The Biological and Physico-chemical Database (version 2): User Manual

Report to the
Water Research Commission

by

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EXECUTIVE SUMMARY

BACKGROUND

Research on the ecological aspects of rivers in South Africa began in the early 1950s and was followed by a number of studies in the '60s, '70s, '80s and '90s. Many recent studies utilise historical data from earlier studies which enable comparisons of biological and/or physico-chemical data between current and historical conditions to be made and the degree of change in, for example, water quality, to be ascertained. Availability and accessibility of documented studies are often problematic since much of the early work was published in reports that are presently not readily available.

In 1998 a database (known as the Biobase) was developed comprising biological (macroinvertebrate) and physico-chemical data derived from documented studies of riverine ecosystems within South Africa (Dallas and Janssens, 1999; Dallas et al., 1999). The database, which collates a vast amount of information pertaining to riverine macroinvertebrates and water chemistry, has been used extensively in several projects aimed at the protection and management of our lotic ecosystems. These include the assessment of water quality guidelines (e.g. Malan and Day, 2002), several ecological Reserve determinations, the generation of ecological reference conditions for aquatic macroinvertebrates (DWAF) and the setting of conservation targets (Rivers-Moore, pers. Comm., WRC project K5/1796 Deriving conservation targets for Freshwater systems), amongst others.

RATIONALE

The software platform that version 1 of Biobase resided on was Microsoft Access 97. At the time of the original development this was the most suitable software platform, but since then, huge advances in software development have resulted in more suitable platforms being available. This led to data in the Biobase becoming inaccessible to most users. One platform in particular, which has been developed over the last ten years for the River Health Programme, is known in South Africa as the "Rivers Database" (DWAF, 2007). The Rivers Database, which incorporates web-based functionality, is the national data management and storage facility for river health data collected in South Africa. It was recognized that it would be of great national benefit to upgrade the Biobase so that it ran on the same platform as the Rivers Database. Access to the Rivers Database is free and readily available via registration on the Rivers website. This would allow valuable data in Biobase to become available to all users. By combining the entry point for the two databases, both the River Health Programme practitioners and all other water sector contributors will benefit by having access to the Biobase and the vast amount of historical information it contains. The data in the Biobase are of huge value, particularly as it would be logistically and financially impossible to obtain a similar set of data today. In addition, the database includes the only data that reflect historical conditions, which in some instances, represent a period when the degree of impairment was less than the present-day conditions.

OBJECTIVES AND AIMS

AIM 1

To upgrade the Biobase functionality and make it accessible via the Rivers web application, and to incorporate current spatial aspects, thereby making it compatible with more recent spatial classifications and applications.

METHODOLOGY

The proposed solution involved implementing the Biobase functionality as part of the menu in the Rivers web application (http://www.riv.co.za/Rivers). Current Rivers

Database users would have access to the Biobase via their Rivers login, which is controlled by the Rivers Administrator. Integration of Biobase data with Rivers Database data occurs at river level where the Biobase would use the existing River entities. All other entities (Site, biotope, macroinvertebrate and physico-chemical data, etc.) are managed separately. Functionality has been replicated as closely as possible on the web, with the exception of the query capability. Current query and pivoting functionality has been replaced by the query master and new QM queries have been created as required. The tasks undertaken included:

- Creation of the database (upgrade to SQL, design and build tables, import and convert data, match rivers)
- Generation of application infrastructure (setting up object model)
- Development of complex forms (spatial frameworks, site search, site detail, biological and chemical link, biotopes and taxon management, chemistry, taxonomy, references, pick lists, data list views)
- Development of the Query master (reports and data export)
- Implementation (testing, implementation on web and issue management)
- Development of a user manual

Soft Craft Systems have undertaken the redesign of the application, while The Freshwater Consulting Group (FCG) has assisted with the design, validation and spatial aspects. FCG has produced the user guide, in collaboration with Soft Craft Systems, for publication by the WRC. This report is the User Manual.

RESULTS AND DISCUSSION

Detailed information on viewing and querying data in the Biobase has been provided, together with screen dumps of the actual database. These include the four key viewing components, namely Sites, Biological & Physico-Chemical Data, Taxonomic Data, and Study Reference Information. The Query Master is described and steps for extracting data listed. The utility and limitations of the database have been discussed. These include, amongst others, deducing ranges of different physico-chemical parameters, for different taxa; assessing changes in community structure, using historical records; examining biotope preferences of specific taxa; assessment of water quality guidelines and input into the ecological Reserve; determination of macroinvertebrate reference conditions; development of conservation targets; and determination of the geographic distribution of taxa.

CONCLUSIONS

The database, which collates a vast amount of information pertaining to riverine macroinvertebrates and water chemistry, has several useful applications if used with the awareness of the problems outlined in this report. In establishing this database, one of the problems encountered, that was both difficult to resolve and avoidable, was that caused by the lack of consistency in the way in which different authors present their data. Frequently, useful data are lost, merely because they cannot be compared with others. The data captured in the Biobase include most of the biological data on macroinvertebrates prior to 1998. Since then numerous studies have been undertaken and a wealth of data exists. It would be highly advantageous to incorporate these data into the Biobase.

RECOMMENDATIONS FOR FUTURE RESEARCH

One of the more important recommendations to emerge from this area of work is that future biological and chemical collections should conform to the standard units of physico-chemical measurements as described in this User Manual and that for biological data details of proportional abundance, as well as factors such as biotope type, should be provided. In addition, the actual dates on which both biological and physico-chemical data were collected should be available for reference, where they are not actually presented in published reports. Preferably an electronic copy of all data in its original form should be lodged with a responsible organisation such as the Water research Commission. It is recommended that funding be sought to enable data from studies undertaken after 1998, as well as those prior to 1998 that are not yet in the Biobase, to be captured into the Biobase.

ACKNOWLEDGEMENTS

This database was first developed in 1998 as part of a Water Research Commission Research Project: Water quality requirements for riverine biotas, WRC K5/626. The revised version, which incorporates web-based functionality, was released in 2010, as part of the Water Research Commission Research Consultancy: WRC K8/906. This report is the technical manual for the Biological and Physico-chemical Database (Biobase), which is accessible on the RHP Rivers Database website http://www.riv.co.za/Rivers. The authors gratefully acknowledge the financial support of the WRC and the managerial support of Dr Steve Mitchell and Dr Stanley Liphadzi who facilitated the funding. The authors of each study reference included in the database are thanked for their contributions, particularly those who provided us with information that had not yet been published. Lastly, Mike Silberbauer (Resource Quality Services, Department of Water Affairs) is thanked for hosting the Rivers Database over the last few years, and for his useful comments on this report.

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1 INTRODUCTION

1.1 Historical background

Research on the ecological aspects of rivers in South Africa began in the early 1950s (e.g. Harrison and Elsworth, 1958; Scott, 1958) and was followed by a number of studies in the 60s (e.g. Allanson, 1961; Harrison and Agnew, 1962; Chutter, 1963; Hughes, 1966; Chutter, 1967; Brand et al., 1967a, b; Allanson, 1968; Forbes, 1968; Archibald et al., 1969), 70s (e.g. Kemp et al., 1976; Coetzer, 1978; Fowles et al., 1979), 80s (e.g. Fowles, 1984a; 1984b; O'Keeffe, 1985; Coetzer, 1986) and 90s (e.g. Palmer and O'Keeffe, 1990; Brown, 1993; King and Tharme, 1994; Dallas, 1995). Many recent studies utilise historical data from earlier studies which enable comparisons of biological and/or physico-chemical data between current and historical conditions to be made and the degree of change, in for example, water quality, to be ascertained. Availability and accessibility of documented studies are often problematic since much of the early work was published in reports that are presently not readily available.

In 1998 a database (known as the Biobase) was developed comprising biological (macroinvertebrate) and physico-chemical data derived from documented studies of riverine ecosystems within South Africa (Dallas and Janssens, 1999; Dallas et al., 1999). The database, which collates a vast amount of information pertaining to riverine macroinvertebrates and water chemistry, has been used extensively in several projects aimed at the protection and management of our lotic ecosystems. These include the assessment of water quality guidelines (e.g. Malan and Day, 2002), several ecological Reserve determinations, the generation of ecological reference conditions for aquatic macroinvertebrates (DWAF) and the setting of conservation targets (Rivers-Moore, pers. Comm., WRC project K5/1796 Deriving conservation targets for Freshwater systems), amongst others.

The software platform that version 1 of Biobase resided on was Microsoft Access 97. At the time of the original development this was the most suitable software platform, but since then, huge advances in software development have resulting in more suitable platforms being available. This led to data in the Biobase becoming inaccessible to most users. One platform in particular, which has been developed over the last ten years for the River Health Programme, is known in South Africa as the "Rivers Database" (DWAF, 2007). The Rivers Database, which incorporates web-based functionality, is the national data management and storage facility for river health data collected in South Africa. It was recognized that it would be of great national benefit to upgrade the Biobase so that it ran on the same platform as the Rivers Database. Access to the Rivers Database is free and readily available via registration on the Rivers website. This would allow valuable data in Biobase to become available to all users. By combining the entry point for the two databases, both the River Health Programme practitioners and all other water sector contributors will benefit by having access to the Biobase, and the vast amount of historical information it contains. The data in the Biobase are of huge value, particularly as it would be logistically and financially impossible to obtain a similar set of data today. In addition, the database includes the only data that reflect historical conditions, which in some instances, represent a period when the degree of impairment was less than the present day conditions.

1.2 Sources of data

The database has been constructed using data pertaining to South African rivers and extracted from much of the available literature and unpublished reports, in which biological and physico-chemical data have been collected concurrently. Most of the biological data that are available relate to the benthic invertebrate fauna, although some work has been done on fish taxa. This bias is probably a result of the early recognition of the fact that benthic fauna provide an easy and fairly reliable way of assessing pollution (Chutter, 1972). Records of the invertebrate riverine fauna thus form the biological component of this database. These data include those from intensive studies of individual systems (Harrison, 1958; Chutter, 1963; 1967), extensive one-off surveys of regions (Kemp et. al., 1976), ad hoc surveys (Harrison and Agnew, 1960; 1962) and impact assessment reports (O'Keeffe, 1987; 1989). Thus far forty-three studies, of which 40 had associated physico-chemical data, have contributed to the biological records of the database.

The physico-chemical data used have been extracted from the same literature sources as the biological data, but vary between studies in terms of the number of variables analyzed. The main criteria for the inclusion of physico-chemical data have been the exact or approximate coincidence of these measurements with those of the relevant invertebrate biological details. A complete list of the study references used is provided in Appendix A. Appendix B describes each of these studies in detail, listing which records were extracted and what if any adjustments were made to allow compatibility with other records. A total of 140 000 biological records have been entered into the database thus far, and most of these are accompanied by records of physico-chemical conditions (between 1 and 48 physico-chemical variables covered in each case) in the river at the time of sampling. The time spanned by the records dates from 1951 (Berg River; Harrison and Elsworth, 1958) to the 1998, and, in the case of some rivers (e.g. Berg River, Western Cape), records are available from several consecutive studies, which provide a historical trace of both biological and physico-chemical conditions.

1.3 Access to the database

The Biobase has been incorporated into the website of the River Health Programme: ***http://www.riv.co.za/Rivers***. For users that are already registered to use the Rivers Database, they simply need log in and select “Biobase” on the menu bar. New users not yet registered need to register as a new user by completing the user registration form and submitting the electronic form to the Rivers Administrator. Once they receive their user information the user can login to the Rivers Database and select “Biobase” on the menu bar. This manual is available for download from the Biobase menu bar option.

1.4 Structure of this report

This report takes the form of a manual. It describes the structure of the database, both in terms of the spatial frameworks incorporated and the type and quality of data. It outlines the steps for users to select and view the data online and to extract data by using the Query Centre, which is designed to facilitate extraction of data by users. Pre-defined query frameworks enable querying of biological data, physico-chemical data, and physico-chemical parameters linked to biological ones. This manual also describes the potential uses of the database and, more importantly, expands on the limits of its applicability. There is always a danger that a large store of data such as this may exude an air of reliability by virtue of its size alone. It is important to understand and be aware of the problems involved in amalgamating records from different sources, relating to data gathered by different authors, at different levels of intensity, and for different purposes.

1.5 Structure of the database

The intrinsic variability of biotic (Harrison and Agnew, 1962; Eekhout et al., 1997) and physico-chemical (Day and King, 1994) components of riverine ecosystems within South Africa has necessitated the adoption of a hierarchical framework within which biological and physico-chemical data are accessed and queried. The primary level is the regional or geographic framework, the secondary level is at the longitudinal differentiation and the tertiary level is the site. Biological data are further differentiated into the level of biotope.

Physico-chemical data are at the level of site. The hierarchical relationship between each level is schematically indicated in Figure 1.

1.5.1 Primary level: Geographic frameworks

Five spatial frameworks have been incorporated to allow for selection of sites and hence biological and physico-chemical data within the regions defined below.

- Ecoregion Level I: One of 31 as identified in Kleynhans et al. (2005).
- Ecoregion Level II: One of 135 as identified in Kleynhans et al. (In prep).
- Bioregions: One of 18 as defined by Brown et al. (1996). They are a refinement of the Biogeographic Regions, which were based on the biological distribution of aquatic organisms (Eekhout et al.,1997).
- Political Region: One of nine regions.
- Water Chemistry Management Region: One of seven as identified in Day et al. (1998).

1.5.2 Secondary level: Longitudinal zones

In addition to the above geographic frameworks, it was considered important to incorporate a measure which takes account of the longitudinal zonation of rivers (Harrison, 1965; King, 1981). Longitudinal zones based on Rowntree and Wadeson's (2000) geomorphological zonation of river channels is thus incorporated.

1.5.3 Tertiary level: Site

The site is the level at which the biological (with an additional level of biotope in some cases) and physico-chemical data are collected and thus far data are available for 684 sites on 205 rivers within South Africa. Associated with each site is information on the spatial location of the site, including a description of the site and details of the river, longitudinal zone, ecoregion, bioregion, political region, water chemistry management region, latitude, longitude and altitude of the site. Biological and physico-chemical data for each site are linked to the site in a hierarchical manner as illustrated in Figure 1.

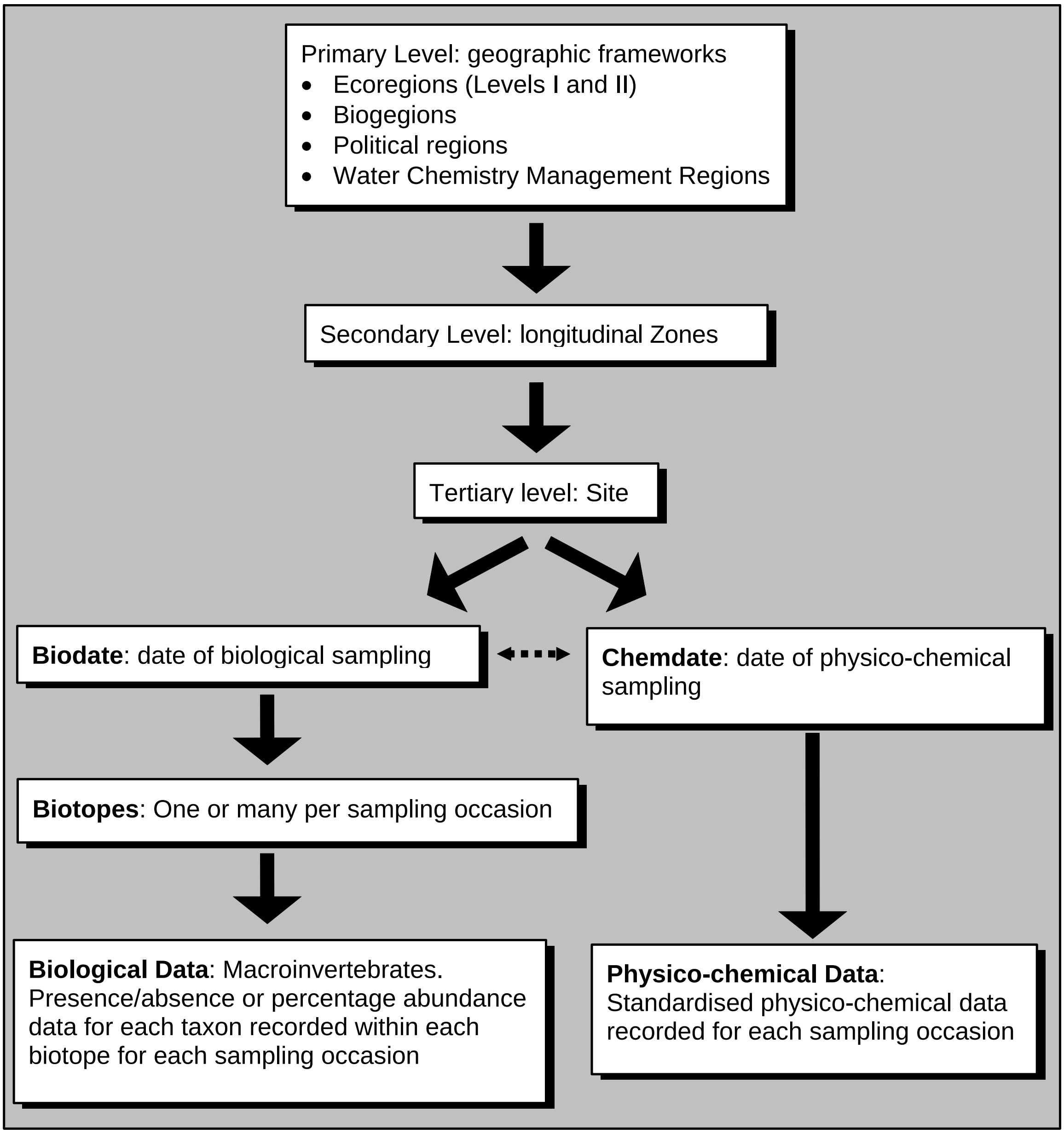


Figure 1 Schematic diagram illustrating the hierarchical nature of the database structure

1.5.4 Links to RHP sites in the Rivers Database

The sites in the Biobase that are within a 5 km radius of RHP sites in the Rivers Database may be viewed on the Rivers Server website via the "Site Detail" form. The names of the rivers as reported in the original studies have been retained although they may be linked to rivers in the Rivers Database by examining the site location using the georeference provided.

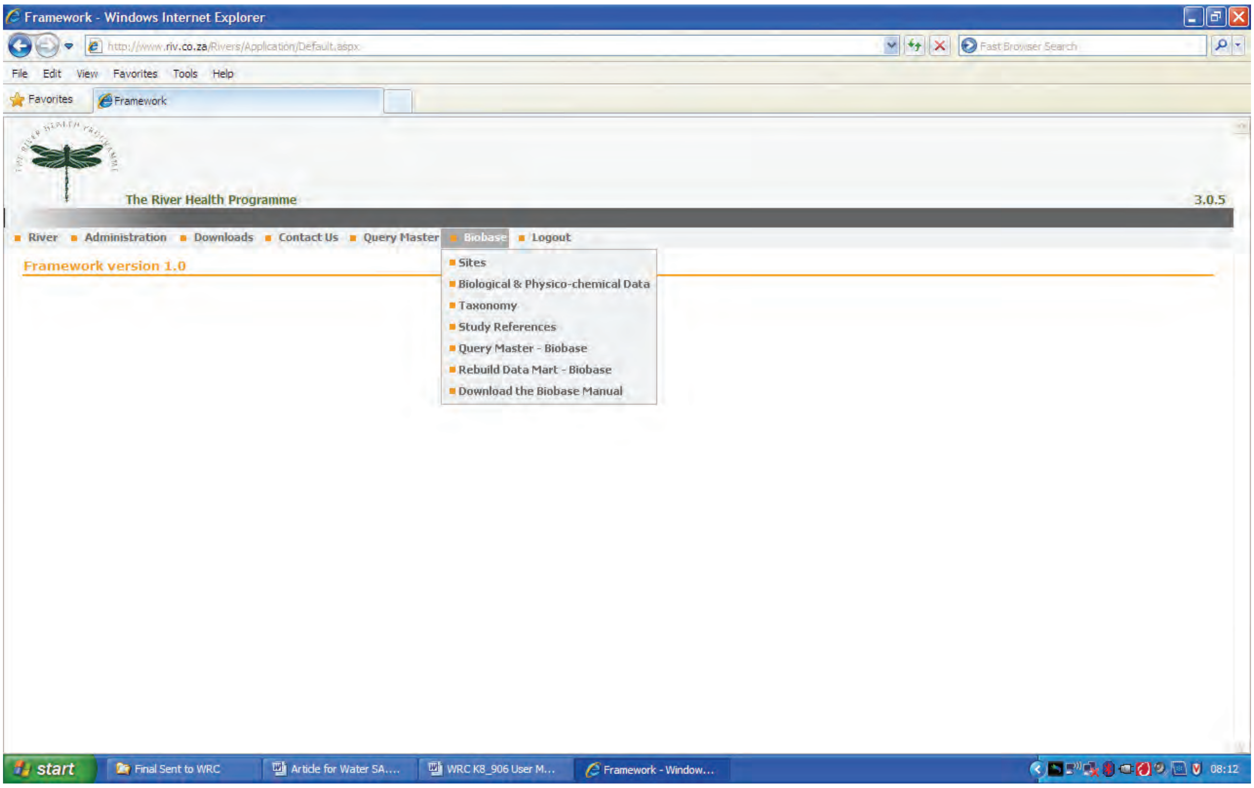
1.5.5 Biological and physico-chemical data

Biological data are given as percentage abundances (or presence/absence where abundance was not given), for each biotope (e.g. stones-in-current, marginal vegetation) sampled, for each sampling occasion. Biotopes are at the level at which the biological information was collected. Variability in both terminology and methodology between studies necessitated the adoption of a hierarchical structure (i.e. broad biotope, specific biotope and substratum) in order to take into account the numerous biotopes sampled. Each biotope is also assigned a SASS biotope (Dickens and Graham, 2002) which provides a more uniform basis from which comparisons can be made. Physico-chemical data were recorded at 40 of the 43 sites documented in this database. The variables measured and units reported varied between studies. These units have been standardized into SI units where possible, and conversions made where applicable.

2 VIEWING DATA IN THE DATABASE

All users are able to view data. In the future it may be possible to enable users to add their own data to the database, although aspects such as quality control will need to be resolved prior to this function being made available. All viewing and querying is accessed via the "Biobase" on the menu bar in the Rivers Database website (Screen 1). Data for viewing include Sites, Biological and Physico-chemical Data, Taxonomy and Study references, the Query Master and User Manual.

Screen 1

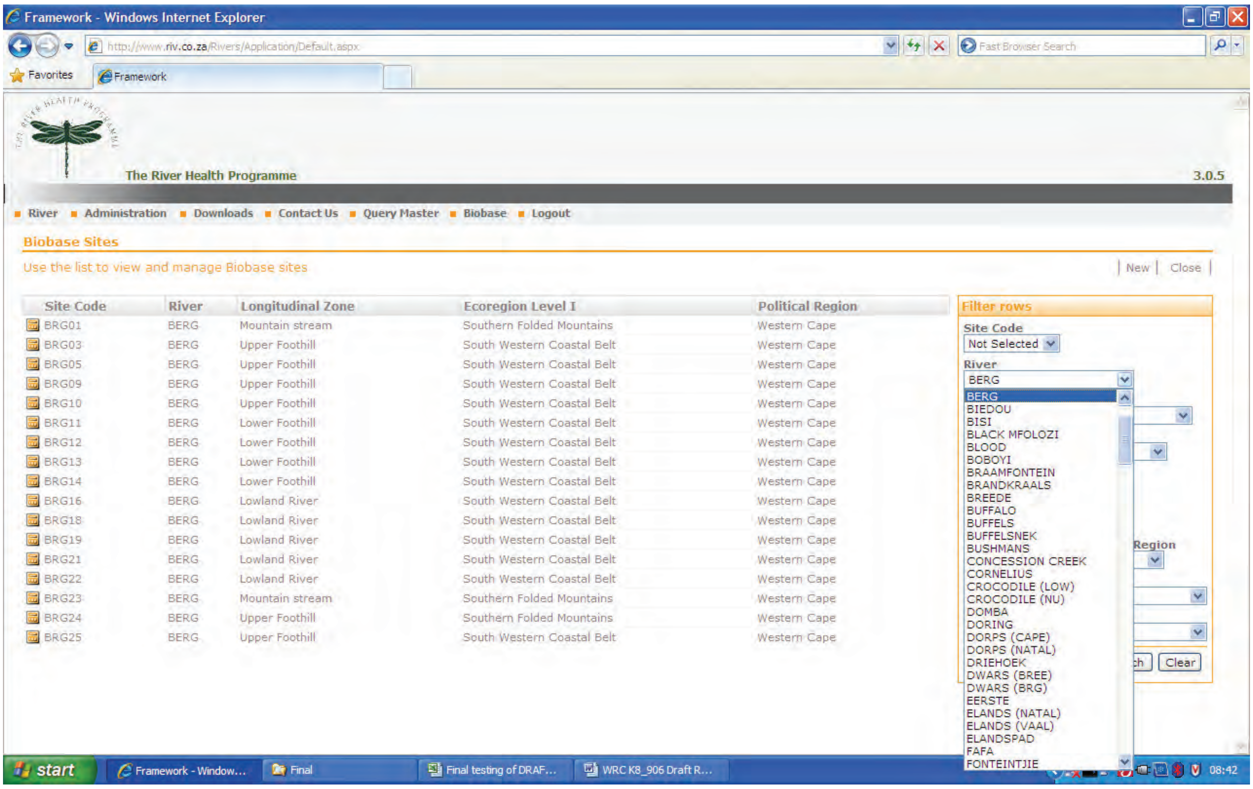


2.1 Site data

Existing data on sites incorporated in the database are viewed using the filters and drop-down lists to select the site (Screen 2). Selection may be based on Site Code, River, Longitudinal Zone, Ecoregion level I, Ecoregion level II, Bioregion, Political region or Water Chemistry Management region. Selection may also be based on a Biological Data Reference or Physico-chemical Data Reference if data from a particular study only is to be viewed. To activate a filter click "Search". The initial view is a list of Biobase Sites, which provides an overview of sites giving the river, longitudinal zone, ecoregion level 1 and political region in which the selected site(s) occur (Screen 2). Details of the filter criteria are as follows:

- Longitudinal Zone: Based on Rowntree and Wadeson's (2000) geomorphological zonation of river channels.
- Ecoregion Level I: One of 31 as identified in Kleynhans et al. (2005).
- Ecoregion Level II: One of 135 as identified in Kleynhans et al. (In prep).
- Bioregions are a refinement of the Biogeographic Regions, which were based on the biological distribution of aquatic organisms (Eekhout et al., 1997).
- Political Region: One of nine regions.
- Water Chemistry Management Region: One of seven as identified in Day et al. (1998).

Screen 2

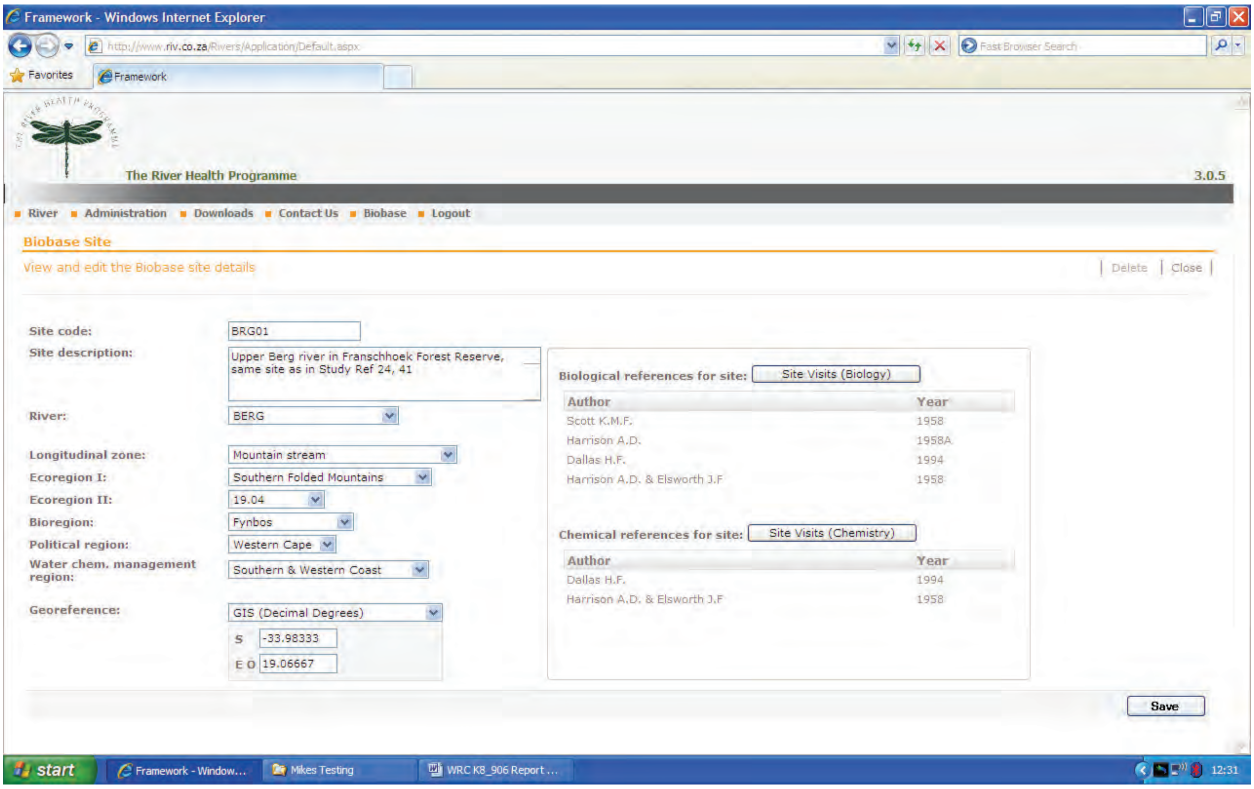


Detailed information is viewed by clicking on the desired site. Further information pertaining to the site is returned including Site description, georeference, Bioregion, Water Chemistry Management region, and the biological and physico-chemical reference for the site (Screen 4). Further details may be viewed as follows:

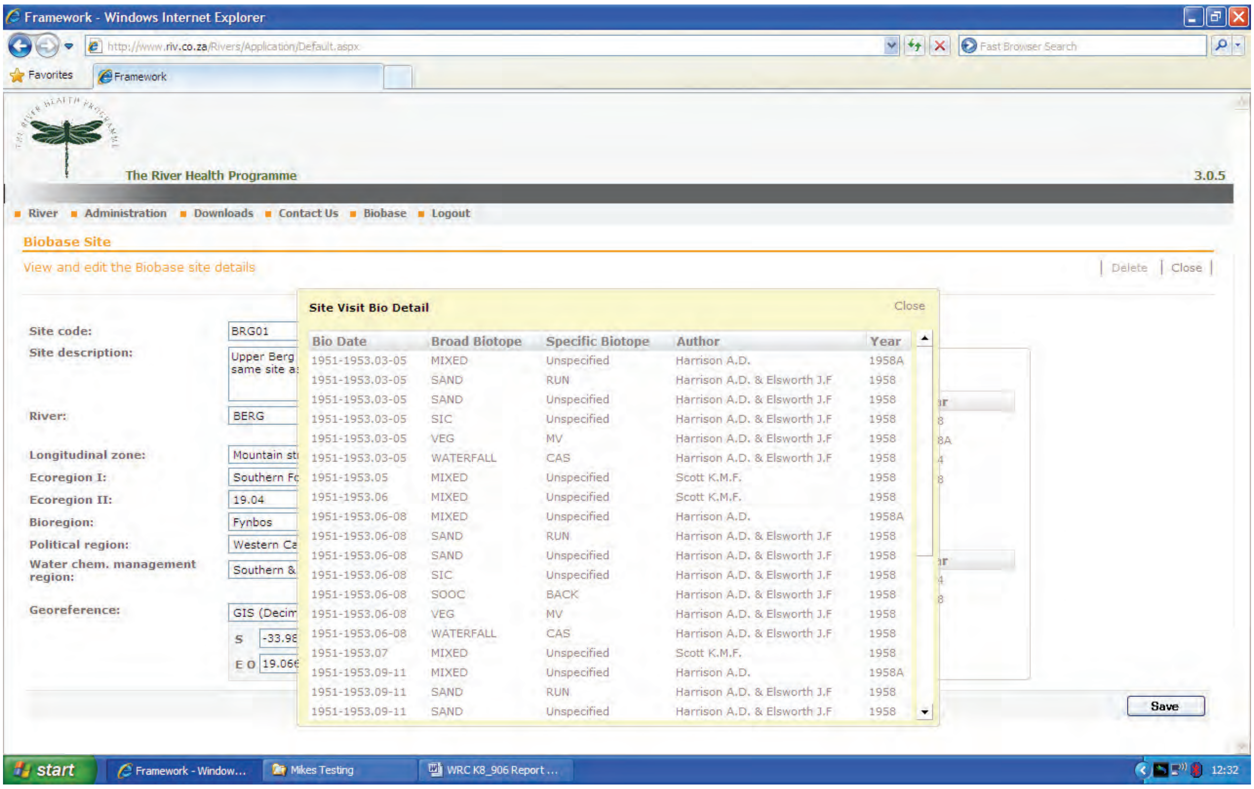
- Summary information of the actual biological data collected may be viewed by clicking the “Site Visits (Biology)” (Screen 4). The sampling date, broad and specific biotopes, author and year are provided. If no BioDate is returned for the selected site, then no biological data are available for this site.
- Summary information of the actual physico-chemical data collected may be viewed by clicking the “Site Visits (Chemistry)” (Screen 5). The sampling date, author and year are provided. If no ChemDate is returned for the selected site, then no physico-chemical data are available for this site.
- Details of the study may be viewed by clicking the “Author”, which returns details of the study including the author(s), year, Title and Journal reference (Screen 6).

The user may navigate from detailed site information to lists of sites, by clicking "close". The process may be repeated for further sites.

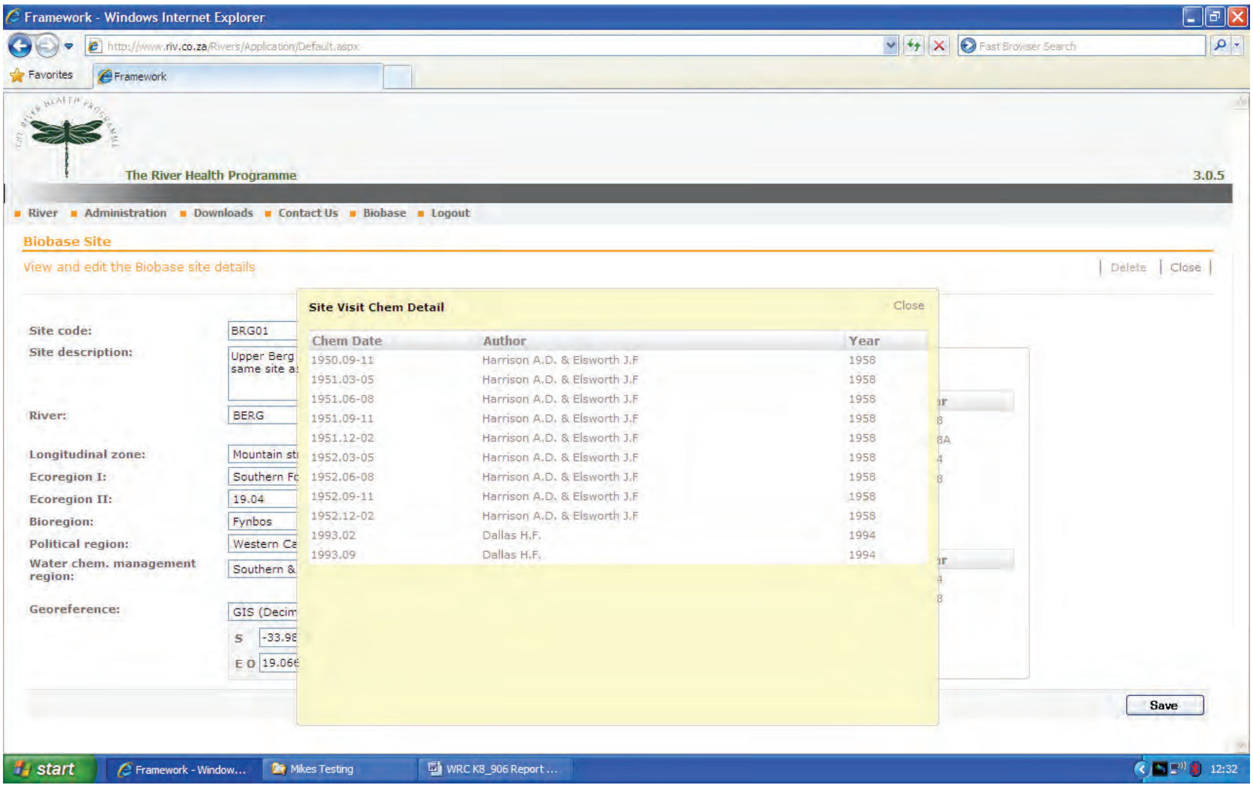
Screen 3



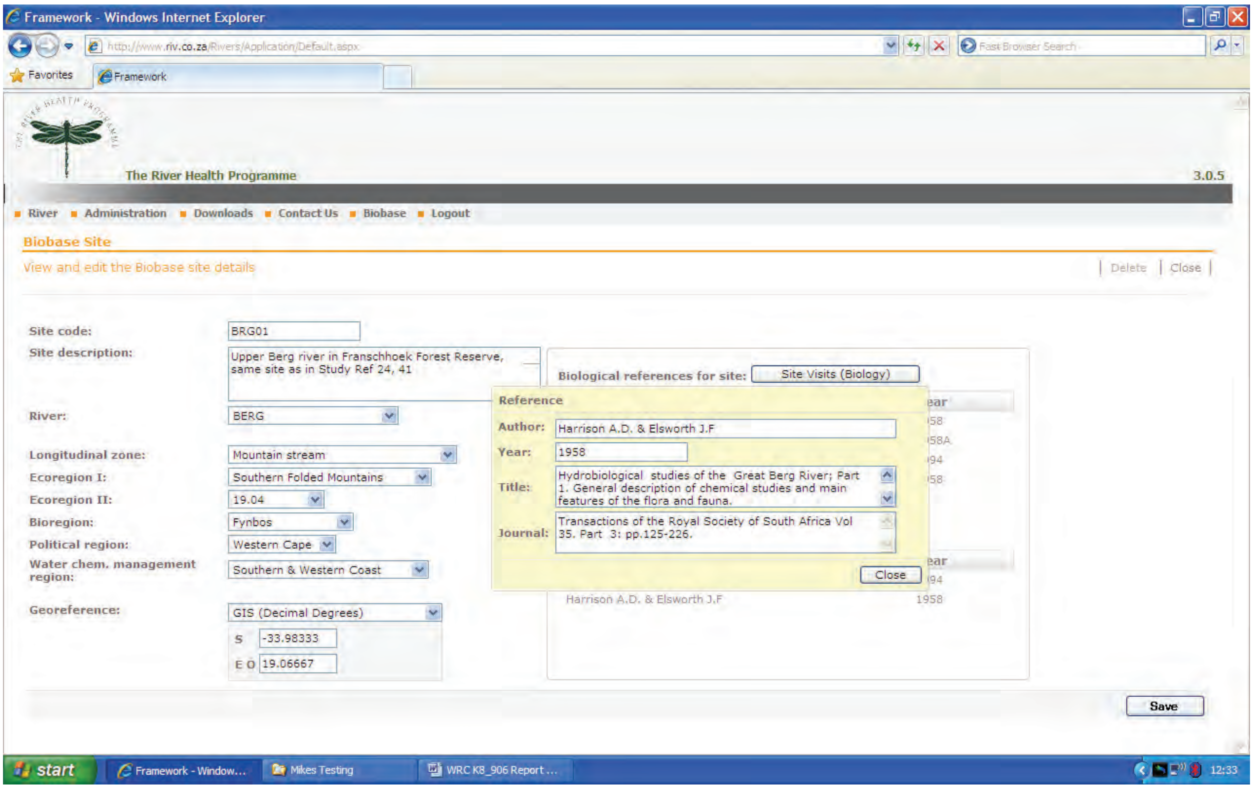
Screen 4



Screen 5



Screen 6

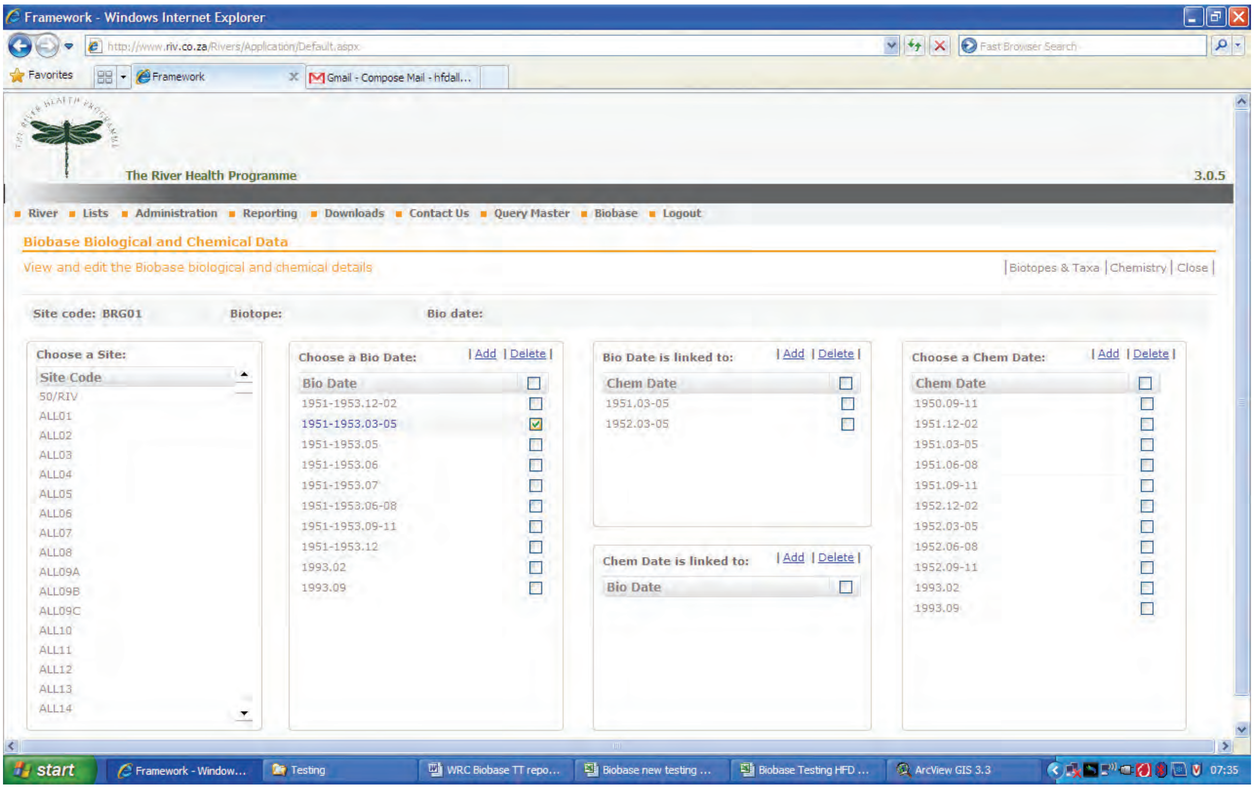


2.2 Biological and Physico-chemical data

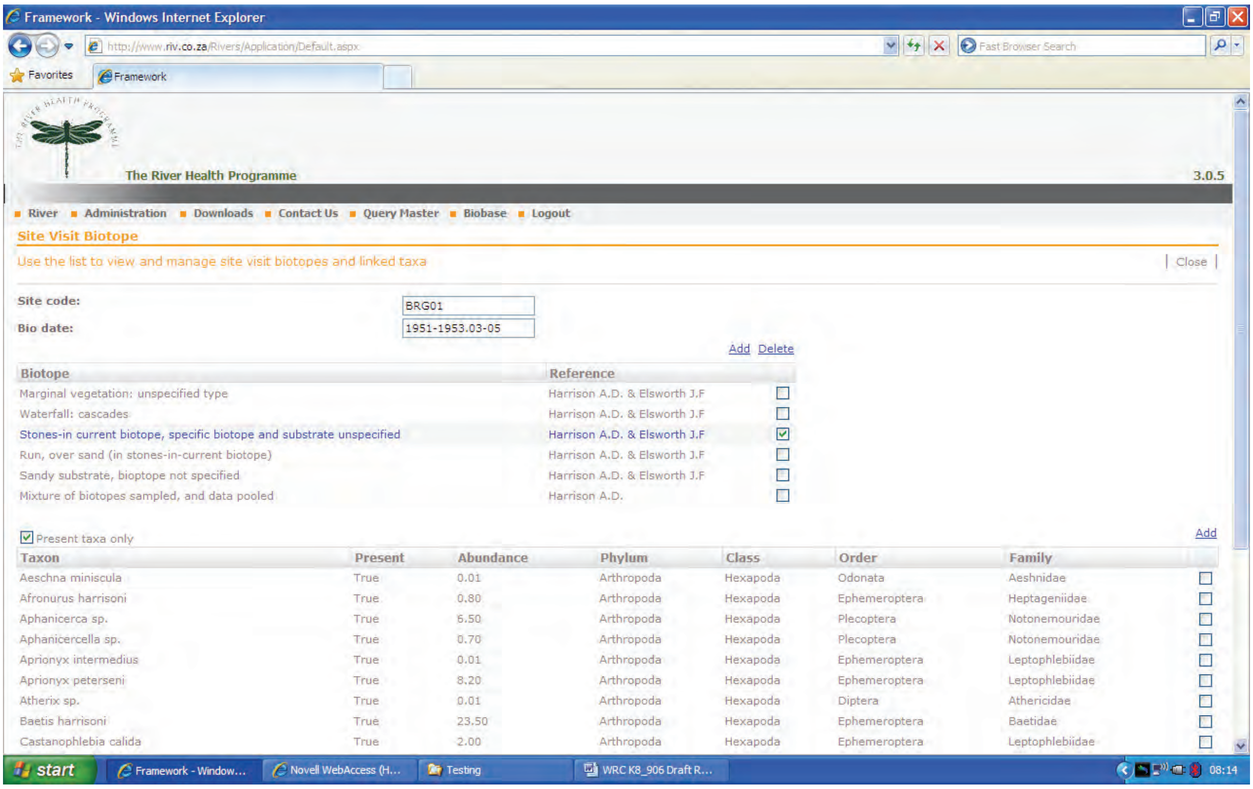
This allows users to view the biological and physico-chemical data in the Biobase (Screen 7). The user selects a Site Code from the list of available Site Codes. Once selected the BioDates on which the sampling was undertaken are returned in the BioDate sub-form. The user then selects a BioDate by clicking one of the available date boxes. If this BioDate has physico-chemical data linked to it then they are returned in the “BioDate is linked to ChemDate” sub-form. The appropriate ChemDate may then be selected in the ChemDate sub-form. Further details may be viewed as follows:

- Details of the actual biological data collected may be viewed by clicking the “Biotopes and Taxa” (Screen 8). The selected Site Code and BioDate are shown, and a list of biotopes sampled provided. The user selects one biotope by clicking in the box. The taxa present are listed alphabetically with its associated Phylum, Class, Order and Family provided. The “Taxon” is at the taxonomic resolution that the data were collected at and may be species, genus or family. Where “Present” is “True” but abundance is 0.01, then the taxon was present but the abundance was not recorded.
- Details of the actual physico-chemical data collected may be viewed by clicking the “Chemistry”. (Screen 9) The value for each physico-chemical variable measured is provided as well as the units of measurements.

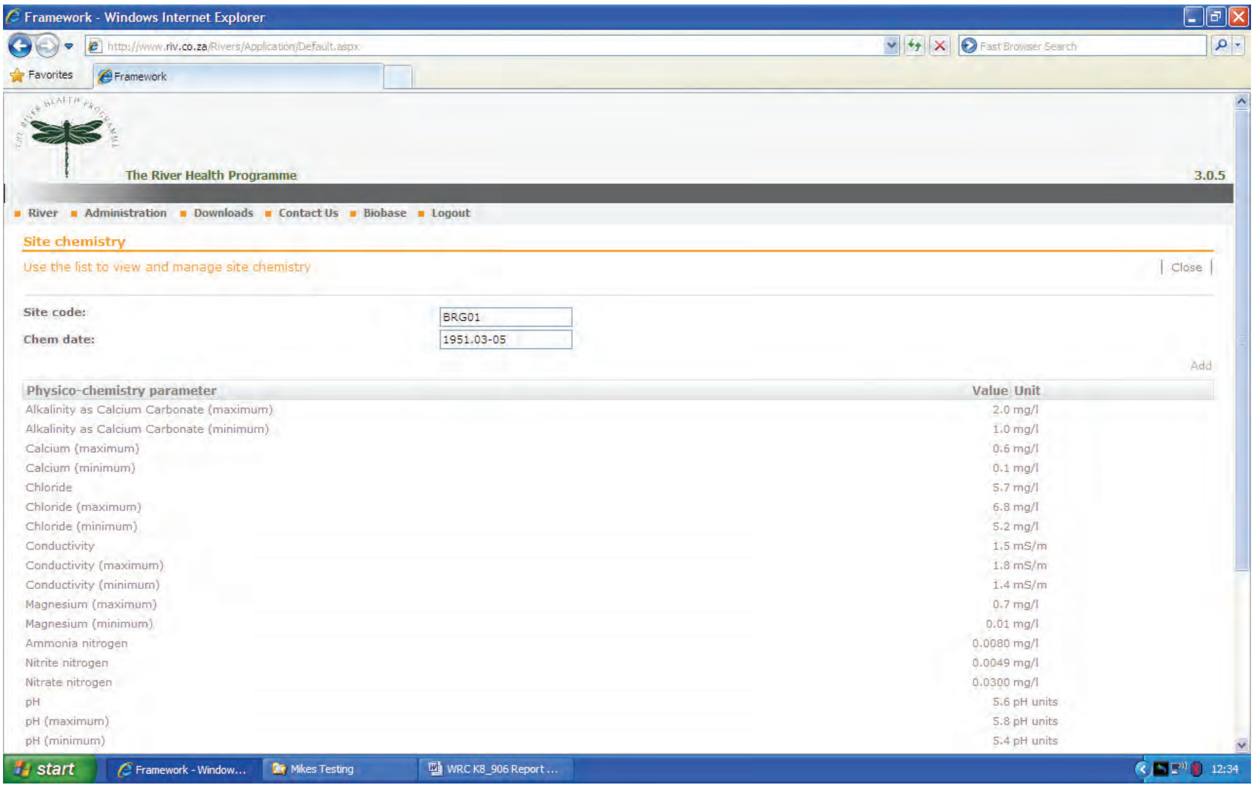
Screen 7



Screen 8



Screen 9



2.2.1 Explanation of terms and conventions used in biological and physico-chemical data

BioDates and ChemDates

"BioDate" and "ChemDate" refer to the dates at which biological and physico-chemical data were collected respectively. Sampling frequency was highly variable, with some records being one-off "spot" samples, while others are the means of weekly, monthly, seasonal or annual samples. The presentation of data in reports and published papers is also highly variable, with results being presented either as one-off samples with different degrees of detail as to day, month and year of sampling, or as monthly, seasonal or yearly means. In some cases, results are of monthly or seasonal data, presented as a mean over a few years (although data that have been used in this database never span more than three years). To facilitate querying the BioDates and ChemDates have been standardized (Year.Month.Day) and "Sampling Month", "Sampling Year" and "Sampling Season" allocated to each. To allow this, some dating conventions have had to be established. As with all conventions, these should be regarded with both caution and flexibility, since while they render the accessing of data more convenient, they also decrease the accuracy with which the data are presented. The dating hierarchy is linked to the actual "BioDates" which are unique to each study reference. The dating conventions are as follows:

- Where two months are linked, the first month is chosen as the representative month; where more months are linked together, the middle month is used.
- In cases where the study reference provides only seasonal means, the mid-month of that particular season is used. In cases where the reference provides no details as to which months constitute each season, the mid-month used in the season "convention" is used.
- *Seasons*: Unless specified otherwise, each season is assumed to comprise the following months:

- Autumn (AUT): March (MAR), April (APR), May (MAY)
- Winter (WIN): June (JUN), July (JUL), August (AUG)
- Spring (SPR): September (SEP), October (OCT), November (NOV)
- Summer (SUM): December (DEC), January (JAN), February (FEB)

Where the reference does assign different months to each season, these months are used instead.

- *Years*: Where records refer to samples as a mean over two years, the first year is taken as the "Sampling Year". Where three years are used, it is the second that is taken. No data from records that have been averaged over more than three years are used.
- Some inaccuracies are inherent to such a hierarchical system and to counteract this to some degree, the following warning codes have been added (Table 1).

Table 1 Dating conventions and codes used for biological and physico-chemical sampling

Code	Type	Description
Spot	Spot sample	Data based on a one-off survey
MP	Month Pool	Data were seasonal and Sampling Month was deduced by convention
YP	Year Pool	Data taken in the same month were presented together, but as a mean over several years
BP	Both Pool	Both month and year sort dates are artificial and records are presented as seasonal means, over a number of years.

Linking biological and physico-chemical data

One of the reasons for the development of this database was to facilitate a linking of biological and physico-chemical data. Whilst acknowledging that there are inherent problems in doing this, there is sufficient utility in such a function. For example, one is able to ascertain the range of pHs at which a particular species or family has been recorded. It was therefore necessary to link the biological and physico-chemical data. Problems arose due the inconsistent nature in which the data were reported, making it impossible to link the data in a straightforward manner. To overcome this problem, the sampling dates from each study have been assessed, and a subjective judgment made as to the best matched physico-chemical and biological data, for each site. When biological and physico-chemical samples were taken at the same time, however, matching was automatic. The rules that have been applied to the linking process are as follows:

Where biological and physico-chemical sampling was not done simultaneously, or data were not presented in the same time format:

- Data that were not taken in the same years were never linked.
- If either the "BioDate" or the "ChemDate" was presented as a seasonal mean, then the mid month of that season was linked to the records for the appropriate month of the other dataset.
- If no direct date match was found, data taken at reasonably close intervals were linked, provided those intervals did not mean that data fell into different seasonal categories.
- Each set of records could only be linked once, unless records included the means of several years. For example, biological data with a "BioDate" of 1951-1952.08 could be linked to physico-chemical data with "BioDates" in both August 1951, and August 1952, should these data be available. Such a system does, however, mean that the records are open to duplication, and users should be aware of this when running queries.

A conservative attitude was adopted for the linking of these data sets, such that not all the biological data stored in the database have been linked to physico-chemical data, and vice versa. The linking of data within each study is documented in Appendix B.

Biotopes

This is the level at which the biological information was collected. A hierarchical structure was adopted to take into account the numerous biotopes sampled and the variability in both terminology and methodology between studies. Each of the documented biotopes has also been assigned to a SASS (South African Scoring System) biotope which provides a more uniform basis from which comparisons can be made (Appendix C).

Taxa (Biological Data)

The presence or absence of each taxon has been included in a true/false manner, with the default being to view or extract only taxa present at a site. For the taxa present abundance of the taxon is expressed as a percentage occurrence because of the semi-quantitative nature of much of the data. Abundances given as "p" in the study text, indicating that "a taxon was present but in a very low abundance", have been reported as 0.01. If a taxon is present but no abundance was given in the study reference, the abundance field is blank. Absent taxa are those not recorded at particular sites or at particular time periods within a study reference.

Physico-chemical Data

Physico-chemical data were recorded at forty of the forty-three sites documented in this database. The variables measured and units reported varied between studies. These units have been standardized into SI units where possible, and conversions made where applicable. A complete list of all physico-chemical variables in the database is given in Appendix D and detailed study references in Appendix B. In certain studies physico-chemical values were given as "trace", "not detected" or "0.0". On the basis of reported physico-chemical values for each variable, the following standardization was adopted (Table 2). If values are given as 0.00, 0.000 or 0.0000 it means that the value recorded was below the levels of detection as stipulated below. Note that differences in analytical methods and changes in detection limits with time could influence the reliability of comparisons between sites and between points on a time series.

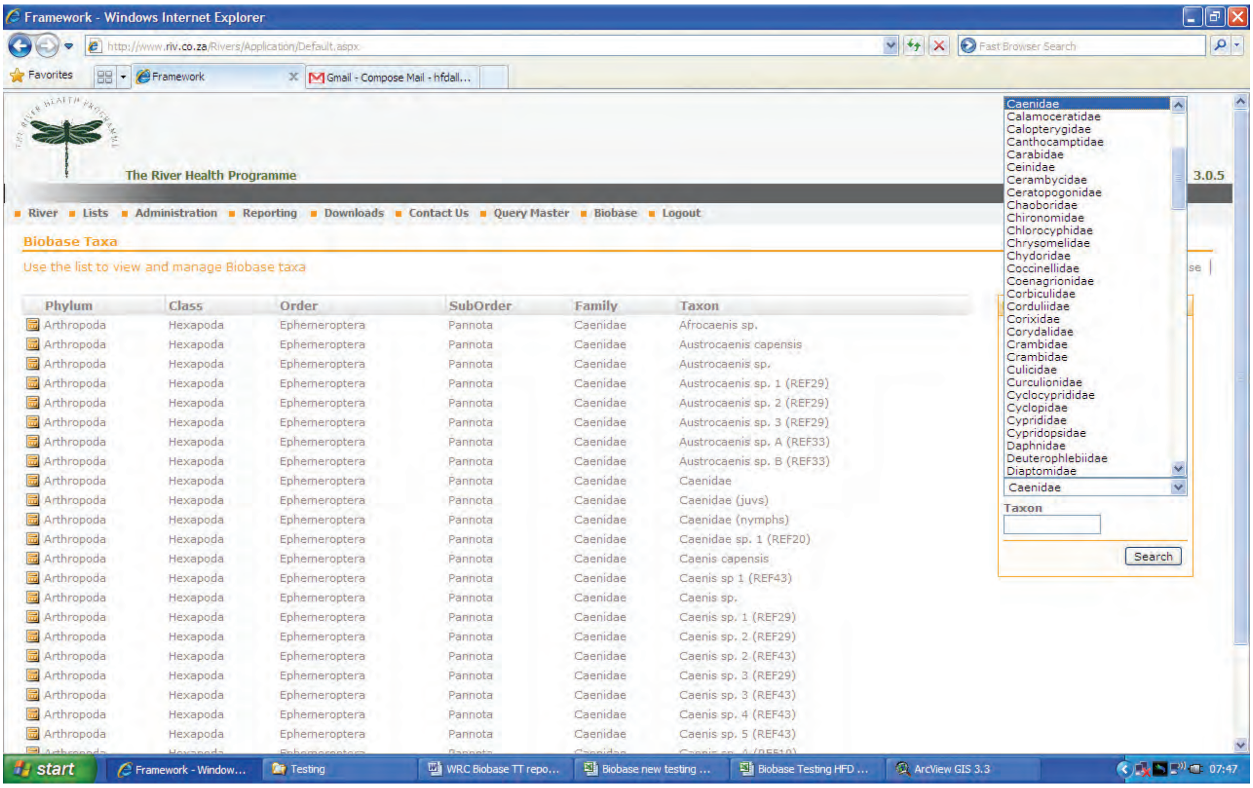
Table 2 Standardisation used for physico-chemical values given as trace or "not detected"

Variable	Trace or "not detected" value
Total Suspended Solids	0.01
Anions and cations	0.01
Total alkalinity	0.01
Fluoride	0.01
Free CO_2	0.01
Metals	0.001
Kjeldahl nitrogen, ammonium and phosphorus	0.001
Nitrite and nitrate	0.0001

2.3 Taxonomic data

Each species has been given a unique, numerical genus/species code. The state of flux of the taxonomy and inconsistent historic record of species names is to be noted, and caution is advised when querying on the lower taxonomic levels (e.g. species). Synonymous names and all taxonomic levels have been incorporated when known. Existing taxonomic data incorporated in the database is viewed using the filters and drop-down lists to select the taxon (Screen 10). Selection may be based on Phylum, Class, Order, SubOrder, Family or Taxon level, which allows for selection based on genus or species, as well as selection based on a portion of a genus/species. For example "Caen" will return "*Afrocaenis*" sp. and "*Caenis capensis*". To activate a filter click "Search". Detailed taxonomic information is viewed by clicking a specific taxon (Screen 11). The fields listed above are returned in addition to the South African Scoring System (SASS) taxon to which it is allocated. Provision is made for comments about a particular taxon such as its previous taxonomic classification, where names have been modified. To view all taxa in the Biobase click "Search" without filtering. This may take a while but it allows users to list all the taxa currently in the Biobase.

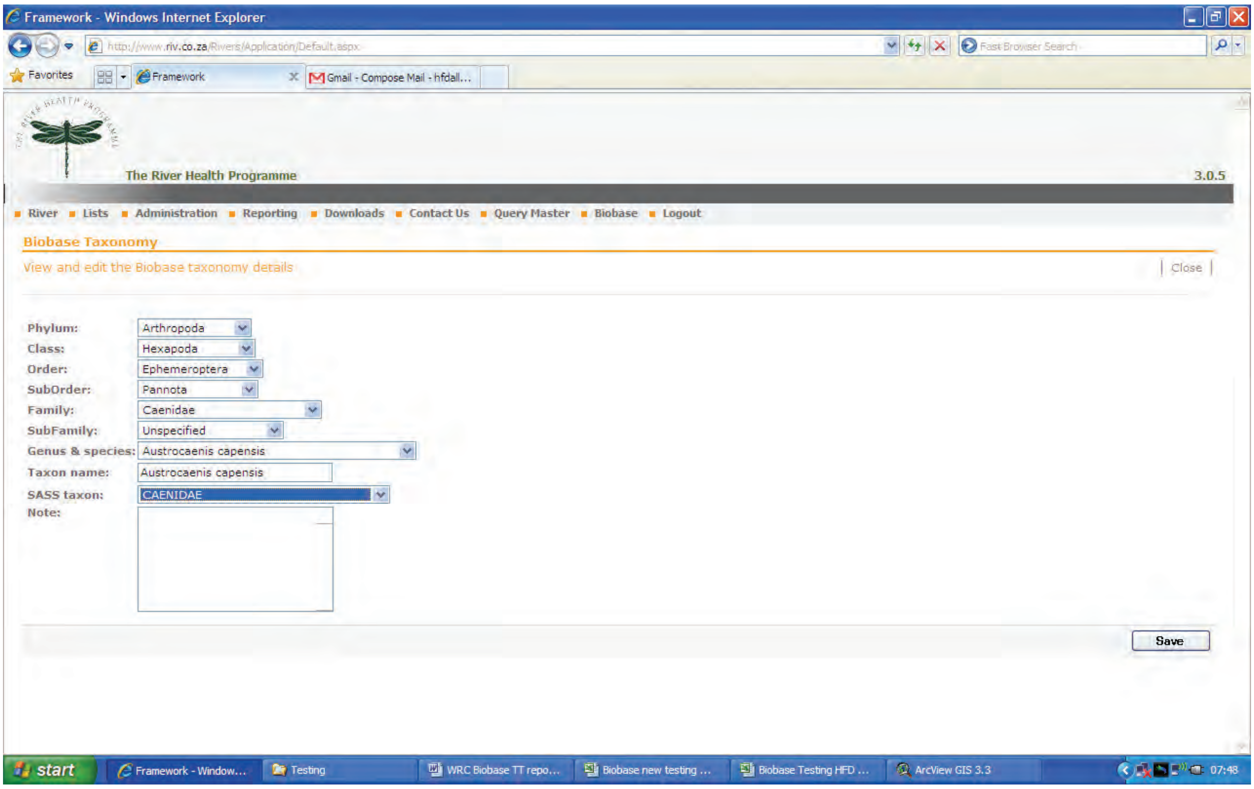
Screen 10



2.4 Study references

Existing study references in the Biobase may be viewed using the filters and drop-down lists to select the site (Screen 12). Selection may be based on Site Code, River, Longitudinal Zone, Ecoregion level I, Ecoregion level II, Bioregion, Political region or Water Chemistry Management region. The author, year, title and source (journal/report etc) details are given for each study in the database (see Appendices A and B for details). Study references are numerically coded and linked to both the biological and physico-chemical data. Details of the sites for which biological and physico-chemical data have been collected for each study reference may be viewed using "*Site Visits (Chemistry)*" and "*Site Visits (Biology)*" in the Biological and Physico-chemical data.

Screen 11



Screen 12

3 QUERYING THE DATA (QUERY MASTER)

The Query Master is accessed via the Biobase on the Rivers menu bar by selecting “Query Master – Biobase”. The Query Master is an HTML application, which allows the user to construct user-defined queries by combining the available attributes (fields) of registered data components (pre-defined queries). These can be sorted and filtered to control the data that is returned by the query. The Query Master is designed to filter the dataset using set criteria so that the raw data required can be copied to a spreadsheet (such as MS Excel) for further analyses. **Note** for biological data only taxa PRESENT at a site are returned.

3.1 Basic structure of the Query Master

The Query Master consists of five main screens, each with a header that provides a description of the steps that should be followed to select data components and filter data. These forms are:

3.1.1 Primary Data Component Selection (Screen 13)

This allows the selection of one of the primary data components that group primary data relevant to specific query requirements. The “Description” field indicates the type of information that can be accessed by a specific component and the “Data Category” field indicates the source of the information within the Biobase. There are four primary components, including “Biological data by site”, “Biological data by biotope”, “Physico-chemical data”, and “Physico-chemical data linked to Biological data”. Only one Primary Data Component is selected for a specific query.

3.1.2 Secondary Data Component (Combine Components) (Screen 14)

This allows the selection of additional Secondary Data Components to combine with the Primary Data Component previously selected on the "Primary Component Screen". There are two to three secondary components linked to each Primary component.

3.1.3 Field Selection (Screen 15)

This contains a list of the available fields that can be used in a query for filtering and displaying.

3.1.4 Define Filter Criteria (Screen 16 and 17)

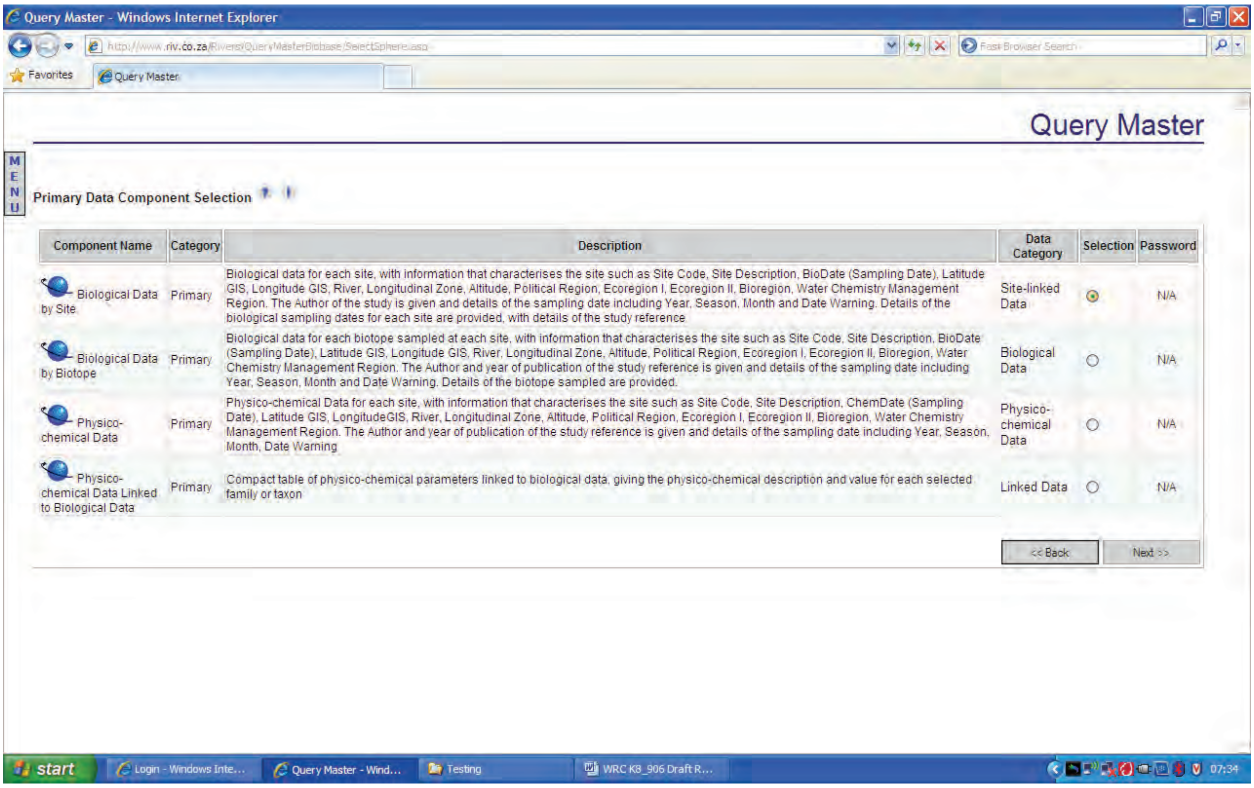
This allows the user to define criteria for filtering the data. It includes a screen, which permits the selection of values or items that are already in the database.

3.1.5 Display report (Screen 18)

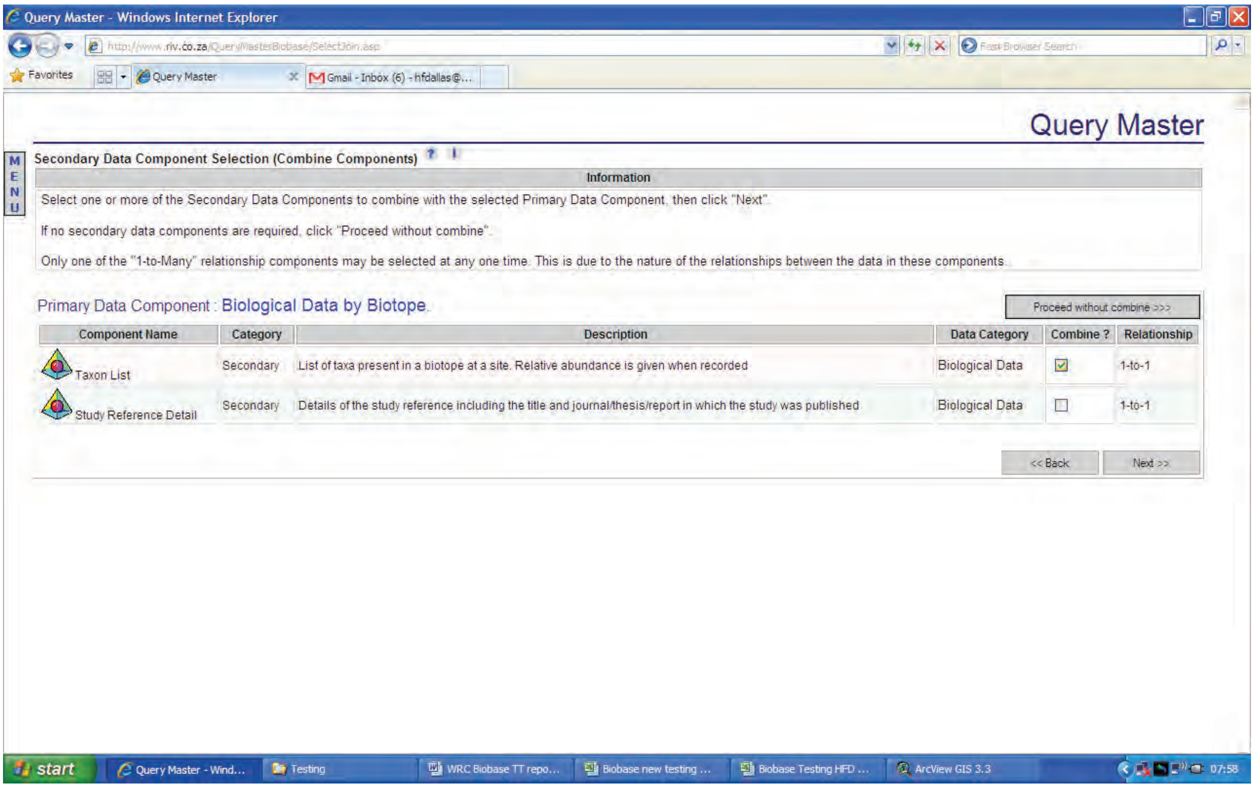
This displays the results of the query. Results are easily exported to excel using the Menu Bar.

These screens can be accessed via the Menu bar on the left of each screen under “Go to” with the same names. The full Menu bar “pops out” when the cursor is moved over the bar. Additional guidance and descriptions of the process may be viewed by clicking on the icon next to the various headings.

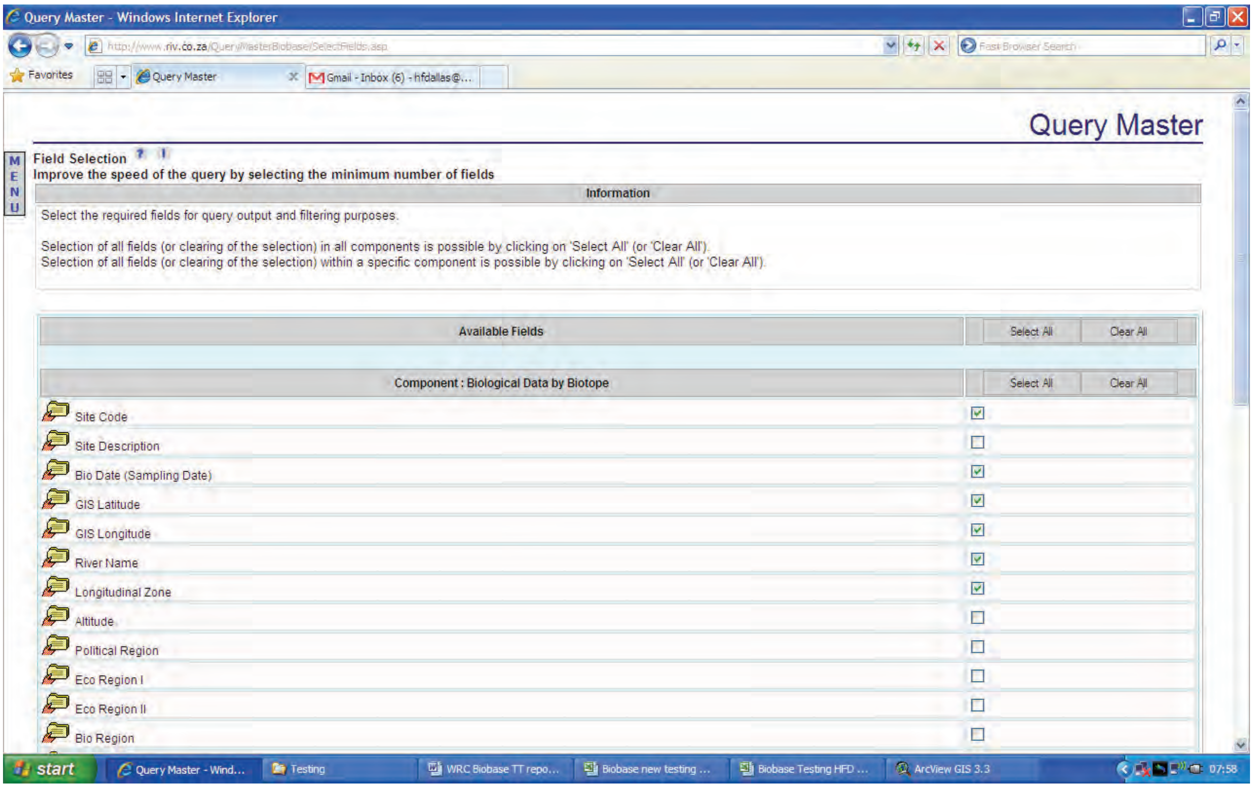
Screen 13



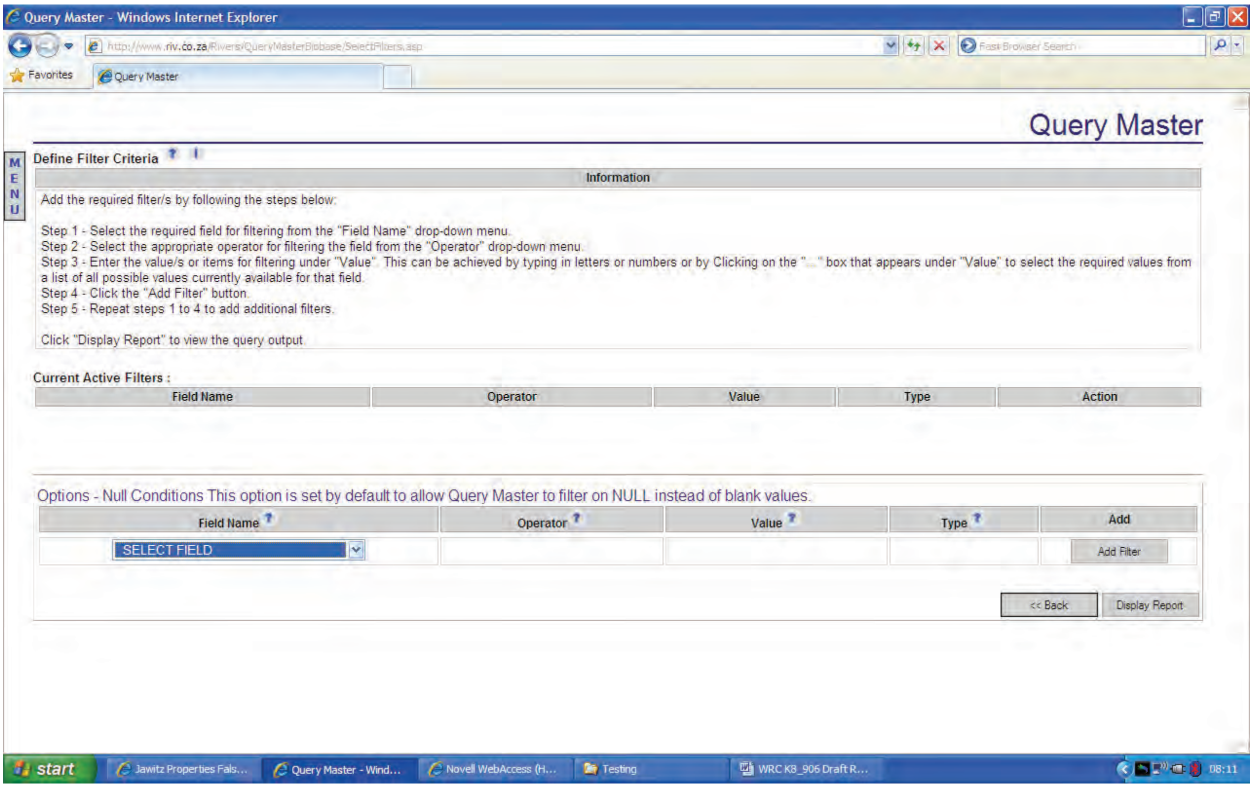
Screen 14



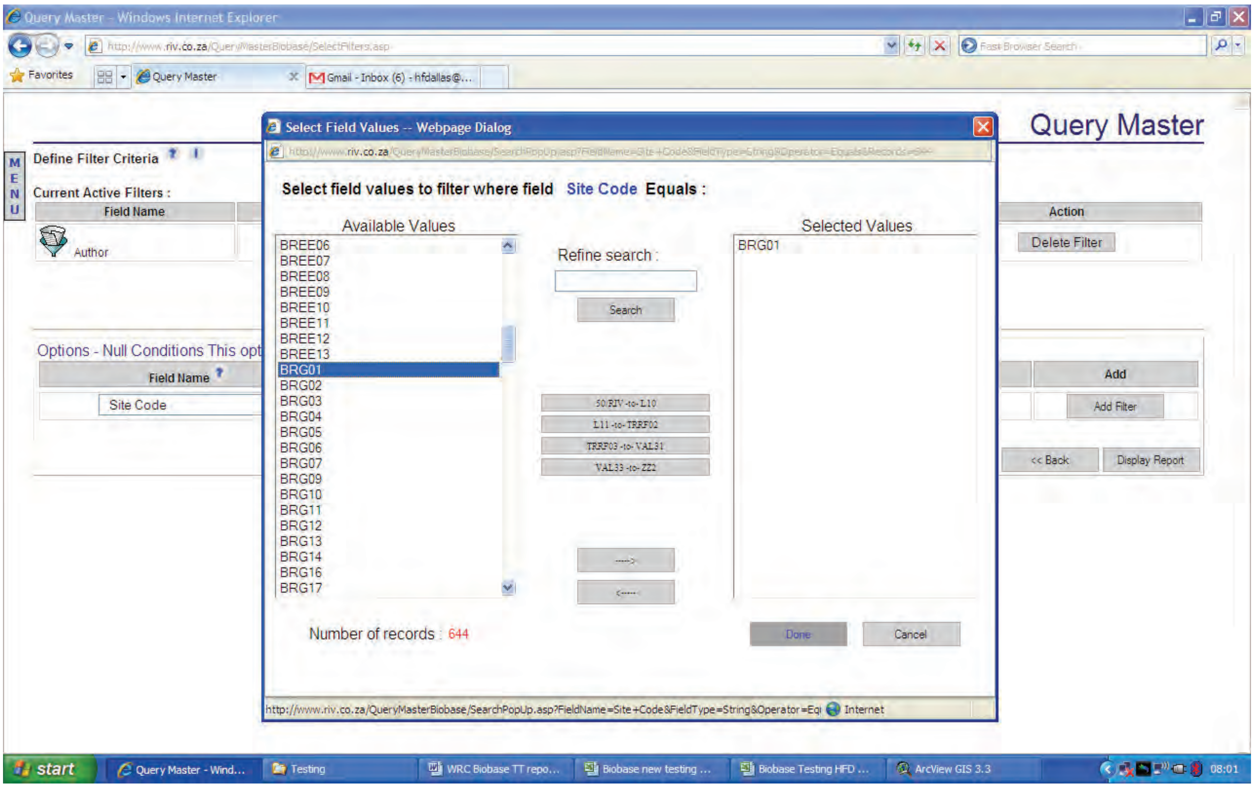
Screen 15



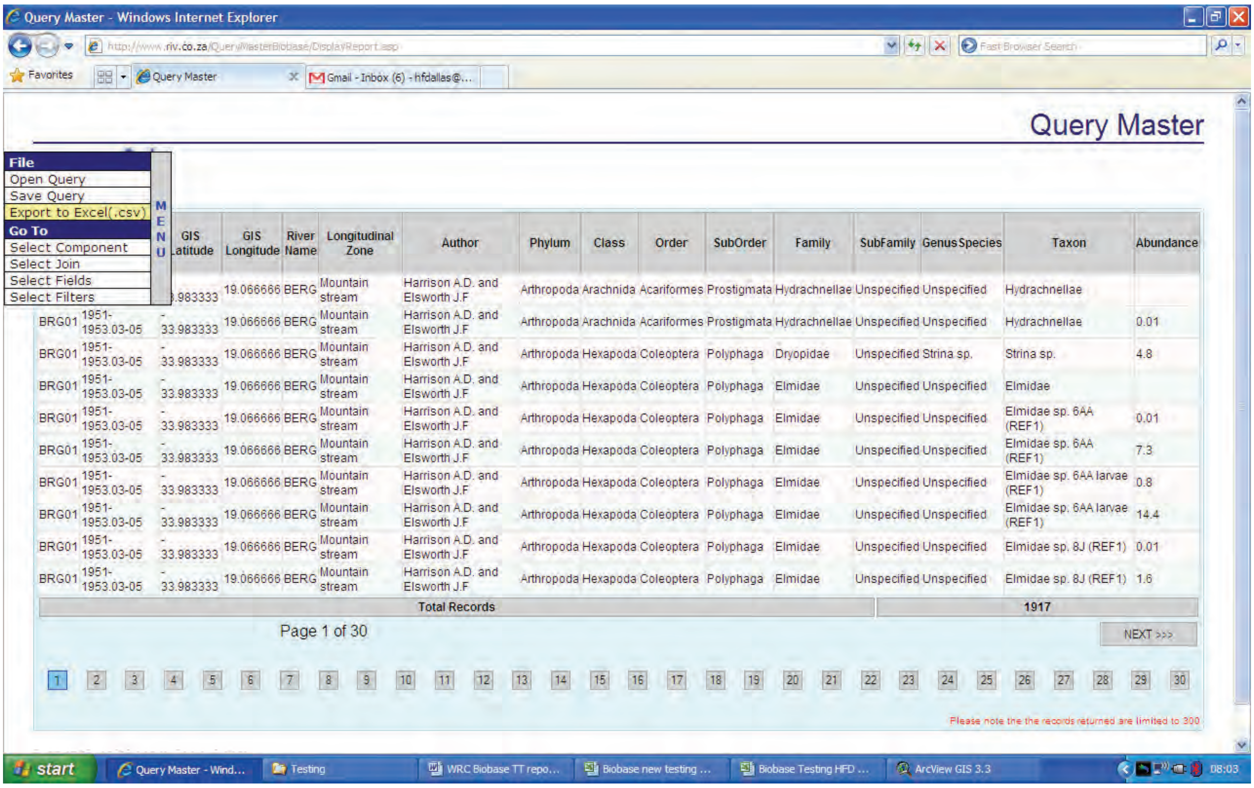
Screen 16



Screen 17



Screen 18



3.2 Step-by-step instructions on using the Query Master

The Query Master may be accessed via “Biobase” on the menu bar of the Rivers Database website.

3.2.1 Creating a new query:

In the “Primary Data Component Selection” screen (Screen 13):

- Select one of the four pre-defined Primary Data Components that contain the primary fields that are relevant to a specific query. For example, to return biological data for taxa per biotope, select “Biological Data by Biotope”.
- Use the description field to guide the selection of the most appropriate Primary Data Component.
- Click on “Next” to proceed to the “Secondary Data Components (Combine Components) screen.

In the “Secondary Data Components (Combine Components)” screen (Screen 4):

- Select one or more Secondary Data Components. Note: Because of the nature of the relationships between data in different tables, only one of the "one-to-many" relationship components can be selected at a time.
- Use the description field to guide the selection of the most appropriate Secondary Data Component.
- Should all the required fields be contained within the Primary Data Components, then select the “proceed without combine” button to continue without combining any Secondary Data Components.
- If Secondary Data Components have been combined, then click “next” to continue to the “Field Selection” screen or “back” to return to the previous screen.

In the “Field Selection” screen (Screen 15):

- Select the fields that are desired for filtering or querying. These are listed according to the respective data components previously selected. “Select all” and “Clear all” are used to select or clear all the displayed fields respectively. Alternatively, the individual fields can be selected by ticking the appropriate boxes.
- If no filtering of data is required, then click “Display report” to return the query results.

In the “Define Filter Criteria” screen (Screen 16 and 17):

- Add the required filter/s by following the steps below:
- Select a field from the "Field Name" drop-down menu.
- Select the appropriate operator (see section 2.3.3) for filtering the field from the "Operator" drop-down menu.
- Enter the value/s or items for filtering from the “Values” column according to the operator that has been selected. This can be achieved by simply typing in letters or numbers or by clicking on the “….” box that appears under “Value”. This opens a

list of all items/values already entered into the database. Select the required values or items that appear in the “available fields” box on the left of the screen. Click the right arrow button or double click on these values or items to move them to the “selected fields” box on the right hand side of the screen. Click “done” to return to the “Define Filter Criteria”.

- Click the "Add Filter" button. To add additional filters, repeat the steps outlined above.
- To delete a filter click the corresponding "Delete" button.
- Click “next” to continue to the “Display Report” screen or “back” to return to the previous screen.

In the “Query Output” Screen (Screen 18):

- The final screen displays the query result as specified in the filtering criteria previously selected. The query can be:
- saved by clicking the “save query” button available under “file” in the menu to the left of the screen and then accessed via the “open query” button at a later stage, or
- exported to Excel as a CSV file, click “Export to Excel (csv) under “File” in the menu to the left of the screen. (Hint: it is better to select “Save As” rather than “Open”.)

3.2.2 Setting criteria

Below is a short explanation of the different operators that can be used to set criteria:

Equals	This key is used to select only one value or item to return records for a single value or item. For example, if “River Name” “Equals” ‘Berg’ is selected, then only records for the Berg River are returned. Compare with the operator “In”. [1: Number; 2: a string (text), a single letter]
Not Equals	This key is used to exclude a single value or item from the list of those records returned. For example, if “River Name” “not equals” ‘Berg’ is selected, then all records for all rivers are returned, excluding those associated with the Berg River. Compare with the operator “Not In”.
In	This key is used when searching for more than one item. For example, if “River Name” “In” ‘Berg’, ‘Eerste’, ‘Olifants’ is selected, then all records for these 3 rivers are returned. Compare with the operator “Equals”.
Not In	This key is used to exclude several values or items. For example, if “River Name” “not in” ‘Berg’, ‘Eerste’, ‘Olifants’ is selected, then all rivers are returned, excluding those associated with these 3 rivers. Compare with the operator “Not Equals”.
Greater Than	This key is used to return all records where the specified field has values greater than a specified value. For example, if “Chem value” “Greater than” ‘5’ is selected, then all records where the specified chemistry code has values greater than 5 will be returned.

Less Than	This key is used to return all records where the specified field has values less than a specified value. For example, if “Chem value” “less than” ‘5’ is selected, then all records where the specified chemistry code has values less than 5 will be returned.
Greater Than Equal to	This key is used to return all records where the specified field has values equal to or greater than a specified value. For example, if “Chem value” “Greater Than Equal To” ‘5’ is selected, then all records where the specified chemistry code has values equal to or greater than 5 will be returned.
Less Than Equal to	This key is used to return all records where the specified field has values equal to or less than a specified value. For example, if “Chem value” “Less Than Equal To” ‘5’ is selected, then all records where the specified chemistry code has values equal to or less than 5 will be returned.
Starts With	This key can be used to select all items that start with a specified item or value. For example, if “River Name” “Starts With” ‘B’ is selected, then all rivers (and associated records) that start with the letter B will be returned. Filtering can be further refined by selecting more letters or values. For example, if “River Name” “Starts With” ‘Brak’ is selected, instead of selecting just ‘B’, then all rivers (and associated records) that start with ‘Brak’ will be returned.
Ends With	This key can be used to select all items that end with a specified item or value. For example, if “River Name” “Ends With” ‘E’ is selected, then all rivers (and associated records) that end with the letter E will be returned. Filtering can be further refined by selecting more letters or values. For example, if “River Name” “Ends With” ‘tjie’ is selected, instead of selecting just ‘E’, then all rivers (and associated records) that end with ‘tjie’ will be returned.
Containing	This key works in the same way as “Starts With” and “Ends With” with the exception that all records for a given field that contain a specified item or value will be returned. For example, if “River Name” “Containing” ‘B’ is selected, then all rivers (and associated records) that contain the letter ‘B’ in the name will be returned, regardless of where in the name the letter occurs.

4 USES AND LIMITATIONS OF THE DATABASE

4.1 Deducing ranges of different physico-chemical parameters, for different taxa

Deducing ranges of different physico-chemical parameters, for different taxa, was the purpose for which the database was originally designed. Whilst the data does not lend itself to correlative analyses due to inconsistencies in the range and thoroughness of physico-chemical measurements (Dallas et al., 1999), descriptive information may be derived on which biological taxa are found, and under what conditions. An example of the kinds of results which queries of physico-chemical and biological data may produce is given in Dallas et al. (1999).

They caution however that there are a number of problems inherent in such a manipulation, most of which are concerned with difficulties with the data themselves.

The range of a particular chemical variable associated with a taxon, is only the recorded range at which the particular group of organisms has been found. It is not a measure of actual tolerance ranges, since these organisms may well survive in conditions outside of these ranges, but such zones have either never been sampled, or the animals, while they may never have been exposed to these ranges in natural systems, would nonetheless be quite capable of surviving there. Thus if the recorded ranges are used to gauge tolerance, the values obtained will probably err on the conservative side. Antagonistic or synergistic effects of different chemical variables are not taken into account and these data cannot provide any satisfactory indication of cause and effect in terms of water quality variables and taxon distributions. For example, the cause of a taxon's absence at a site may be due to an event such as an oil spill, which is not recorded in the database but which will, nonetheless, have a profound effect on biotic communities. This problem can, to some extent, be circumvented by including such details in the site descriptions. The onus is then on the user to exercise both caution and discretion in interpreting the results provided by an interrogation of the database. Unfortunately, however, such information is not always available in the literature. At times, for example, critical chemical variables such as heavy metals, which are expensive to analyze, have not been measured.

Further, they caution that "temporal changes in water conditions are not taken into account in the recorded tolerance ranges. Samples of both physico-chemical and biota represent 'snapshot' or instantaneous pictures of an ecosystem, and the mere fact that a taxon appears to be present under certain conditions does not mean that it is unaffected in the long term by such conditions. Water conditions at that time may indicate short-term 'flushes' of a certain variable; a recent change to which the biota have not yet responded; a past effect from which they have not yet recovered; or a condition under which they really feel no ill effects at all. Recorded tolerance ranges of different taxa to different variables derived from the database should therefore be used with caution and the problems outlined above should be taken into consideration".

4.2 Assessing changes in community structure, using historical records

The true strength of the database probably lies in assessing changes in community structure, using historical records, for it provides an excellent record of biological and physico-chemical data at particular sites, at specific times in the past. In some cases, these records reflect conditions as close to pristine as we are ever likely to be able to record. Pristine or not, they do provide a means of tracking community and water quality changes over time. The Berg River data-set is a good example of this where data from 1951 to 1953 are available for comparison with those of 1978, as well as 1992 and 1993. Once again, as cautioned by Dallas et al. (1999) there are some potential pitfalls that ought to be brought to the attention of would-be users. The chief of these is that sampling and analytical methods are not always directly comparable in different studies, particularly those that are separated by long periods of time, during which technical innovations have been made. In addition, as has already been mentioned, the taxonomy of many species is subject to frequent changes.

4.3 Biotope preferences of specific taxa

It has often been observed that certain taxa are more commonly found in one biotope than another, although this has seldom been shown quantitatively in South African rivers (e.g. Palmer et al., 1991; Dallas, 2007). An analysis of taxa found in different biotopes will give some indication of their biotope preferences. Such information would be of great value, for example when interpreting SASS scores and determining the environmental flow requirements of different taxa in relation to biotopes at a site. The inconsistent terminology and methodology with respect to biotope-data reported means that interrogations are most meaningful at upper levels of the hierarchy (i.e. at the levels of stones-in-current and marginal vegetation, for example) and less reliable at lower levels.

4.4 Assessment of water quality guidelines and ecological Reserve determinations

Data extracted from the previous version of the Biobase have been used in the assessment of water quality guidelines (e.g. Malan and Day 2002) and several ecological Reserve determinations. The Biobase should continue to provide a useful resource of both biological and physico-chemical data for future Reserve determinations.

4.5 Determination of macroinvertebrate reference conditions

The historical nature of much of the biological data in the Biobase makes it a useful resource for establishing the ecological reference conditions of a particular site, river or river type. Since a reference site represents the “least impacted” condition, historical data may provide insight as to the macroinvertebrate assemblages present in the past. This information may then be used in conjunction with data from current reference sites to derive a reference condition for a suite of sites, representative of a particular river type.

4.6 Development of conservation targets

Data extracted from the Biobase have been used to assess patterns of alpha, beta and gamma diversity patterns in river systems with the aim of developing conservation targets (Rivers-Moore, pers. Comm. WRC project K5/1796, Deriving conservation targets for Freshwater systems).

4.7 Geographical distribution of taxa

Users have the option to include a georeference with the extracted data. This data may then be viewed in geographical information systems (GIS) and maps may be produced from records. The exact utility of this may lie in displaying the taxon distributions and in ascertaining geographical regions where rivers have not been sampled.

5 CONCLUSIONS

The database, which collates a vast amount of information pertaining to riverine macroinvertebrates and water chemistry, has several useful applications if used with the awareness of the problems outlined in this report. In establishing this database, one of the problems encountered, that was both difficult to resolve, and unnecessary, was that caused by the lack of consistency in the way in which different authors present their data. Frequently, useful data are lost, merely because they cannot be compared with others. The data captured in the Biobase includes most of the biological data on macroinvertebrates prior to 1998. Since then numerous studies have been undertaken and a wealth of data exists. It would be highly advantageous to incorporate this data into the Biobase.

6 RECOMMENDATIONS

One of the more important recommendations to emerge from this area of work is that future biological and chemical collections should conform to the standard units of physico-chemical measurements as described in this User Manual and that for biological data details of proportional abundance, as well as factors such as biotope type, should be provided. In addition, the actual dates on which both biological and physico-chemical data were collected should be available for reference, where they are not actually presented in published reports. Preferably an electronic copy of all data, in its original form should be lodged with a responsible organisation such as the Water research Commission. It is recommended that funding be sort to enable data from studies undertaken after 1998, as well as those prior to 1998 that are not yet in the Biobase, to be captured into the Biobase.

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Appendix B. Details of the biological and physico-chemical data for each study reference

STUDY REFERENCE: 1

RIVER	GREAT BERG RIVER
REFERENCE	HARRISON A.D. & ELSWORTH J.F 1958. HYDROBIOLOGICAL STUDIES OF THE GREAT BERG RIVER, WESTERN CAPE PROVINCE. PART 1. GENERAL DESCRIPTION, CHEMICAL STUDIES AND MAIN FEATURES OF THE FLORA AND FAUNA. TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AFRICA. VOL. 35. PART 3. PP.125-226.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	in stickles and runs	Surber sampler or hand net
	in stickle	Surber sampler or hand net
	in cascade/torrent	hand net
	in backwaters	hand net
B) vegetation:	marginal vegetation	hand net
	stream bottom vegetation	hand net
C) sediment:	sandy bottom	Birge-Ekman grab sampler
	muddy bottom	Birge-Ekman grab sampler

Mesh size » 950 µm. All sites were sampled monthly for approximately 1.5 years (May 1951 to December 1952). Animal associations from each biotope were grouped seasonally and are represented as mean percentage per season for the whole sampling period. Spring=September, October, November; Summer=December, January, February; Autumn=March, April, May; Winter=June, July, August. Thirteen sites were sampled.

CHEMICAL DATA

The results of analyses of samples collected monthly over 2.5 years have been grouped together seasonally by year. Mean, minimum and maximum values are frequently given. The following variables are reported:

- temperature (TEMP): mean, minimum and maximum (in °C), measured on a daily basis for all stations except BERG1,13,14,16,18,19, which were measured monthly
- pH (PH), measured using a Beckman pH probe (mean, max and min values given)
- conductivity (COND): measured with a Dionic water tester reading in micromhos. Values converted to mS m^{-1} at 25°C (mean, max and min values given)
- total dissolved solids (TDS), in mg ℓ^{-1} (mean, max and min values given)
- dissolved oxygen % saturation (DOPER) in % (mean values given)
- Biological Oxygen Demand (BOD), 5-day measured in mg ℓ^{-1} (mean values given)
- albuminoid ammonia, equivalent to Kjeldahl nitrogen (J.F. Elsworth, pers. comm.), (KJN) in mg ℓ^{-} (mean values given)
- ammonia nitrogen (NH4-N), in mg ℓ^{-1} (mean values given)
- nitrite (NO2-N), in mg ℓ^{-1} (mean and max values given)
- nitrate (NO3-N), in mg ℓ^{-1} (mean values given)
- phosphate: equivalent to soluble reactive phosphate (SRP), in mg ℓ^{-1} (mean values given)
- total alkalinity (TAL): in mg ℓ^{-1} converted to meq ℓ^{-1} (mean, max and min values given)
- total hardness (CACO3): in mg ℓ^{-1} (mean, max and min values given)
- calcium (CA), magnesium (MG), sulphate (SO_4), silicate (SI), iron (FE): only extreme minimum and maximum values in mg ℓ^{-1} over the whole period were published.
- chloride (CL), and iron (FE): in mg ℓ^{-1}, published as a seasonal mean, minimum and maximum for most sites
- colour (COL): in A.P.H.A. units (mean, max and min values given)
- turbidity (TURB): in mg ℓ^{-1} SiO_2 (mean, max and min values given)

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data for each site has been linked with the chemical data collected during the same time period. Since the biological data is not divided into years, there are often more than one set of chemical data per biological data set. The chemical data is recorded per zone and thus each chemical data set may encompass more than one site within each zone.

STUDY REFERENCE: 2

RIVERS	PRINCIPLE RIVERS OF SOUTHERN NATAL (UMKOMAAS RIVER CATCHMENT AND RIVERS SOUTH TO MTAMVUMA)
REFERENCE	KEMP P.H., CHUTTER F.M. & COETZEE D.J. 1976. WATER QUALITY AND ABATEMENT OF POLLUTION IN NATAL RIVERS. PART V. THE RIVERS OF SOUTHERN NATAL. NATIONAL INSTITUTE FOR WATER RESEARCH, CSIR AND THE TOWN AND REGIONAL PLANNING COMMISSION REPORT.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	Surber sampler or hand net
	stone-out-of-current	hand net
	cascades/waterfall	hand net
B) vegetation:	marginal vegetation	hand net (2-3m sweep)
	aquatic vegetation	hand net
C) sediment:	mixed	corer (5/sample)

Mesh size = 300 µm. All sites were sampled once in June 1972. The number of individuals of each taxon are expressed as a percentage of the total number of animals found in a sample.

CHEMICAL DATA

Water samples for chemical analysis were collected between 1968 and 1971. Values given are the means expressed as rainy and dry season values. The latter is reported in the database as this is the period during which benthic collections were undertaken. The following variables were measured:

- temperature (TEMP), mean (in °C)
- pH (PH)
- conductivity (COND), mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- dissolved oxygen, (DO) mg ℓ^{-1}
- dissolved oxygen % saturation (DOPER) in %
- Biological Oxygen Demand (BOD): 5-day measured in mg ℓ^{-1}
- Kjeldahl nitrogen (KJN), in mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- phosphate, mg ℓ^{-1} assumed equivalent to soluble reactive phosphorus (SRP)
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), magnesium (MG), sulphate (SO_4), sodium, (NA), potassium (K), chloride (CL) and fluoride (F), all in mg ℓ^{-1}
- Free carbonic acid, as mg ℓ^{-1} CO_2 (FREE CO2)

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data for each site [sampled in June (WINTER) 1973] has been linked with the chemical data for the dry season.

STUDY REFERENCE: 3

RIVERS	ASSEGAAIBOSCH STREAM, KUILS RIVER, SOUT RIVER
REFERENCE	HARRISON A.D. 1958a. HYDROBIOLOGICAL STUDIES OF THE GREAT BERG RIVER, WESTERN CAPE PROVINCE. PART 2. QUANTITATIVE STUDIES ON SANDY BOTTOMS, NOTES ON TRIBUTARIES AND FURTHER INFORMATION ON THE FAUNA, ARRANGED SYSTEMATICALLY. TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AFRICA. VOL. 35. PART 2. PP.227-276.

BIOLOGICAL DATA

River:	Biotopes sampled:	Sampling devices:
Assegaaibosch	stony bottom in stickles (riffle)	hand net
Kuils	stony bottom in stickles (riffle)	hand net
Sout	marginal vegetation	hand net
Berg	mixed biotopes	Surber sampler or handnet

Mesh size » 950 µm

Assegaaibosch: Sampled monthly from June 1950 to August 1951. Animal associations were grouped seasonally and are represented as mean percentage per season for the whole sampling period. Spring=September, October, November; Summer=December, January, February; Autumn=March, April May; Winter=June, July, August.

Kuils: Temporary stream, sampled in October 1950, April (four weeks after it started flowing), July, October and November 1951 (after which it dried up).

Sout: Temporary stream, sampled in April (three weeks after it started flowing), June, August and October 1951 (after which it dried up).

Berg: Sampling as described in reference 1, since these data (which refer only to simuliid abundance) were obtained during the course of this study.

CHEMICAL DATA

Assegaaibosch: Water in this tributary was very similar to that at site 1 on the main Berg River (see study reference 1). Only temperature (°C), pH and TDS (in mg ℓ^{-1}) are published. All values were one-off measurements.

Kuils & Sout: All values were one-off measurements taken on a single day. The following variables were measured:

- temperature (in °C)
- pH (measured using a Beckman pH probe)
- conductivity (measured with a Dionic water tester reading in micromhos, values converted to mS m^{-1} at 25°C)
- total dissolved solids (TDS) (in mg ℓ^{-1})
- total alkalinity (TAL), as $CaCO_3$ in mg ℓ^{-1} and converted to meq ℓ^{-1})
- total hardness (CACO3), (as $CaCo_3$ in mg ℓ^{-1})
- sulphate (SO4), chloride (CL) and turbidity (TURB) (mg ℓ^{-1} SiO_2)

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological data for each site is linked with the chemical data collected during the same time period.

STUDY REFERENCE: 4

RIVERS	CROCODILE, SABIE, OLIFANTS, LETABA, LUVUVHU AND MUTALE RIVERS IN THE KRUGER NATIONAL PARK, EASTERN TRANSVAAL.
REFERENCE	MOORE C.A. & CHUTTER F.M. 1988. A SURVEY OF THE CONSERVATION STATUS AND BENTHIC BIOTA OF THE MAJOR RIVERS OF THE KRUGER NATIONAL PARK. CSIR AND NIWR CONTRACT REPORT, PRETORIA.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current (riffle)	hand net (kick sampling)
	stone-out-of-current	hand net (kick sampling)
B) vegetation:	marginal, trailing and emergent vegetation sampled together	hand net
C) sediment:	including diatom growth on rocks and sand, fine sediment on sand or bedrock, and sand	hand net

Mesh size = 300 µm. Sampling months varied between sites, but generally included all or some of the following months: April 1985, June 1985, September 1985, November 1985, January 1986, April 1986, June 1986, August 1986 and October 1986.

CHEMICAL DATA

Chemical data was collected by the Hydrological Research Institute at their routine monitoring sites from October 1983 to October 1986. Mean values were calculated for each monitoring site and were expressed by season: dry winter (April to September) and wet summer (October to March). The following variables were reported:

- pH (PH)
- conductivity (COND), mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- Kjeldahl nitrogen (KJN), in mg ℓ^{-1}
- nitrate + nitrite (NO2+NO3), mg ℓ^{-1}
- total phosphorous (TOT-P), mg ℓ^{-1}
- total dissolved phosphorous (SRP), mg ℓ^{-1}
- ammonium (NH4-N), in mg ℓ^{-1}
- calcium (CA), magnesium (MG), sulphate (SO4), sodium, (NA), potassium (K), chloride (CL) and fluoride (F), silica (SI); all in mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Using the latitude and longitude co-ordinates biological sites were matched with HRI chemical sites. Biological dates were linked with the appropriate winter or summer season chemical date.

STUDY REFERENCE: 5

RIVERS	JUKSKEI-CROCODILE RIVER SYSTEM
REFERENCE	WILKINSON R.C. 1979. THE INDICATOR VALUE OF THE STONES-IN-CURRENT FAUNA OF THE JUKSKEI-CROCODILE RIVER SYSTEM, TRANSVAAL, SOUTH AFRICA. UNPUBLISHED M.SC. THESIS, UNIVERSITY OF PRETORIA, SOUTH AFRICA.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stone-in-current	Surber sampler

Mesh size = 250 µm. 18 sites were sampled monthly from March 1972 until February 1974.

CHEMICAL DATA

Chemical samples were taken monthly from March 1972 until February 1974. All chemical analyses were done on filtered samples by the National Institute for Water Research (NIWR) based on Standard Methods for the Examination of Water and Waste Water (1971). The following variables are reported in the document. The relevant details in terms of conversions and assumptions are reported.

- conductivity (COND): No units were given in the document. By calculation of TDS and conversion into conductivity, it was calculated to be in µS cm^{-1}. These were then converted to mS m^{-1}.
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- chemical oxygen demand (COD), mg ℓ^{-1}
- total inorganic carbon (TIC), mg ℓ^{-1}
- total organic carbon (TOC), mg ℓ^{-1}
- dissolved inorganic nitrogen (DIN), mg ℓ^{-1}
- dissolved organic nitrogen (DON), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonia nitrogen (NH4-N), mg ℓ^{-1}
- total phosphorous (TOT-P), mg ℓ^{-1}
- PO_4-P, assumed equivalent to soluble reactive phosphorus (SRP), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched on a monthly basis.

STUDY REFERENCE: 6

RIVERS	RIVERS OF NEWCASTLE AND LADYSMITH AREA, NATAL
REFERENCE	FOWLES B.K., BUTLER A.C., BROWN H.M., KEMP P.H., COETZEE O.J. & METZ H. 1979. WATER QUALITY AND ABATEMENT OF POLLUTION IN NATAL RIVERS. PART VII. SPECIAL STUDIES IN THE RAPIDLY DEVELOPING AREAS OF NEWCASTLE AND LADYSMITH. NATAL TOWN AND REGIONAL PLANNING COMMISSION.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	hand net
B) vegetation:	marginal vegetation	hand net (1-4m sweep)

Mesh size = 300 µm. One sample per biotope was taken each month.

CHEMICAL DATA

Water samples for chemical analysis were collected monthly between February 1975 and January 1976. The standard analytical methods of the National Institute for Water Research were used. The following variables were measured:

- temperature (TEMP), mean (in °C)
- pH (PH)
- conductivity (COND), mS m^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- dissolved oxygen % saturation (DOPER), %
- biological oxygen demand (BOD): 5-day measured in mg ℓ^{-1}
- Kjeldahl nitrogen (KJN), in mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- phosphate, mg ℓ^{-1}, assumed equivalent to soluble reactive phosphorus (SRP)
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), magnesium (MG), sulphate (SO4), chloride (CL), all in mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Monthly biological data for each site have been linked with the chemical data for the same month.

STUDY REFERENCE: 7

RIVERS	KUBUSI RIVER
REFERENCE	O'KEEFFE J.H. 1990. KUBUSI RIVER ECOLOGICAL ASSESSMENT. A PRELIMINARY ASSESSMENT OF THE KUBUSI RIVER AT WRIGGLESWADE, WITH RECOMMENDATIONS FOR THE OPERATION OF WRIGGLESWADE DAM SO AS TO MINIMISE ECOLOGICAL DISRUPTION DOWNSTREAM. UNPUBLISHED REPORT FOR THE DEPARTMENT OF WATER AFFAIRS.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stone-in-current	Box sampler (0.055 m^2)

Mesh size = 80 µm. Benthic samples were collected in May 1988 at 5 sites in a 45km stretch of the Kubusi River.

CHEMICAL DATA

A single set of chemical samples was taken in May 1988. The following variables are reported.

- conductivity (COND), mS m^{-1}
- pH (PH)
- total alkalinity (TAL), mg ℓ^{-1} and converted to meq ℓ^{-1}
- nitrite + nitrate (NO2+NO3), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- PO_4-P, assumed equivalent to soluble reactive phosphorus (SRP), in mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- turbidity (NTU), in NTUs
- total suspended solids (TSS), in mg ℓ^{-1}
- chlorophyll *a* (CHLA), in µg ℓ^{-1} and converted to mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 8

RIVER	YELLOWWOODS RIVER
REFERENCE	O'KEEFFE J.H. 1987. ECOLOGICAL IMPACTS OF AN INTERBASIN TRANSFER OF WATER TO THE YELLOWWOODS RIVER (EASTERN CAPE PROVINCE): A PRELIMINARY ASSESSMENT.

BIOLOGICAL DATA

The biotope sampled and the sampling device used was dependent on the amount of water which was extremely low at most sites.

Biotope sampled:		Sampling device:
A) stony bottom:	riffle (at sites 3, 6, 7)	Box sampler
	riffle (at site 1A, 2, 4)	sieve
	stone-out-of-current (at site 5)	sieve

Mesh size of the Box sampler was 80 µm, and of the sieve 1 mm. Benthic samples were collected in July 1987 at 7 sites.

CHEMICAL DATA

A single set of chemical samples (filtered water samples) was taken on 18 July 1987. The following variables are reported.

- temperature (TEMP), °C
- conductivity (COND), mS m^{-1}
- pH (PH)
- total dissolved solids (TDS), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} and converted to meq ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- ammonia (NH4-N), mg ℓ^{-1}
- PO_4, assumed equivalent to soluble reactive phosphorus (SRP), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- total suspended solids (TSS), in mg ℓ^{-1}
- % organics (%ORG IN TSS), %
- chlorophyll *a* (CHLA), in µg ℓ^{-1} and converted to mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 9

RIVERS	ORANGE FREE STATE RIVERS
REFERENCE	ANONYMOUS. 1966. HIDROCHEMIE VAN DIE BELANGRIKSTE VRYSTAATSE RIVIERE. NATIONALE INSTITUUT VIR WATERNAVORSING WETENSKAPLIKE EN NYWERHEIDNAVORSINGSRAAD. WNNR NAVORSINGSVERSLAG 252. PP1-179. PRETORIA.

BIOLOGICAL DATA

Biotopes sampled:		Sampling device:
A) stony bottom:	stone-in-current	Surber sampler or hand net
B) vegetation:	marginal vegetation	hand net

Mesh size 950 µm. Ten sites were sampled in April 1964 and one in October 1963. Species abundance was converted into percentages at each site where this was not done in the reference.

CHEMICAL DATA

Chemical samples were taken at nine sites in April 1964. The following variables are reported in the document. Any relevant conversion details and assumptions are detailed below.

- pH (PH)
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- biological oxygen demand (BOD, 5-day), mg ℓ^{-1}
- Kjeldahl-nitrogen (KJN), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- PO_4-P, assumed equivalent to soluble reactive phosphorus (SRP), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Chemical data from the nine sites were collected on the same date as the biological samples at the same sites. Direct matching was thus possible.

STUDY REFERENCE: 10

RIVER	MOOI RIVER
REFERENCE	O'KEEFFE J.H. 1989. REPORT OF AN INVESTIGATION OF WATER QUALITY IN THE UPPER MOOI RIVER. UNPUBLISHED REPORT OF THE INSTITUTE FOR FRESHWATER STUDIES, RHODES UNIVERSITY, GRAHAMSTOWN.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stone-in-current	Box sampler

Mesh size = 80 µm. Benthic samples were collected on 31 October 1989 from 6 sites.

CHEMICAL DATA

A single set of chemical samples was taken on 31 October 1989. The following variables are reported.

- water temperature (TEMP), °C
- conductivity (COND), mS m^{-1}
- pH (PH)
- total alkalinity (TAL), mg ℓ^{-1} and converted to meq ℓ^{-1}
- nitrite (NO2-N), in µmol ℓ^{-1} and converted to mg ℓ^{-1}
- nitrate (NO3-N), in µmol ℓ^{-1} and converted to mg ℓ^{-1}
- ammonium (NH4-N), in µmol ℓ^{-1} and converted to mg ℓ^{-1}
- PO_4, assumed equivalent to soluble reactive phosphorus (SRP), in µmol ℓ^{-1} and converted to mg ℓ^{-1}
- Percentage dissolved oxygen (DOPER), %
- chlorophyll *a* (CHLA), in µg ℓ^{-1} and converted to mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 11

RIVER	SWARTBOSKLOOF STREAM, SOUTH-WESTERN CAPE
REFERENCE	BRITTON D.L. 1990. A STUDY OF A CAPE MOUNTAIN STREAM ECOSYSTEM AND ITS RESPONSE TO FIRE. Ph.D THESIS, UNIVERSITY OF CAPE TOWN.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	riffle	Box sampler

Mesh size = 80 µm. Three samples were collected each month from Jan1986 until March 1988.

CHEMICAL DATA

The following variables were measured. The relevant details in terms of conversions and assumptions are reported.

- pH (PH)
- conductivity (COND), mS m^{-1}
- total alkalinity (TAL), given as mg ℓ^{-1} CO_3, converted to meq ℓ^{-1}
- total dissolved solid (TDS), mg ℓ^{-1}
- total suspended solid (TSS), mg ℓ^{-1}
- total organics (TORGS), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- nitrate (NO3-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- nitrite (NO2-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- ammonium (NH4-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- PO_4-P, assumed equivalent to soluble reactive phosphorus (SRP),in µmol ℓ^{-1}, converted to mg ℓ^{-1}
- Phenols (PHEN), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched on a monthly basis.

STUDY REFERENCE: 12

RIVER	BUFFALO RIVER, NATAL
REFERENCE	FOWLES, B.K. 1984A. SURVEY OF THE BUFFALO RIVER DURING ATYPICAL FLOW CONDITIONS. PART 111C. UNPUBLISHED NATIONAL ISTITUTE FOR WATER RESEARCH REPORT.

This study was undertaken to determine the biological and chemical characteristics of the Buffalo River and its tributaries *during extremely atypical drought conditions* (1 in 200-year drought).

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	Surber sampler
B) vegetation:	marginal vegetation	hand net
C) sediment:	mixed	Birge-Ekman grab sampler

Mesh size = 300 µm. Sites were sampled once in September 1983. The number of individuals of each taxon are expressed as a percentage of the total number of animals found in a sample.

CHEMICAL DATA

One-off water samples were collected at each site in September 1983. They were analysed using the standard analytical methods of the National Institute for Water Research. The following variables were measured:

- temperature (TEMP), °C)
- pH (PH)
- conductivity (COND), given as mS m^{-1} at 20°C and converted to mS m^{-1} at 25°C
- total suspended solids (TSS), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- dissolved oxygen % saturation (DOPER), %
- soluble reactive phosphorus (SRP), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- total phosphorus (filtered) (TOT-P), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- Kjeldahl nitrogen (filtered) (KJN), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- nitrate (NO3-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- nitrite (NO2-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- ammonia (NH4-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium, (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- soluble silica (SI), mg ℓ^{-1}
- iron (FE), µg ℓ^{-1} and converted to mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data and chemical data have been linked directly.

STUDY REFERENCE: 13

RIVERS	RIVERS OF THE TUGELA BASIN, NATAL
REFERENCE	FOWLES, B.K. 1984B. CHEMICAL AND BIOLOGICAL RESURVEY OF THE RIVERS OF THE TUGELA BASIN. PART IIIC. UNPUBLISHED NATIONAL INSTITUTE FOR WATER RESEARCH REPORT.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	Surber sampler

Mesh size = 300 µm. 16 sites were sampled in August 1984. The number of individuals of each taxon are expressed as a percentage of the total number of animals found in a sample.

CHEMICAL DATA

One-off water samples were collected at 10 sites in August 1984. They were analysed using the standard analytical methods of the National Institute for Water Research. The following variables were measured:

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), given as mS m^{-1} at 20°C and converted to mS m^{-1} at 25°C
- total dissolved solids (TDS), mg ℓ^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- dissolved oxygen % saturation (DOPER), %
- free carbon dioxide (FREE CO2), mg ℓ^{-1}
- soluble reactive phosphorus (SRP), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- total phosphorus (filtered) (TOT-P), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- Kjeldahl nitrogen (filtered) (KJN), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- dissolved organic nitrogen (DON), in mg ℓ^{-1}
- nitrate (NO3-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- nitrite (NO2-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- ammonia (NH4-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium, (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- soluble silica (SI), mg ℓ^{-1}
- iron (FE), µg ℓ^{-1} and converted to mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data and chemical data from the common sites have been linked directly.

STUDY REFERENCE: 14 AND 15

RIVER	SOUTH WESTERN CAPE RIVERS
REFERENCE	14: HARRISON A.D. & AGNEW J.D. 1962. THE DISTRIBUTION OF INVERTEBRATES ENDEMIC TO ACID STREAMS IN THE WESTERN AND SOUTHERN CAPE PROVINCE. ANN. CAPE PROV. MUS. II. SOUTH AFRICA, 273-291.
	15: HARRISON A.D. & AGNEW J.D. 1960. EXPLORATORY SURVEY OF EASTERN PART OF REGION A (SOUTH WESTERN CAPE) AND REGION B. NATIONAL INSTITUTE FOR WATER RESEARCH REPORT NO. 5 (PROJECT 6.8.H. REF W.6/6/8H.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	Surber sampler and hand net
	pools	Surber sampler and hand net
	stony backwaters	Surber sampler and hand net
B) vegetation:	marginal vegetation	hand net

Mesh size » 950 µm. Faunal samples were collected during March 1960.

CHEMICAL DATA

The primary aim of the study was to determine the relationship between the biota and pH. For this reason pH was recorded at all sites, whilst other chemical variables were only recorded at some of the sites. The following variables are reported:

- pH: mean (PH), max (PHMAX) and min (PHMIN) values measured using a Lovibond Comparator;
- total dissolved solids (TDS), in mg ℓ^{-1} (mean, max and min values given)
- total alkalinity (TAL): in mg ℓ^{-1} converted to meq ℓ^{-1}
- total hardness (CACO3): in mg ℓ^{-1}
- calcium (CA) in mg ℓ^{-1}; (mean, max and min values given)
- magnesium (MG) in mg ℓ^{-1} (mean, max and min values given)
- sodium (NA) in mg ℓ^{-1} (mean, max and min values given)
- potassium (K) in mg ℓ^{-1} (mean, max and min values given)
- sulphate (SO4) in mg ℓ^{-1} (mean, max and min values given)
- chloride (CL) in mg ℓ^{-1} (mean, max and min values given)

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological and chemical data were collected at the same time period and were therefore matched directly.

STUDY REFERENCE: 16

RIVER	SUNDAYS RIVER
REFERENCE	FORBES A.T. 1968. CONTRIBUTIONS TO THE ECOLOGY OF THE SUNDAYS RIVER. UNPUBLISHED M.SC THESIS, DEPARTMENT OF ZOOLOGY, RHODES UNIVERSITY.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	Surber sampler or hand net
	stone-out-of-current	Surber sampler or hand net
	slow flowing water	Surber sampler or hand net
	rapidly flowing water	Surber sampler or hand net
B) vegetation:	marginal vegetation	hand net
	vegetation in water	hand net

Mesh size = 900 µm. Faunal samples were taken in February and July 1967.

CHEMICAL DATA

Chemical samples were collected at the same time as faunal samples. The following variables were reported:

- pH
- total dissolved solids (TDS), mg ℓ^{-1}
- carbonate (CO3), mg ℓ^{-1}
- bicarbonate (HCO3), mg ℓ^{-1}
- total alkalinity (TAL), calculated by adding carbonate and bicarbonate concentrations (mg ℓ^{-1}), and converting to meq ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- phosphate taken to be equivalent to soluble reactive phosphorus (SRP), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 17

RIVER	GREAT FISH RIVER
REFERENCE	ALLANSON B.R. 1968. AN INTRODUCTORY NOTE ON THE CHEMISTRY AND BIOLOGY OF THE GREAT FISH RIVER. DIRECTOR'S REPORT, INSTITUTE FOR FRESHWATER STUDIES, RHODES UNIVERSITY.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stone-in-current	hand net (two to five samples)

Faunal samples were taken in July 1964 and February 1965. Animal abundances (%) were calculated from the raw data given.

CHEMICAL DATA

Chemical samples were collected at the same time as faunal samples. The following variables were reported:

- temperature (TEMP), °C
- pH (PH)
- total dissolved solids (TDS), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

NOTE: Data from this study are subsequently discussed and compared in the study: O'Keeffe J.H. & De Moor F.C. 1988. Changes in the physico-chemistry and benthic invertebrates of the Great Fish River, South Africa, following an interbasin transfer of water. *Regulated Rivers: research and management* 2: 39-55.

STUDY REFERENCE: 18

RIVER	GREAT FISH RIVER
REFERENCE	PALMER R.W. & O'KEEFFE J.H. 1990. DOWNSTREAM EFFECTS OF A SMALL IMPOUNDMENT ON A TURBID RIVER. ARCH. HYDROBIOL. 119 (4): 457-473.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stone-in-current	Box sampler

Mesh size = 80 µm. Three samples were collected during each sampling period.

CHEMICAL DATA

The following variables were measured. The relevant details in terms of conversions and assumptions are detailed.

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), mS m^{-1}
- total alkalinity (TAL), given as mg ℓ^{-1}, converted to meq ℓ^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- % organics in TSS (% ORG IN TSS), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- silica (SI), mg ℓ^{-1}
- nitrate (NO3-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- nitrite (NO2-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- ammonium (NH4-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- soluble reactive phosphate (SRP), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- turbidity (NTU), in NTUs
- chlorophyll *a* (CHLA), µg ℓ^{-1} converted to mg ℓ^{-1}
- particulate organic matter (POM), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched for each sampling period. NOTE: Data used are from the original raw datasheets, provided by the authors.

STUDY REFERENCE: 19

RIVER	BREEDE RIVER
REFERENCE	COETZER A.H. 1986. BENTHIC INVERTEBRATE COMMUNITIES AND THE BIOLOGICAL ASSESSMENT OF THE WATER QUALITY OF THE BREEDE RIVER DURING 1975 AND 1976. BONTEBOK 5: 42-51.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	hand net or Surber sampler

Mesh size = 290 µm. Qualitative macro-invertebrate sampling was carried out in the first week of March in 1975 and 1976.

CHEMICAL DATA

No chemical data were collected.

STUDY REFERENCE: 20

RIVERS	MOUNTAIN STREAMS OF THE BARBERTON AREA
REFERENCE	HUGHES D.A. 1966. MOUNTAIN STREAMS OF THE BARBETON AREA, EASTERN TRANSVAAL. PART 1, A SURVEY OF THE FAUNA. HYDROBIOLOGIA 27: 401-438. HUGHES D.A. 1966. MOUNTAIN STREAMS OF THE BARBERTON AREA, EASTERN TRANSVAAL. PART 2, THE EFFECT OF VEGETATIONAL SHADING AND DIRECT ILLUMINATION ON THE DISTRIBUTION OF STREAM FAUNA. HYDROBIOLOGIA 27: 439-459.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	cascades	cascade net
	spray flanking regions	round tin sampler
	stickles	Surber sampler
	backwaters	hand net
	pools	hand net

No mesh size given. Sampling was conducted in May and July 1961.

CHEMICAL DATA
No chemical data were collected.

STUDY REFERENCE: 21

RIVERS	SABIE AND GROOT-LETABA RIVERS
REFERENCE	O'KEEFFE J.H. 1985. THE CONSERVATION STATUS OF THE SABIE AND GROOT LETABA RIVERS WITHIN THE KRUGER NATIONAL PARK. SPECIAL REPORT NO. 85/2, INSTITUTE FOR FRESHWATER STUDIES, RHODES UNIVERSITY.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	hand net
	rock in current	scraping method
b) vegetation:	marginal vegetation	hand net

300 µm mesh size used. Sampling was conducted in January 1985.

CHEMICAL DATA

No chemical data were collected.

STUDY REFERENCE: 22

RIVERS	THREE RIVERS REGION
REFERENCE	BRAND P.A.J., KEMP P.H., PRETORIUS S.J. & SCHOONBEE H.J. 1967. WATER QUALITY AND ABATEMENT OF POLLUTION IN NATAL RIVERS. PART II. SURVEY OF THE THREE RIVERS REGION. NATIONAL INSTITUTE FOR WATER RESEARCH, CSIR AND THE TOWN AND REGIONAL PLANNING COMMISSION REPORT.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) vegetation:	marginal vegetation	hand net (2-3m sweep)
B) sediment:	mixed	corer (3/sample)

Mesh size = 300 µm. The survey commenced in 1962. All sites were sampled once, with the exception of a more intense survey program on the Umgeni River conducted from 1958 to 1962.

CHEMICAL DATA

Values given are the means expressed as a rainy and a dry season value. The latter is reported in the database as this is the period during which benthic collections were undertaken. In the Umgeni River, biological and chemical sampling were done at the same time, although the exact dates were not specified in the literature. The following variables were measured:

- temperature (TEMP), mean (in °C)
- pH (PH)
- conductivity (COND), micromhos, converted to mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- dissolved oxygen % saturation (DOPER), %
- biological oxygen demand (BOD): 5-day measured in mg ℓ^{-1}
- Kjeldahl nitrogen (KJN), in mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonia (NH4-N), mg ℓ^{-1}
- phosphate, mg ℓ^{-1} assumed equivalent to SRP
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- fluoride (F), mg ℓ^{-1}
- silica (SI), mg ℓ^{-1}
- iron (FE), mg ℓ^{-1}
- free carbonic acid (FREE CO2), as mg ℓ^{-1} CO_2
- turbidity (TURB), mg ℓ^{-1} silica scale
- colour (COL), APHA units

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data for each site (sampled in the dry season) has been linked with the chemical data for the dry season.

STUDY REFERENCE: 23

RIVER	VAAL RIVER
REFERENCE	CHUTTER F.M. 1963. HYDROBIOLOGICAL STUDIES ON THE VAAL RIVER IN THE VEREENIGING AREA. PART 1: INTRODUCTION, WATER CHEMISTRY AND BIOLOGICAL STUDIES ON THE FAUNA OF HABITATS OTHER THAN MUDDY BOTTOM SEDIMENTS. HYDROBIOLOGIA 21 (1/2): 1-65.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stony run	Surber sampler
	backwater	hand net
B) vegetation:	marginal vegetation	hand net
	aquatic weed	hand net

Mesh size » 950 µm. Sites were sampled monthly and data are given as the average percentage composition on a seasonal basis. The number of individuals of each taxon are expressed as a percentage of the total number of animals found in a sample. Rare species were recorded as being present or absent and given the value "0.01" in the database.

CHEMICAL DATA

Water samples for chemical analysis were collected monthly. Mean, minimum and maximum values are given on a seasonal basis. The following variables were measured:

- pH (PH)
- conductivity (COND), microhos at 20°C, converted to mS m^{-1} at 25°C
- total dissolved solids (TDS), mg ℓ^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonia (NH4-N), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}

Some variables were not detectable and these have been entered as 0.0001 mg ℓ^{-1}; others were found in trace amounts, entered as 0.0009 mg ℓ^{-1}.

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data for each site have been matched with the chemical data within the same or similar time period. Caution should be taken when using combined biological and chemical data.

STUDY REFERENCE: 24

RIVERS	GREAT BERG RIVER AND TRIBUTARIES
REFERENCE	SCOTT K.M.F. 1958. HYDROBIOLOGICAL STUDIES OF THE GREAT BERG RIVER, WESTERN CAPE PROVINCE. PART 3. THE CHIRONOMIDAE. TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AFRICA. VOL. 35. PART 3. PP.277-298.

BIOLOGICAL DATA

Biotopes sampled:	Sampling devices:
stone-in-current	hand net
backwater	hand net
marginal vegetation	hand net
pool	hand net
sandy bottom	hand net
mix of all biotopes	

Adult midges and larvae (bred out) were collected simultaneously to the main Berg River study (Harrison & Elsworth 1958, study reference No.1) from 1951 to 1953. Intensive collection sites included BRG3, BRG12, and BRG18; subsidiary sites: ASSEG1 (Assegaaibosch tributary), ASSEG2 (Assegaaibosch Kloof Waterfall), BRG1, BRG5, BRG10; and small collection sites: BRG4 (Franschhoek tributary), BRG6 (Wemmers tributary), BRG9, BRG13 and BRG21. Presence or absence only is recorded.

CHEMICAL DATA

Chemical data from some of the main Berg River sites may be matched with biological data from this study. However, the nature of the collections and the sampling periods make direct matching problematic. For this reason, no matching of biological and chemical data has been undertaken.

STUDY REFERENCE: 25

RIVERS	DWARS RIVER, KROM RIVER
REFERENCE	HARRISON A.D. 1958B. HYDROBIOLOGICAL STUDIES OF THE GREAT BERG RIVER, WESTERN CAPE PROVINCE. PART 4. THE EFFECTS OF ORGANIC POLLUTION ON THE FAUNA OF PARTS OF THE GREAT BERG RIVER SYSTEM AND OF THE KROM STREAM, STELLENBOSCH. VOL. 35. PART 3. PP.299-329.

BIOLOGICAL DATA

River:	Biotopes sampled:	Sampling devices:
Dwars River:	stony runs and stickles	hand net
Plankenbrug Stream:	stony runs and stickles	hand net
Krom River:	stony runs and stickles	hand net
	marginal vegetation	hand net

Mesh size » 950 µm. Biological samples were collected in February, July, September, November 1951 and January, March and April 1952 on the Dwars River (HAR5). The Plankenbrug Stream and Krom River were sampled monthly from August 1952 to January 1953 (sites HAR1 and HAR2) and April 1953 (HAR4).

CHEMICAL DATA

The following variables are reported:

- pH (PH), measured using a Beckman pH probe
- total dissolved solids (TDS), mg ℓ^{-1}
- total alkalinity (TAL): in mg ℓ^{-1} converted to meq ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- dissolved oxygen % saturation (DOPER), %
- biological oxygen demand (BOD), 5-day measured in mg ℓ^{-1}
- albuminoid ammonia, equivalent to Kjeldahl nitrogen (KJN) (Elsworth, pers. comm.), (KJN) in mg ℓ^{-1}
- ammonia nitrogen, equivalent to total ammonia (NH4-N), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- turbidity (TURB): mg ℓ^{-1} SiO_2

MATCHING BIOLOGICAL AND CHEMICAL DATA

"Spot" chemical samples were taken at the same time as biological samples. They are therefore matched directly.

STUDY REFERENCE: 26

RIVERS	OLIFANTS RIVER, SOUTH-WESTERN CAPE
REFERENCE	KING J.M. & THARME R.E. 1994. ASSESSMENT OF THE INSTREAM FLOW INCREMENTAL METHODOLOGY AND INITIAL DEVELOPMENT OF ALTERNATIVE INSTREAM FLOW METHODOLOGIES FOR SOUTH AFRICA. WRC REPORT NO. 295/1/94. REPORT TO THE WATER RESEARCH COMMISSION BY THE FRESHWATER RESEARCH UNIT, UNIVERSITY OF CAPE TOWN.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	cobble/bedrock riffle	Box sampler
	bedrock rapid	Box sampler
	bedrock run	Box sampler
	cobble riffle	Box sampler
	cobble run	Box sampler
	cobble backwater	Box sampler
	gravel/cobble backwater	Box sampler
	bedrock pool (38)	Box sampler
	bedrock/cobble pool	Box sampler
	bedrock/cobble rapid	Box sampler
	bedrock/boulder run	Box sampler
	cobble/bedrock run	Box sampler
B) sandy bottom:	sand/gravel run	corer
	sand run	corer
	sand backwater	corer
	sand pool	corer
	silt/sand pool	corer

Mesh size = 80 µm. Eleven sites were sampled once in summer 1991. The number of samples within each biotope was dependent on the relative proportion of each biotope at each sampling site. The mean number of animals per biotope was calculated for each site.

CHEMICAL DATA

Chemical data were collected at the same time as biological data. The following variables were measured. The relevant details in terms of conversions and assumptions are detailed.

- temperature (TEMP), °C (mean, minimum, maximum)
- pH (PH)
- conductivity (COND), mS m^{-1} at 25°C
- total alkalinity (TAL), meq ℓ^{-1}
- phenolthalein alkalinity (PHALK), meq ℓ^{-1}
- total dissolved solid (TDS), mg ℓ^{-1}
- total suspended solid (TSS), mg ℓ^{-1}
- percentage organics in TSS (%ORG IN TSS), %
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- nitrate (NO3-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- nitrite (NO2-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- ammonium (NH4-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- PO_4-P, assumed equivalent to soluble reactive phosphate (SRP), in µmol ℓ^{-1}, converted to mg ℓ^{-1}
- iron (FE), mg ℓ^{-1}
- copper (CU), mg ℓ^{-1}
- silica (SI), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 27

RIVERS	MOLENAARS RIVER, BERG RIVER, EERSTE RIVER, FRANSCHHOEK RIVER, KRAALSTROOM RIVER (ALL SOUTH-WESTERN CAPE)
REFERENCE	BROWN C. 1993. INITIAL SURVEYS IN THE INVESTIGATION TO DETERMINE THE EFFECTS OF TROUT FARM EFFLUENT ON RIVERINE BIOTAS IN THE SOUTH-WESTERN CAPE. FINAL INTERIM REPORT TO THE DEPARTMENT OF WATER AFFAIRS AND FORESTRY.

Since the primary aim of this study was the determination of the potential effect of trout farms on riverine biotas, sites were selected to best represent an unimpacted/control site (above the inlet), an effluent site, and a recovery site (100 m below the effluent outlet) at each farm.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
stony bottom:	riffle	Box sampler

Mesh size = 80 µm. Three samples were collected from each site in August 1991 and February 1992.

CHEMICAL DATA

The following water quality variables were measured at the same time as the collecting of biological samples. The relevant details in terms of conversions and assumptions are detailed.

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), µS cm^{-1} and converted to mS m^{-1}
- total dissolved solid (TDS), mg ℓ^{-1}
- total suspended solid (TSS), mg ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- nitrate (NO3-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- nitrite (NO2-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- ammonium (NH4-N), µmol ℓ^{-1}, converted to mg ℓ^{-1}
- PO_4-P, assumed equivalent to soluble reactive phosphorus (SRP), µmol ℓ^{-1}, converted to mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly for the two sampling periods.

STUDY REFERENCE: 28

RIVER	ORANGE RIVER
REFERENCE	PALMER R.W. 1992. BLACKFLY CONTROL PROJECT. PROGRESS REPORT FOR WATER RESEARCH COMMISSION.

BIOLOGICAL DATA

Biotopes sampled:		Sampling device:
A) stony bottom:	stone-in-current	Box sampler
	stone-out-of-current	Box sampler
B) vegetation	marginal vegetation	hand net

Most sites were sampled once in February 1992. Gifkloof (GIF) was sampled monthly from July 1991 to March 1992. All abundance data are reported in terms of presence or absence only.

CHEMICAL DATA

Only temperature (TEMP) in °C, and total suspended solids (TSS) in mg ℓ^{-1}, were measured.

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 29

RIVERS	TUGELA RIVER AND ITS TRIBUTARIES.
REFERENCE	BRAND P.A.J., KEMP P.H., OLIFF W.D. & PRETORIUS S.J. 1967. WATER QUALITY AND ABATEMENT OF POLLUTION IN NATAL RIVERS. PART III. THE TUGELA RIVER AND ITS TRIBUTARIES. NATIONAL INSTITUTE FOR WATER RESEARCH, CSIR AND THE TOWN AND REGIONAL PLANNING COMMISSION REPORT.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) vegetation:	marginal vegetation	hand net

Mesh size = 300 µm. The survey was divided into different time periods and was conducted by different workers. All sites were sampled once.

CHEMICAL DATA

Values given are the average values for the following time periods : Bushmans River: 1956-1957; Buffalo River and tributaries: 1959-1960; Mooi River: 1961; Sundays River: 1960-1963. The variables listed below were measured:

- pH (PH)
- conductivity (COND), micromhos, converted to mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- biological oxygen demand (BOD): 5-day measured in mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- phosphate, mg ℓ^{-1} assumed equivalent to SRP
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- silica (SI), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological data for each site have been linked with the average yearly chemical data for the same time period, and should therefore be treated with caution.

STUDY REFERENCE: 30

RIVERS	NORTHERN NATAL AND ZULULAND.
REFERENCE	ARCHIBALD C.G.M., COETZEE O.J., KEMP P.H., PRETORIUS S.J. & SIBBALD R.R. 1969. WATER QUALITY AND ABATEMENT OF POLLUTION IN NATAL RIVERS. PART IV. THE RIVERS OF NORTHERN NATAL AND ZULULAND. NATIONAL INSTITUTE FOR WATER RESEARCH, CSIR AND THE TOWN AND REGIONAL PLANNING COMMISSION REPORT.

BIOLOGICAL DATA

Biotope sampled:	Sampling device:
A) bottom sediment	corer

Mesh size = 300 µm. Samples are all one-off collections.

CHEMICAL DATA

Only chemical data for which there are matching biological data are included. Values given are for the dry season. The following variables were measured:

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), micromhos, converted to mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- percentage saturation dissolved oxygen (DOPER), %
- Kjeldahl nitrogen (KJN), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- phosphate, mg ℓ^{-1} assumed equivalent to SRP
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- fluoride (F), mg ℓ^{-1}
- free carbon dioxide (FREE CO2), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

The biological and the chemical data have been matched for each site.

STUDY REFERENCE: 31

RIVER	VAAL RIVER
REFERENCE	CHUTTER F.M. 1967. HYDROBIOLOGICAL STUDIES ON THE VAAL RIVER. NATIONAL INSTITUTE FOR WATER RESEARCH, CSIR REPORT WAT 38 .

This report consists of two main studies. They will be outlined separately.

VAAL DAM REGION: Preliminary survey in September 1958-February 1959. Main survey in July 1959-October 1960. Final survey in August 1961. (Sites VAL1, VAL2A, VAL3, VAL4, VAL5, VAL5A, VAL7, VAL8, VAL9, VAL10, VAL11A, VAL11B, VAL11C, VAL11X, VAL12, VAL13, VAL14, VAL17, VAL19, VAL21, VAL21A, VAL22, VAL24, VAL24A, VAL25, VAL26, VAL27, VAL29, VAL30, VAL31, VAL33, VAL34, VAL36, VAL38, VAL39, VAL40, VAL41, VAL42, VAL43, VAL44).

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	Surber sampler or hand net
	backwater	hand net
B) vegetation:	marginal vegetation	hand net

Mesh size » 950 µm. Sites were sampled during the following three seasons: WIN.58-61: winter (late April to August); DES.58-61: dry early summer (September to November); SUM.58-61 (end of November to March). The biological data are given as the mean seasonal percentages for each site. Rare species were recorded as being present or absent.

CHEMICAL DATA

Water samples for chemical analysis were collected simultaneously to the biological data, but have not always been presented in the same manner. Determinands varied between sites and with season. The following variables were measured at some or all of the sites, and mean, maximum and minimum values were given for nearly all of them :

- pH (PH)
- total dissolved solids (TDS), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- nitrite + nitrate (NO2+NO3), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- total nitrogen (TOT-N), mg ℓ^{-1}
- Kjeldahl nitrogen (KJN), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- turbidity (TURB), as mg ℓ^{-1} SiO_2

MATCHING BIOLOGICAL AND CHEMICAL DATA

Because of differences in the presentation of the biological and chemical data, matching was problematic. Mean, minimum and maximum values for 1957-1958 are given for sites VAL1, VAL2A, VAL3, VAL4, VAL5, VAL5A, VAL17, VAL19, VAL20, VAL21, VAL21A. These have not been matched with biological data because the latter were given for each season. Spot chemical data are given for August 1961, for sites VAL9, VAL10, VAL11A, VAL11B, VAL11X, VAL13, VAL24,

VAL25, VAL26, VAL30, VAL41, VAL42, VAL44. These have been matched with biological data for WIN.58-61. Caution should be used when using the combined biological and chemical data.

VAAL RIVER IN THE WARRENTON AREA
Each site was sampled in October 1963, January 1964, April 1964 and August 1964 (sites VAL51, VAL52, VAL53, VAL54, VAL54A, VAL55, VAL55A, VAL56).

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current	collection of fauna associated with individual stones (5 per site)
B) vegetation:	marginal vegetation	hand net

Mesh size » 950 µm. Data are given as the mean number of animals per surface area of stone. Rare species were recorded as being present or absent .

CHEMICAL DATA
Water samples for chemical analysis were collected at the same time as the biological data. Determinands varied between sites and with season. The following variables were measured at some or all of the sites:

- temperature (TEMP), °C
- pH (PH)
- total dissolved solids (TDS), mg ℓ^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- Kjeldahl nitrogen (KJN), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- turbidity (TURB), as mg ℓ^{-1} SiO_2

MATCHING BIOLOGICAL AND CHEMICAL DATA
Biological and chemical data were matched for each sampling period. Some chemical data were obtained at unspecified dates between 1957 and 1958 (dated "1957-58" in database), and thus no biological-chemical date link was possible for these sites.

STUDY REFERENCE: 32

RIVER	ORANGE RIVER
REFERENCE	DE MOOR F.C. & CAR M. 1986. A FIELD EVALUATION OF *BACILLUS THURINGIENSIS* VAR. *ISRAELENSIS* AS A BIOLOGICAL CONTROL AGENT FOR *SIMULIUM CHUTTERI* (DIPTERA: NEMATOCERA) IN THE MIDDLE ORANGE RIVER. J. VET. RES. 53: 43-50.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stones-in-current	hand collection of stones

Mesh size = 92 µm. Biota associated with 5 stones were collected at each site prior to treatment.

CHEMICAL DATA

Only pH (PH), conductivity (COND), mS m^{-1}, turbidity (NTU), and flow were measured, on a one-off basis.

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 33

RIVERS	JUKSKEI-CROCODILE RIVER SYSTEM
REFERENCE	ALLANSON B.R. 1961. INVESTIGATIONS INTO THE ECOLOGY OF POLLUTED INLAND WATERS IN THE TRANSVAAL. PART 1. THE PHYSICAL, CHEMICAL AND BIOLOGICAL CONDITIONS IN THE JUKSKEI-CROCODILE RIVER SYSTEM. HYDROBIOLOGIA 18: 1-76.

BIOLOGICAL DATA

Biotopes sampled:		Sampling devices:
A) stony bottom:	stone-in-current (stickles and cascades)	Surber sampler
B) vegetation:	marginal vegetation	hand net
C) sediment:	bottom mud/sand in pools	scoop

Mesh size » 950 µm. Samples were collected monthly but have not always been presented as such. The following biological data are given: monthly abundance at sites ALL2, ALL3, ALL6, ALL19, ALL21, ALL23; those present in winter or summer 1956-1957 (WIN.56-57: April to October; SUM.56-57: November to January/March respectively, indicated with as present since no abundance value was given); chironomid presence during the study period (1956-1957); and those associated with sandy sediments in winter 1958.

CHEMICAL DATA

Water samples for chemical analysis were collected simultaneously to the biological data, but have not always been presented in the same manner. Determinands varied between sites and with season. The following variables were measured at some or all of the sites (mean, minimum and maximum values normally given):

- pH (PH)
- conductivity (COND), in micromhos and converted to mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- total alkalinity (TAL), as mg ℓ^{-1} $CaCO_3$, converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- dissolved oxygen (DO), mg ℓ^{-1} (mean values only)
- percentage saturation dissolved oxygen (DOPER), % (mean values only)
- biological oxygen demand (BOD), mg ℓ^{-1} (mean values only)
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- calcium (CA), as mg ℓ^{-1} $CaCo_3$, converted to mg ℓ^{-1} Ca
- magnesium (MG), as mg ℓ^{-1} $CaCo_3$, converted to mg ℓ^{-1} Mg
- sulphate (SO4), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- turbidity (TURB), as mg ℓ^{-1} SiO_2

MATCHING BIOLOGICAL AND CHEMICAL DATA

Because of differences in the presentation of the biological and chemical data, matching was problematic. Mean, minimum and maximum values for the monthly sites have been matched with the relevant monthly chemical data. Biological data from SUM.56-57 and WIN.56-57 have been matched with the same chemical data. In many cases, chemical data for SUM.56-57 have, by convention, been matched with the biological data of February 1957.

STUDY REFERENCE: 34

RIVERS	KLIPSPRUIT, KLIP (NEAR OLIFANTSVLEI), SADELBOOM AND KLIP RIVERS (NEAR WITBANK)
REFERENCE	HARRISON A.D. 1958C. THE EFFECTS OF SULPHURIC ACID POLLUTION ON THE BIOLOGY OF STREAMS IN THE TRANSVAAL, SOUTH AFRICA. VERH. INTERNAT. VER. LIMNOL. 23: 603-610.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stone-in-current	hand net
B) vegetation:	aquatic vegetation	hand net
	submerged vegetation	hand net
C) mixture of all biotopes		

Mesh size = > 950 µm. Fauna of the aquatic vegetation was sampled on the Klipspruit and Klip rivers in October 1954, January 1955, April 1955 and July 1955. Fauna from stones-in-current and submerged vegetation was sampled on the Sadelboom River in May 1956 and the Klip River in May 1956 and November 1956.

CHEMICAL DATA

Chemical samples were taken at the same time as biological samples. The following variables are reported (normally as a mean and/or, minimum and maximum).

- pH (PH)
- total dissolved solids (TDS), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- calcium (CA), given as mg ℓ^{-1} $CaCO_3$ and converted to mg ℓ^{-1} Ca
- magnesium (MG), given as mg ℓ^{-1} $MgCO_3$ and converted to mg ℓ^{-1} Mg

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 35

RIVER: BERG RIVER, WESTERN CAPE PROVINCE

REFERENCE: COETZER A. 1978. THE INVERTEBRATE FAUNA AND BIOTIC INDEX VALUE OF WATER QUALITY OF THE GREAT BERG RIVER, WESTERN CAPE. JOURNAL OF THE LIMNOLOGICAL SOCIETY OF SOUTHERN AFRICA 4(1): 1-7.

BIOLOGICAL DATA

Biotopes sampled:		Sampling device:
A) stony bottom:	stones-in-current	Surber sampler (3 samples per site-pooled)

Mesh size = 290 µm. Sampling was conducted between April 1978 and March 1979. The mean number of animals per season were calculated for each site. The following seasons were defined: EW=early winter (April, May, June); W=wet winter (July, August, September); ED=early dry summer (October, November, December) and D=dry summer (January, February, March).

CHEMICAL DATA

Chemical samples were collected at the same time as biological samples. The following variables were reported (conversions and assumptions are detailed:)

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), µS cm^{-1}, converted to mS m^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- percentage saturation dissolved oxygen (DOPER), %
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- Combined nitrogen: (ammonium+nitrite+nitrate) (NH4+NO3+NO2)-N), mg ℓ^{-1}
- orthophosphate, assumed equivalent to soluble reactive phosphorus (SRP), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly on a seasonal basis.

STUDY REFERENCE: 36

RIVER	OLIFANTS RIVER, WESTERN CAPE PROVINCE
REFERENCE	COETZER A. 1982. HYDROBIOLOGICAL REPORT ON THE OLIFANTS RIVER SYSTEM, WESTERN CAPE PROVINCE. REPORT OF RESEARCH SECTION, DEPARTMENT OF NATURE CONSERVATION.

BIOLOGICAL DATA

Biotopes sampled:		Sampling device:
A) stony bottom:	stone-in-current	Surber sampler (3 samples per site-pooled)

Mesh size = 290 µm. Sampling was conducted between April 1978 and March 1979. The mean number of animals per season were calculated for each site. The following seasons were defined: EW=early winter (April, May, June); W=wet winter (July, August, September); ED=early dry summer (October, November, December) and D=dry summer (January, February, March).

CHEMICAL DATA

Chemical samples were collected simultaneously to biological samples. The following variables were reported (conversions and assumptions are detailed:)

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), µS cm^{-1}, converted to mS m^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- percentage saturation dissolved oxygen (DOPER), %
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- hardness (CACO3), mg ℓ^{-1}
- N-combined: [ammonia+nitrite+nitrate (NH_3+NO_3+NO_2)], mg ℓ^{-1}
- orthophosphate, assumed equivalent to SRP, mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly on a seasonal basis.

STUDY REFERENCE: 37

RIVER	LETABA RIVER
REFERENCE	CHUTTER F.M. & HEATH R.G.M. 1992. RELATIONSHIP BETWEEN LOW FLOWS AND THE RIVER FAUNA IN THE LETABA RIVER. PROGRESS REPORT PREPARED FOR THE WATER RESEARCH COMMISSION STEERING COMMITTEE MEETING OF 24.08.92. PROJECT NO. K5/293.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A) stony bottom:	stones-in-current	hand net

Mesh size = 300 µm. A complete distribution table is given for all sites (monthly data combined for each site). Biological data from sites LET6, LET8 and LET9 are given separately for February, May, August and November 1990, and February, May, August and November 1991.

CHEMICAL DATA

Chemical samples were collected at the same time as biological samples. The following variables were reported (conversions and assumptions are detailed:)

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), mS m^{-1} at 25°C
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- Kjeldahl nitrogen (KJN), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- nitrate + nitrite (NO2+NO3), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- orthophosphate, assumed equivalent to SRP, in µg ℓ^{-1} and converted to mg ℓ^{-1}
- ammonium (NH4-N), in µg ℓ^{-1} and converted to mg ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- turbidity (NTU), in NTUs

MATCHING BIOLOGICAL AND CHEMICAL DATA

Only the monthly biological and chemical data given for sites LET6, LET8 and LET9 were matched.

STUDY REFERENCE: 38

RIVER	PALMIET RIVER, WESTERN CAPE PROVINCE
REFERENCE	GALE B.A. 1992. THE EFFECT OF REGULATION BY TWO IMPOUNDMENTS ON AN ACID, BLACKWATER, CAPE MOUNTAIN STREAM. PHD THESIS. ZOOLOGY DEPARTMENT. UNIVERSITY OF CAPE TOWN, SOUTH AFRICA.

BIOLOGICAL DATA

Biological sampling was conducted monthly. Mesh size = 80 µm.

Biotope sampled:		Sampling device:
A. stony bottom:	stone-in-current (riffle)	Box sampler

CHEMICAL DATA

Chemical samples were collected at the same time as biological samples. The following variables were measured:

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), µS cm^{-1}, converted to mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- percentage saturation dissolved oxygen (DOPER), %
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- Soluble Reactive Phosphorus (SRP), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 39

RIVER	LOURENS RIVER, WESTERN CAPE PROVINCE
REFERENCE	RACTLIFFE G. 1991. THE EFFECTS OF SUSPENDED SEDIMENTS ON THE MACROINVERTEBRATE COMMUNITY STRUCTURE OF A RIVER ECOSYSTEM. HONOURS THESIS, ZOOLOGY DEPARTMENT, UNIVERSITY OF CAPE TOWN.

BIOLOGICAL DATA

Biotope sampled:		Sampling device:
A. stony bottom:	stone-in-current (riffle)	Box sampler

Mesh size = 80 µm.

CHEMICAL DATA

Chemical samples were collected at the same time as biological samples. The detection limit for the nutrients was 0.5 mg ℓ^{-1}. The following variables were measured:

- temperature (TEMP), °C
- pH (PH)
- conductivity (COND), µS cm^{-1}, converted to mS m^{-1}
- percentage saturation dissolved oxygen (DOPER), %
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- nitrate-nitrogen (NO3-N), mg ℓ^{-1}
- ammonium-nitrogen (NH4-N), mg ℓ^{-1}
- orthophosphates (PO4-P), assumed equivalent to SRP, mg ℓ^{-1}
- Chemical Oxygen Demand (COD), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological data for July and August were linked to chemical data for June.

STUDY REFERENCE: 40

RIVER	EERSTE RIVER, WESTERN CAPE PROVINCE
REFERENCE	KING J.M. 1983. ABUNDANCE, BIOMASS AND DIVERSITY OF BENTHIC MACRO-INVERTEBRATES IN A WESTERN CAPE RIVER, SOUTH AFRICA. TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTHERN AFRICA. 45:11-33

BIOLOGICAL DATA
Sampling was conducted monthly between March 1975 and April 1976. Samples were however combined and data were presented seasonally for March-May, June-August, September-November and December-February. Mesh size = 0.6 mm.

Biotope sampled:		Sampling device:
A. stony bottom:	stone-in-current (riffle)	Box sampler

CHEMICAL DATA
Chemical data were collected simultaneously to biological data but are given as May-August and December-March means. The following variables were measured:

- temperature (TEMP), °C
- pH (PH)
- percentage saturation dissolved oxygen (DOPER), %
- dissolved oxygen (DO), mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- nitrite-nitrogen (NO2-N), mg ℓ^{-1}
- nitrate-nitrogen (NO3-N), mg ℓ^{-1}
- total phosphorus (TOT-P), mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA
Biological data for June-August have been linked to chemical data for May-August, and December-February to December-March.

STUDY REFERENCE: 41

RIVERS	VARIOUS RIVERS IN THE WESTERN CAPE (E.G. BERG RIVER AND TRIBUTARIES, KRAALSTROOM, EERSTE, MOLENAARS, PALMIET, OLIFANTS RIVERS)
REFERENCE	DALLAS H.F. 1994. AN EVALUATION OF SASS (SOUTH AFRICAN SCORING SYSTEM) AS A TOOL FOR THE RAPID ASSESSMENT OF WATER QUALITY. MSC THESIS. ZOOLOGY DEPARTMENT, UNIVERSITY OF CAPE TOWN, SOUTH AFRICA.

BIOLOGICAL DATA

SASS (South African Scoring System) sampling was conducted using a 950 µm mesh. A mixture of biotopes were sampled and data pooled.

Biotope sampled:		Sampling device:
A. mixed:	all available biotopes, (e.g. sic, sooc, mv, aqv, sand)	SASS Kick net

CHEMICAL DATA

Chemical samples were collected at the same time as biological samples. The following variables were measured:

- temperature (TEMP), °C
- conductivity (COND), µS cm^{-1}, converted to mS m^{-1}
- pH (PH)
- total dissolved solids (TDS), mg ℓ^{-1}
- total suspended solids (TSS), mg ℓ^{-1}
- total organics (TORGS), mg ℓ^{-1}
- dissolved oxygen (DO), mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- ammonium (NH4-N), mg ℓ^{-1}
- Soluble Reactive Phosphorus (SRP), mg ℓ^{-1}
- silica, mg ℓ^{-1}
- total alkalinity (TAL), meq ℓ^{-1}
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- aluminium, mg ℓ^{-1}
- iron, mg ℓ^{-1}
- lead, mg ℓ^{-1}
- phenols, mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA

Biological and chemical data were matched directly.

STUDY REFERENCE: 42

RIVER	PALMIET RIVER, WESTERN CAPE PROVINCE
REFERENCE	DE DECKER H.P. 1981. CHANGES IN THE COMMUNITY STRUCTURE OF BENTHIC MACROINVERTEBRATES IN THE STONY-BED AREAS OF THE PALMIET RIVER, IN RELATION TO THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE RIVER. HONOURS THESIS, ZOOLOGY DEPARTMENT, UNIVERSITY OF CAPE TOWN, SOUTH AFRICA.

BIOLOGICAL DATA
Biological sampling was conducted in March and August 1981. Mesh size = 0.6 mm.

Biotope sampled:		Sampling device:
A. stony bottom:	stone-in-current (riffle)	Box sampler

CHEMICAL DATA
Chemical samples were collected at the same time as biological samples. The following variables were measured:

- temperature (TEMP), °C
- pH (PH)
- percentage saturation dissolved oxygen (DOPER), %
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- Soluble Reactive Phosphorus (SRP), mg ℓ^{-1}
- silica, mg ℓ^{-1}

MATCHING BIOLOGICAL AND CHEMICAL DATA
Biological and chemical data were matched directly.

STUDY REFERENCE: 43

RIVER	UMGENI RIVER, WESTERN CAPE PROVINCE
REFERENCE	SCHOONBEE H.J. 1964. A HYDROBIOLOGICAL INVESTIGATION OF THE UMGENI RIVER SYSTEM, NATAL, AND ITS BEARING ON THE ECOLOGICAL INTERPRETATION OF FAUNAL COMMUNITIES IN SOUTH AFRICAN RIVERS. PHD THESIS, ZOOLOGY DEPARTMENT, POTCHEFSTROOM UNIVERSITY, SOUTH AFRICA.

BIOLOGICAL DATA

Biological data are given for each season, with a further division into early and late in some instances. Mesh size approximately 500 µm.

Biotopes sampled:		Sampling devices:
A) stony bottom:	in stickles	Surber sampler or hand net
	in run	Surber sampler or hand net
	in cascade	hand net
	in flats	Surber sampler or hand net
	in backwaters	hand net
	in pool	Surber sampler or hand net
B) vegetation:	marginal vegetation	hand net
	stream bottom vegetation	hand net

CHEMICAL DATA

Composite and snap samples of water were taken throughout the period 1959 to 1960. Data are presented as mean, minimum and maximum values for the entire period. The following variables were measured:

- pH (PH)
- conductivity (COND), in micromhos at 20°C, converted to mS m^{-1}
- total dissolved solids (TDS), mg ℓ^{-1}
- biological oxygen demand (BOD), 5 days at 20°C, mg ℓ^{-1}
- total alkalinity (TAL), mg ℓ^{-1} $CaCO_3$ and converted to meq ℓ^{-1}
- total hardness (CACO3), mg ℓ^{-1} $CaCO_3$
- calcium (CA), mg ℓ^{-1}
- magnesium (MG), mg ℓ^{-1}
- sulphate (SO4), mg ℓ^{-1}
- sodium (NA), mg ℓ^{-1}
- potassium (K), mg ℓ^{-1}
- chloride (CL), mg ℓ^{-1}
- silica, mg ℓ^{-1}
- nitrate (NO3-N), mg ℓ^{-1}
- nitrite (NO2-N), mg ℓ^{-1}
- free and saline ammonia, assumed equivalent to ammonium (NH4-N), mg ℓ^{-1}
- phosphate, assumed equivalent to Soluble Reactive Phosphorus (SRP), mg ℓ^{-1}
- turbidity (TURB), as mg ℓ^{-1} SiO_2

MATCHING BIOLOGICAL AND CHEMICAL DATA

Analysis of the chemical data by the author indicated minimal seasonal differences in physical and chemical variables. The seasonal biological data was therefore matched to the composite chemical data.

Appendix C. Hierarchical arrangement of biotope categories giving SASS biotope, broad biotope, specific biotope, substratum and biotope description (blank fields indicate unspecified details).

Sass Biotope	Broad Biotope	Specific Biotope	Substratum	Description of biotope
Marginal and aquatic vegetation (MV/AQV)	Vegetation	Aquatic vegetation	Isolepis	Aquatic vegetation: Isolepis beds
MV/AQV	Vegetation	Aquatic vegetation		Aquatic vegetation: unspecified type
MV/AQV	Vegetation	Marginal vegetation		Marginal vegetation: unspecified type
Stones-in-current/stones-out-of-current (SIC/SOOC)	Waterfall	Cascade		Waterfall: cascades
SIC/SOOC	Waterfall	Mossy rocks		Waterfall: mossy rocks
SIC/SOOC	Waterfall	Sprayed rocks		Waterfall: perpetually sprayed rock regions flanking cascades
SIC/SOOC	Stones-in-current	Riffle		Riffles (in stones-in-current biotope), with no specified substrate
SIC/SOOC	Stones-in-current	Riffle	Cobble	Riffles (in stones-in-current biotope), with cobble substrate
SIC/SOOC	Stones-in-current	Riffle	Bedrock cobble	Riffles (in stones-in-current biotope), with mixed bedrock and cobble substrate
SIC/SOOC	Stones-in-current	High flow		High flow over stones, release phase (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Low flow		Low season trickle over stones, drying phase (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Rock scrapings		Scrapings from large rock in current (in stones-in-current biotope)
SIC/SOOC	Stones-in-current			Stones-in current biotope, specific biotope and substrate unspecified
SIC/SOOC	Stones-in-current	Run	Bedrock	Run, over bedrock (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Run	Bedrock cobble	Run, over bedrock/cobble (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Run	Cobble	Run, over cobble (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Run	Bedrock bolder	Run, over bedrock/boulder (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Run		Run, over unspecified substrate (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Rapid	Bedrock	Rapid, over bedrock (in stones-in-current biotope)
SIC/SOOC	Stones-in-current	Rapid	Bedrock cobble	Rapid, over bedrock/cobble (in stones-in-current biotope)
SIC/SOOC	Stones-out-of-current	Backwater	Cobble	Stones-out-of-current, backwater, with cobble substrate

Sass Biotope	Broad Biotope	Specific Biotope	Substratum	Description of biotope
SIC/SOOC	Stones-out-of-current	Backwater	Gravel cobble	Stones-out-of-current, backwater, with gravel and cobble mixed substrate
SIC/SOOC	Stones-out-of-current	Backwater		Stones-out-of-current, stony bottomed backwater, unspecified substrate
Gravel, sand, mud (GSM)	Sand	Backwater	Sand	Stones-out-of-current, sand bottomed backwater
GSM	Gravel	Run	Gravel sand	Run, over gravel/sand (in stones-in-current biotope)
GSM	Sand	Run	Sand	Run, over sand (in stones-in-current biotope)
GSM	Sand	Back	Mud sand	Stones-out-of-current, backwater, with mixed mud and sand
GSM	Sand	Pool	Sand	Pool, sand bottom
GSM	Sand	Pool	Mud sand	Pool, mixed mud and sand bottom
SIC/SOOC	Stones-out-of-current	Pool	Bedrock cobble	Pool, mixed bedrock and cobble bottom
SIC/SOOC	Stones-out-of-current	Pool	Bedrock	Stone bottomed pool, with bedrock substrate specified
GSM	Mud	Pool	Mud	Mud bottomed pool
SIC/SOOC	Stones-out-of-current	Pool		Stone bottomed pool, no substrate specified
SIC/SOOC	Stones-out-of-current	Pool		Pool, with no substrate type specified
GSM	Sediment			Sediment bottom, with no substrate type specified
GSM	Sand		Sand	Sandy substrate, biotope not specified
Mixed	Mixed	Sand and vegetation	Sand and marginal vegetation	Mixed biotopes: sand and marginal vegetation, unspecified type
Mixed	Mixed			Mixture of biotopes sampled, and data pooled
SIC/SOOC	Stones-in-current	Run	Flat	Stones-in-current, slight to moderate current; smooth flow

Appendix D. Physico-chemical parameters captured in the Biobase, giving codes and units of measurement

Description	Code	Unit
Alkalinity as Calcium Carbonate	CACO3	mg ℓ^{-1}
Alkalinity as Calcium Carbonate (maximum)	CACO3MAX	mg ℓ^{-1}
Alkalinity as Calcium Carbonate (minimum)	CACO3MIN	mg ℓ^{-1}
Aluminium concentration	AL	mg ℓ^{-1}
Ammonia nitrogen	NH4-N	mg ℓ^{-1}
Ammonia nitrogen (maximum)	NH4MAX	mg ℓ^{-1}
Ammonia nitrogen (minimum)	NH4MIN	mg ℓ^{-1}
Bicarbonate	HCO3	mg ℓ^{-1}
Biological Oxygen Demand	BOD	mg ℓ^{-1} (5 days)
Biological Oxygen Demand (maximum)	BODMAX	mg ℓ^{-1} (5 days)
Biological Oxygen Demand (minimum)	BODMIN	mg ℓ^{-1} (5 days)
Calcium	CA	mg ℓ^{-1}
Calcium (maximum)	CAMAX	mg ℓ^{-1}
Calcium (minimum)	CAMIN	mg ℓ^{-1}
Carbonate	CO3	mg ℓ^{-1}
Chemical Oxygen Demand	COD	mg ℓ^{-1}
Chloride	CL	mg ℓ^{-1}
Chloride (maximum)	CLMAX	mg ℓ^{-1}
Chloride (minimum)	CLMIN	mg ℓ^{-1}
Chlorophyll *a*	CHLA	mg ℓ^{-1}
Colour	COL	APHA units
Colour (maximum)	COLMAX	APHA units
Colour (minimum)	COLMIN	APHA units
Conductivity	COND	mS m^{-1}
Conductivity (maximum)	CONDMAX	mS m^{-1}
Conductivity (minimum)	CONDMIN	mS m^{-1}
Dissolved inorganic nitrogen	DIN	mg ℓ^{-1}
Dissolved organic nitrogen	DON	mg ℓ^{-1}
Dissolved oxygen	DO	mg ℓ^{-1}
Dissolved Oxygen: % saturation of oxygen dissolved in the water	DOPER	%
Fluoride	F	mg ℓ^{-1}
Free carbon dioxide/carbonic acid	FREE CO2	mg ℓ^{-1}
Iron	FE	mg ℓ^{-1}
Iron (maximum)	FEMAX	mg ℓ^{-1}
Iron (minimum)	FEMIN	mg ℓ^{-1}
Kjeldahl nitrogen	KJN	mg ℓ^{-1}

Description	Code	Unit
Lead concentration	PB	mg ℓ^{-1}
Magnesium	MG	mg ℓ^{-1}
Magnesium (maximum)	MGMAX	mg ℓ^{-1}
Magnesium (minimum)	MGMIN	mg ℓ^{-1}
Nitrate nitrogen	NO3-N	mg ℓ^{-1}
Nitrate nitrogen (maximum)	NO3MAX	mg ℓ^{-1}
Nitrate nitrogen (minimum)	NO3MIN	mg ℓ^{-1}
Nitrate nitrogen + nitrite nitrogen	NO2+NO3	mg ℓ^{-1}
Nitrite nitrogen	NO2-N	mg ℓ^{-1}
Nitrite nitrogen (maximum)	NO2MAX	mg ℓ^{-1}
Nitrite nitrogen (minimum)	NO2MIN	mg ℓ^{-1}
Nitrogen – combined	(NH4+NO3+NO2)-N	mg ℓ^{-1}
Particulate organic matter	POM	mg ℓ^{-1}
pH	pH	pH units
pH (maximum)	PHMAX	pH units
pH (minimum)	PHMIN	pH units
Phenols	PHEN	mg ℓ^{-1}
Phenolthalein alkalinity	PHALK	meq ℓ^{-1}
Potassium	K	mg ℓ^{-1}
Potassium (maximum)	KMAX	mg ℓ^{-1}
Potassium (minimum)	KMIN	mg ℓ^{-1}
Silica	SI	mg ℓ^{-1}
Silica (maximum)	SIMAX	mg ℓ^{-1}
Silica (minimum)	SIMIN	mg ℓ^{-1}
Sodium	NA	mg ℓ^{-1}
Sodium (maximum)	NAMAX	mg ℓ^{-1}
Sodium (minimum)	NAMIN	mg ℓ^{-1}
Soluble reactive sulphate (maximum)	SRPMAX	mg ℓ^{-1}
Soluble reactive sulphate (minimum)	SRPMIN	mg ℓ^{-1}
Soluble reactive sulphate (often assumed = PO4-P)	SRP	mg ℓ^{-1}
Sulphate	SO4	mg ℓ^{-1}
Sulphate (maximum)	SO4MAX	mg ℓ^{-1}
Sulphate (minimum)	SO4MIN	mg ℓ^{-1}
Temperature	TEMP	degrees C
Temperature (maximum)	TMAX	degrees C
Temperature (minimum)	TMIN	degrees C
Total alkalinity	TAL	meq ℓ^{-1}
Total alkalinity (maximum)	TALMAX	meq ℓ^{-1}
Total alkalinity (minimum)	TALMIN	meq ℓ^{-1}
Total dissolved solids	TDS	mg ℓ^{-1}

Description	Code	Unit
Total dissolved solids (maximum)	TDSMAX	mg ℓ^{-1}
Total dissolved solids (minimum)	TDSMIN	mg ℓ^{-1}
Total inorganic carbon	TIC	mg ℓ^{-1}
Total nitrogen	TOT-N	mg ℓ^{-1}
Total organic carbon	TOC	mg ℓ^{-1}
Total organics in TSS – percentage	TORGS	%
Total organics in TSS	TORGS	mg ℓ^{-1}
Total phosphorus	TOT-P	mg ℓ^{-1}
Total suspended solids	TSS	mg ℓ^{-1}
Total suspended solids (maximum)	TSSMAX	mg ℓ^{-1}
Total suspended solids (minimum)	TSSMIN	mg ℓ^{-1}
Turbidity (maximum)	TURBMAX	NTU
Turbidity (minimum)	TURBMIN	NTU
Turbidity (NTU scale)	TURBIDITY	NTUs
Turbidity (silica scale)	TURBS (SIO2)	mg ℓ^{-1}
Turbidity (silica scale) (maximum)	TURBSMAX (SIO2)	mg ℓ^{-1}
Turbidity (silica scale) (minimum)	TURBSMIN (SIO2)	mg ℓ^{-1}