tolerant empidid fly larvae were recorded for the first and only time. Water quality is impaired, most probably as a result of both effluent from the town of Klipheuwel and agricultural runoff.

Site M12, above the confluence of the Diep and Mosselbank rivers, had a SASS4 Score of 29 and an ASPT of 3.63. HABS1 and HAM scores were 65 and 37, respectively. Only eight taxa were recorded at this site, of which those associated with marginal vegetation were dominant. Both water and habitat quality were reduced at this site.

3.4 CONCLUSIONS

On the basis of this once-off assessment of the macroinvertebrate communities using SASS4, and biotope assessments using HABS1 and HAM, it is apparent that water quality in the Diep River catchment is moderately to severely impaired. With the exception of the uppermost site, in the mountain-stream zone, the macroinvertebrate communities are dominated by taxa which are tolerant to pollution stresses. At some sites, biotope availability is limited and/or habitat destruction has occurred, thereby reducing the overall ecological status of the site. At sites where several biotopes were available, water quality was generally still significantly impaired, particularly in comparison to other sites on south-western Cape rivers. In summary, the following trends, with regard to the status of the aquatic macroinvertebrate communities, were noted:

- communities in the mountain stream represented a healthy aquatic community characteristic of other south-western Cape mountain streams;
- the community at a single site above Malmesbury was dominated by taxa tolerant to water quality impairment, most likely the combined result of agricultural activities and extensive water abstraction upstream;
- below Malmesbury, the community was indicative of severely impaired water quality, in particular organic and nutrient enrichment;

- towards and downstream of Kalbaskraal, the community improved marginally as reflected in the slightly higher SASS Scores. The presence of certain taxa suggests that elevated salinity levels are of significance in this section of the river, although nutrient enrichment as a result of agricultural runoff is most likely also occurring;
- below the confluence of the Diep and Mosselbank rivers, the community is again indicative of one exposed to severely impaired water quality, with low SASS scores and the presence of taxa tolerant to organic pollution;
- at the lower sites, reduced biotope availability influences SASS Scores, although elevated salinity level is most likely the greatest contributor to reduced water quality.
- although the Klapmuts river was dry for most of its length, the community sampled at a single site consisted of an array of taxa commonly associated with marginal vegetation. Under higher flow conditions, it is likely that a greater variety of macroinvertebrates would be recorded at this site. Water quality was considered to be moderately impaired;
- the communities in the Mosselbank river showed a trend whereby the upper and lower sections of the river were severely impaired with respect to water quality, whilst the middle section showed a slight improvement. This may be the result of the addition of water from the Klapmuts River which joins the Mosselbank River upstream of Klipheuwel. Severe organic enrichment was apparent at the uppermost site.

In general, therefore, the biological integrity of the Diep River catchment, as reflected by the macroinvertebrate communities, is low. Abstraction of water, modification of physical habitat and reduction in water quality have combined to transform the system into a conduit for urban effluent and agricultural runoff.

REFERENCES

BURMAN J. 1970. *Waters of the Western Cape*. Briza publications, Arcadia.

CHUTTER, F.M. 1995. *Research on the rapid biological assessment of the water quality impacts in streams and rivers*. Draft Final Report to the Water Research Commission. WRC Report K5/422/0/1.

DALLAS H.F. In press. A preliminary evaluation of aspects of SASS (South African Scoring System) for the rapid bioassessment of water quality in rivers, with particular reference to the incorporation of SASS in a national biomonitoring programme. Submitted to the Southern African Journal of Aquatic Sciences.

DALLAS, H.F., DAY, J.A., & REYNOLDS, E.G. 1994. *The effects of water quality variables on riverine biotas*. Water Research Commission Report, Pretoria.

DALLAS H.F, DAY J.A., MUSIBONO D.E. & DAY E.G. In prep. *Water quality for aquatic ecosystems and tools for evaluating regional guidelines*. Final Report for the Water research Commission. WRC Project: Water quality requirements for riverine biotas.

HAWKES, H. A. 1979. Invertebrates as indicators of river water quality. In: *Biological indicators of water quality* (eds. James A. & Evison L.) , John Wiley & Sons, Chichester.

INSTITUTE FOR WATER QUALITY STUDIES (IWQS) 1997. Terms of Reference: an assessment of the riparian vegetation and macroinvertebrate communities towards the determination of the habitat and biological integrity of the Diep River.

PLAFKIN J. L., BARBOUR M. T. , PORTER K. D., GROSS S. K. & HUGHES R. M. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. *U. S. Environmental Protection Agency Report No. EPA/440/4-89-001*. Assessment and watershed division, Washington, DC 20460. U.S.A.

ROUX D. J. 1993. Evaluation of the SASS2 rapid bioassessment protocol for assessing the health of the aquatic environment: a case study of the Crocodile River, Eastern Transvaal. *Report No. 000/00/REQ/2293*, Department of Water Affairs & Forestry, Pretoria.

DIEP RIVER CATCHMENT - MONITORING POINTS