# CHAPTER 4. SITE CHARACTERISATION AND DATA ANALYSES

#### Summary

This chapter outlines the methods used for analysis of the data and provides results for the Mpumalanga region.

Reference sites are characterised in terms of environmental features. The data analysis procedures are discussed including the standardisations adopted, statistical methods used, methods for the analyses of invertebrate data and classification of reference sites into groups, methods for the identification of environmental variables which distinguish groups of reference sites, methods for examining the influence of biotope availability and methods for examining seasonal variability in invertebrate communities and SASS Scores.

Date gathered from reference sites in Mpumalanga are presented. The results of the multivariate analysis of invertebrate communities are given and sites are classified on the basis of composite invertebrate community data. Distinguishing taxa responsible for grouping of reference sites are identified. Environmental variables which best explain the groups of reference sites are identified and discussed and the potential for developing predictive models using this information explored. The influence of separate- versus combined-biotope sampling is explored. The frequency of occurrence of each SASS taxon amongst biotope-groups and variation in SASS Scores with respect to biotope-groups are examined. Seasonal variation in invertebrate communities and SASS Scores are explored by comparing single-season with multiple-season sampling. The frequency of occurrence of each SASS taxon amongst seasons and variation in SASS Scores with respect to season are examined.

# 4.1 INTRODUCTION

Examination of the ground-truthing data facilitated selection of reference sites for subsequent sampling. Identification of sufficient sites within each possible river type, i.e. at the Level 3 of the spatial framework, proved difficult. At this stage it was also uncertain how a river type classification would be reflected in the invertebrate communities. A decision was taken to limit sampling to perennial systems (i.e. hydrological type = perennial), and to sample across other potential river type delineaters such as river size, substratum composition, channel pattern and canopy cover.

## 4.2 CHARACTERISATION OF REFERENCE SITES

The distribution of 74 reference sites in Mpumalanga into ecoregions and sub-regions is given in (Table 4.1). In each case the number of reference sites within each category or type is given. For example, of

the 14 sites in the Central Highlands-Foothill-cobble Bed grouping, one occurred in the altitude range 601 - 900 m, three in the 901 - 1200 m range, seven in the 1201 - 1500 m range and three were > 1500 m. The total number of sites in each ecoregion/sub-region grouping is indicated in parentheses. The distribution of sites in each category or type are also presented graphically in Figures 4.1, 4.2 and 4.3. All sites were considered to be hydrological type = perennial. Categories or types among which sites have been distributed include:

- Channel pattern
- Altitude
- Substratum dominance/co-dominance
- Stream order
- Distance from source
- Width: active channel width, water width
- Canopy cover
- Geological type
- Vegetation type

Sites sampled were in one of three ecoregions, namely Central Highlands (H), Great Escarpment Mountains (E) or Lowveld (L). Sub-regions represented in each were Mountain Stream (MS) and Foothill-cobble Bed (FC) in the first two ecoregions, and mostly Foothill-gravel Bed (FG) in the Lowveld. The following generalisations may be made with regard to sites:

- H and E sites were mostly single-thread (low or high sinuosity) channels; whilst L sites were mostly multiple-thread: anastomosing/anabranching channels, although some single-thread sites were also present (Figure 4.1).
- H-MS sites were mostly >1200 m altitude; H-FC sites >900 m; E-MS sites >900 m; E-FC sites between 900 m and 1500 m; and L sites < 600 m (Figure 4.1).
- H-MS, H-FC and E-MS sites were cobble-, cobble/boulder-mix- or cobble/sand-mix-dominated; E-FC sites were cobble-dominated with some cobble/boulder-mix-dominated, the L-MS site was cobble-dominated; whilst other L sites were varied although bedrock was frequently the dominant or co-dominant substratum (Figure 4.1).
- H-MS and E-MS sites were mostly on 1<sup>st</sup> or 2<sup>nd</sup> order streams; H-FC and E-FC sites were distributed throughout the range from 1<sup>st</sup> to 4<sup>th</sup> order streams; and L sites were mostly on 4<sup>th</sup> or 5<sup>th</sup> order rivers (Figure 4.2).
- H-MS and E-MS sites were mostly between 0 and 10 km from the source; H-FC sites between 11 and 50 km; E-FC sites varied between 0 and 100 km; and L, excluding the L-MS site, generally >50 km from the source (Figure 4.2).
- Stream or water width at H-MS sites was between 1 and 5 m; at H-FC, E-MS and E-FC between 1 and 20 m with one E-FC site > 20 m ; and L sites, excluding the L-MS site, generally >11 m with many > 20 m in width (Figure 4.2).
- Canopy cover at H-MS was roughly 50:50 open:closed; whilst most other sites were open canopied (Figure 4.3).
- Geological type or lithostratigraphy at sites in H-MS and H-FC was primarily Vp (quartzite, shale,

- conglomerate, iron formation, breccia, diamicitite, limestone, dolomite); at sites in E-MS Vp dominated but sites underlain with Vm (dolomite, chert, subordinate quartzite, conglomerate, shale; diabase and syenite dykes and sills), Vgwb (lava, tuff, quartzite, shale, conglomerate) and Z (granite, granodiorite, tonalite, gneiss, migmatite) were also represented. L sites were predominantly on Z (Figure 4.3).
- Potential natural vegetation at sites in H-MS was mainly NEMG (North-Eastern Mountain Grassland); at sites in H-FC, NEMG, MB (Mixed Bushveld) MSHG (Moist Sandy Highveld Grassland); at sites in E-MS and E-FC, NEMG and SOLB (Sour Lowveld Bushveld); and at sites in L mostly MLB (Mixed Lowveld Bushveld) and SOLB (Figure 4.3).

## 4.3 DATA ANALYSIS

One of the key objectives of this project is to develop a protocol for the derivation of ecological reference conditions for riverine macroinvertebrates in South Africa. During all exploratory stages of such projects, analyses are undertaken so that the trends and variability in the data are examined and the most sensible route for future analyses are established. In this way factors of importance and potential problems are identified.

The 74 reference sites selected for more detailed sampling were sampled during three periods, namely May, July and September 1999. These months represent autumn, winter and spring periods in Mpumalanga when rivers in this summer rainfall region are accessible. The data collected was based on the ecological reference condition field-manual (Dallas 2000). Data were captured into the Rivers Database and extracted for subsequent analyses. The general approach followed was a combination of the multimetric and multivariate methods in that reference sites were initially allocated to ecoregion/sub-region groups. Multivariate analysis, however, was undertaken both within and across the ecoregion/sub-region groups so that the validity of the groups could be tested. In this way site classification based on the degree of similarity of invertebrate fauna at each site could be compared to the *a priori* site classification derived from the ecoregional and sub-regional spatial framework. The following broad steps were taken during the analyses:

- Reference sites were classified into groups based on the similarity between invertebrate communities at each site (see details section 4.3.3).
- Each group was characterised in terms of taxa present and SASS Scores.
- Environmental variables which provided maximum discrimination between groups were identified.
- The influence of biotope availability and season on invertebrate communities and SASS Scores were examined.