University of the Witwatersrand
Department of Animal Plant and Environmental Sciences

Laboratory Practical – Introduction to River Health Assessment Techniques

Aquatic Ecology II
(APES2034) 24 Points

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River Health Assessment

A critical aspect of the sustainable management of South Africa's inland water resources is being able to adequately assess and monitor the ecological integrity and health of individual water bodies. Headwater streams are especially vulnerable to human-caused perturbations, and through correctly identifying the causes of declining water quality and ecosystem function, managers can hope to restore and preserve these vital ecosystems for the benefit of all. The River Health Programme, developed by the Department of Water Affairs, sought to classify all major river systems in South Africa in terms of their biotic diversity, habitat integrity and water quality, so that appropriate management goals could be set for each one.

In the next three weeks, you will visit and assess two headwater streams (small streams, close to their respective sources) that flow through very different landscapes. Your task will be to conduct river health assessments of each stream to determine whether one displays significantly different ecosystem integrity to the other. Your findings will be written up as a laboratory report, presented in the form of a scientific journal article.

Physical Assessment of Habitat

A critical component of river ecosystem function is the availability and quality of physical habitat. Stream habitat includes the wetted habitat and its associated banks, which are both heavily impacted by human activities in the surrounding catchment area. In the provided class hand-outs you will find detailed instructions in Section 1 that explain how to fill out the field data sheets in Section 3, which will be done at the riverside on each field trip.

Aquatic macroinvertebrates as indicators of river health

Aquatic macroinvertabrates (insects and other invertebrates that live in water and are large enough to identify without a microscope) are a powerful tool for understanding the health and function of a stream ecosystem. Macroinvertebrates vary greatly in their life histories, habitat requirements, and sensitivity to water quality. As a result, certain families of invertebrates be considered highly sensitive to human perturbations such as habitat alteration and water pollution.

The South African Scoring System, developed in the 1980s and currently in its 5th iteration, allocates sensitivity scores to all major families of aquatic insects and other common macroinvertebrate groups that occur in South African streams. By adding up the scores of invertebrates found at a certain site on a stream, one can gain a measure of the habitat integrity and water quality at the site relative to other sites within a catchment. This can allow managers to identify sites with poorer-than-expected water quality, and focus resources on improving those streams.

Constructing an Introduction to the Practical Report

As a first step in learning the fundamental skills of scientific writing that will be needed to complete this practical series, each student will write a first draft of the introduction to the final class report. Instructions as to go about writing a scientific report can be found in the Introduction to Practical Sessions hand-out, together with the references to three critical papers you will need to obtain from the library and read in preparation for writing the introduction. Be aware, however, that these three references are only the start of the literature review process, and each student will need to source additional supporting references to construct a concise but well-argued introduction, which provides historical and geographic context for the research being performed, and clearly explains the rationale for conducting such research.

Class excercise

Two of the tasks you will need to complete to generate the data for the class project, are calculating discharge from transects at each stream, and filling out the SASS5 score sheet. While the taking of water depth and velocity is a fairly simple exercise to perform in the stream, the calculation of discharge requires a sequence of calculations, which are explained on the Part 1 page “Calculating Discharge”. You will use these calculations to find the total discharge from a set of data presented in the Laboratory exercise page.

Also as part of the exercise, you will have a chance to familiarise yourself with some of the major insect groups you are likely to encounter in the field. You can use the provided Field Guides for aquatic insects to identify the images and provide some information on what key features make these animals identifiable in the field. This exercise must be completed by the end of the practical, and handed in for marking.

PART 1
DESCRIPTION OF METHODS AND TECHNIQUES FOR RIVER HEALTH ASSESSMENT

GUIDELINE FOR SECTION B. CATCHMENT CONDITION AND LAND-USE - reassessed on each site visit

This section is aimed at assessing the condition of a site and catchment upstream of the site. It incorporates information pertaining to land-use, channel condition, habitat integrity and channel morphology. The site is assessed initially, with subsequent site visits re-assessing the catchment condition and land-use, and modifying the data sheet if conditions have changed in the interim period.

1 PHOTOGRAPHIC RECORD

Photographs of the upstream and downstream views need to be taken when the site is first assessed. Bank to bank or specific features (e.g. riffle) may also be photographed. Photographs of subsequent site visits may be included if desired. These photographs will be available for viewing in the Rivers Database.

2 CONDITION OF LOCAL CATCHMENT

Indicate using the rating scale the land-use(s) present within and beyond the riparian zone of the river. If this is not easily determined or absent, approximate for 10 m width.

Indicate the potential impact of each land-use on river health.

> **Rating Scale**
> 0 - None: none in vicinity of site, no discernible impact.
> 1 - Limited: limited to a few localities, impact minimal.
> 2 - Moderate: land-use generally present, impact noticeable.
> 3 - Extensive: land-use widespread, impact significant, small areas unaffected.
> 4 - Entire: land-use 100% in area, impact significant.

Indicate the level of confidence for each land-use present: high, medium or low. High confidence would be based on the assessor having a thorough knowledge and understanding of the site and area of at least 5 kilometres upstream. Low confidence would be based on the assessor having knowledge based on the site visit only and some supplementary information such as land-use (NLC 2000, http://www.csir.co.za/environmentek/nlc2000).

Provide comments on the distance upstream or downstream if relevant, and on the time since a disturbance, e.g. livestock watering.

Note: 1) Afforestation refers to exotic forest plantations.

2) Agriculture has been split to account for crops, livestock and irrigation.

3) Impoundment refers to dams but also includes diversion weirs, farm dams, etc.

4) Wilderness area refers to an area with limited anthropogenic modification(s) but which is not officially a nature conservation area.

5) Disturbance by wildlife refers to trampling associated with wildlife watering, similar to livestock watering.

3 CHANNEL CONDITION - IN-CHANNEL AND BANK MODIFICATIONS

Using the same rating scale as for 3.2, indicate the extent of in-channel and bank modifications affecting the site and estimate the distance upstream or downstream if appropriate. If the modification is at the site, distance will be zero. Provide comments of relevance such as presence of a fish ladder, height of dam/weir wall, etc.

4 INDEX OF HABITAT INTEGRITY

Within the RHP the Index of Habitat Integrity (IHI, Kleynhans 1996) is applied on a site basis. It aims to assess the number and severity of anthropogenic perturbations on a river and the damage they potentially inflict on the habitat integrity of the system. These disturbances include abiotic factors, such as water abstraction, weirs, dams, pollution and dumping of rubble, and biotic factors, such as the presence of alien plants and aquatic animals which modify habitat. The emphasis in the present assessment is placed on the field-based site assessment, supplemented, where possible, with information gleaned from other sources such as catchment study reports, Integrated Strategic Plans (ISPs) of DWAF per Water Management Area, Ecological Reserve Studies (which may include aerial video material for the river), the land cover database for South Africa (NLC 2000), together with local knowledge. It should be noted that any site-based assessment will lack longitudinal continuity and therefore may not adequately reflect the habitat integrity of the river. Aspects considered in the assessment comprise those instream and riparian zone perturbations regarded as primary causes of degradation of a river ecosystem. The severity of each of these impacts is assessed, using scores as a measure of impact (Table 2).

The assessor must assign a confidence level (high, medium or low) to each criterion based on his/her knowledge of the site and catchment. High confidence would be based on the assessor having a thorough knowledge and understanding of the site and area of at least 5 kilometres upstream. Low confidence would be based on the assessor having knowledge based on the site visit only and some supplementary information (e.g. land cover). Whilst it is near impossible to remove all subjectivity involved in making Index of Habitat assessments, descriptions of each criterion are provided to assist with the assessment (Table 3).

Table 2. Summary of the scoring procedures used to determine the Index of Habitat Integrity.

Impact Class	Description	Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is limited.	1 - 5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are fairly limited.	6 - 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not affected.	11 - 15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16 - 20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21 - 25

Weightings and calculation of instream and riparian status

Once a score has been allocated to an impact, it is moderated by a weighting system, devised by Kleynhans (1996, 1999a). Assignment of weights is based on the relative threat of the impact to the habitat integrity of the riverine ecosystem. The total score for each impact is equal to the assigned score multiplied by the weight of that impact (Table 4).

Based on the relative weights of the criteria, the impacts of each criterion are estimated as follows: Rating for the criterion /maximum value (25) x the weight (percent). Example: for a criterion which receives a rating of 10 in the assessment, with a weighting of 14, the impact score is calculated as follows: 10/25 x 14 = 5.6

The estimated impacts of all criteria calculated in this way are summed, expressed as a percentage and subtracted from 100 to arrive at a present status score for the instream and riparian components, respectively. The Index of Habitat Integrity scores (%) for the instream and riparian zone components are then used to place these two components into a specific class. These classes are indicated in Table 5.

Table 3. Descriptions of criteria used in the IHI assessment (Kleynhans 1996).

Criterion	Description
Water abstraction	Direct abstraction from within the specified river/river reach as well as upstream (including tributaries) must be considered (excludes indirect abstraction by for example exotic vegetation). The presence of any of the following can be used as an indication of abstraction: cultivated lands, water pumps, canals, pipelines, cities, towns, settlements, mines, impoundments, weirs, industries. Water abstraction has a direct impact on habitat type, abundance and size; is implicated in flow, bed, channel and water quality characteristics; and riparian vegetation may be influenced by a decrease in water quantity.
Extent of inundation	Destruction of instream habitat (e.g. riffle, rapid) and riparian zone habitat through submerging with water by, for example, construction of an in-channel impoundment such as a dam or weir. Leads to a reduction in habitat available to aquatic fauna and may obstruct movement of aquatic fauna; influences water quality and sediment transport.
Water quality	The following aspects should be considered; untreated sewage, urban and industrial runoff, agricultural runoff, mining effluent, effects of impoundments. Ranking may be based on direct measurements or indirectly via observation of agricultural activities, human settlements and industrial activities in the area. Water quality is aggravated by a decrease in the volume of water during low or no flow conditions.
Flow modification	This relates to the consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow such as an increase in duration of low flow season can have an impact on habitat attributes, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	This is regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. The effect is a reduction in the quality of habitat for biota. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included. Extensive algal growth is also considered to be bed medication.
Channel modification	This may be the result of a change in flow which alters channel characteristics causing a change in instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Presence of exotic aquatic fauna	The disturbance of the stream bottom during exotic fish feeding may influence, for example, the water quality and lead to increased turbidity. This leads to a change in habitat quality.
Presence of exotic macrophytes	Exotic macrophytes may alter habitat by obstruction of flow and may influence water quality. Consider the extent of infestation over instream area by exotic macrophytes, the species involved and its invasive abilities.
Solid waste disposal	The amount and type of waste present in and on the banks of a river (e.g. litter, building rubble) is an obvious indicator of external influences on stream and a general indication of the misuse and mismanagement of the river.
Decrease of indigenous vegetation from the riparian zone	This refers to physical removal of indigenous vegetation for farming, firewood and overgrazing. Impairment of the riparian buffer zone may lead to movement of sediment and other catchment runoff products (e.g. nutrients) into the river.
Exotic vegetation encroachment	This excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Encroachment of exotic vegetation leads to changes in the quality and proportion of natural allochthonous organic matter input and diversity of the riparian zone habitat is reduced.
Bank erosion	A decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or encroachment of exotic vegetation.

Table 4. Instream and riparian criteria used to develop the Index of Habitat Integrity. Each criterion is weighted (Kleynhans 1996).

Instream Criteria	Wgt	Riparian Zone Criteria	Wgt
Water abstraction	14	Water abstraction	13
Extent of inundation	10	Extent of inundation	11
Water quality	14	Water quality	13
Flow modification	7	Flow modification	7
Bed modification	13		
Channel modification	13	Channel modification	12
Presence of exotic macrophytes	9		
Presence of exotic fauna	8		
Solid waste disposal	6		
		Decrease of indigenous vegetation from the riparian zone	13
		Exotic vegetation encroachment	12
		Bank erosion	14

Table 5. Habitat Integrity classes (from Kleynhans 1999).

Class	Description	Score (% Of Total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place, but the assumption is that ecosystem functioning is essentially unchanged.	80 - 89
C	Moderately modified. A loss or change in natural habitat and biota has occurred, but basic ecosystem functioning appears predominately unchanged.	60 - 79
D	Largely modified. A loss of natural habitat and biota and a reduction in basic ecosystem functioning is assumed to have occurred.	40 - 59
E	Seriously modified. The loss of natural habitat, biota and ecosystem functioning is extensive.	20 - 39
F	Modifications have reached a critical level and there has been an almost complete loss of natural habitat and biota. In the worst cases, the basic ecosystem functioning has been destroyed.	0 - 19

A spreadsheet model to calculate the IHI is available from the author of the model (Email: KleynhansN@dwaf.gov.za).

5 CHANNEL MORPHOLOGY

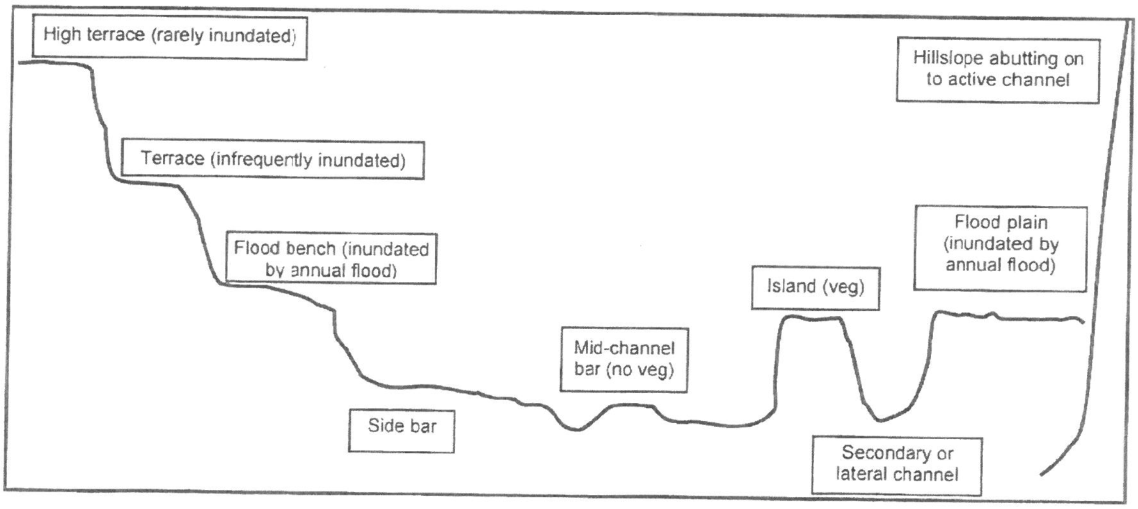
Channel type: River channels may be classified into two broad types: bedrock channels and alluvial channels (Rowntree and Wadeson 1999, 2000), with a mixture also occurring.

- *Bedrock*: bedrock bed
- *Mixed bedrock and alluvial*: mixture of bedrock and alluvial beds, with dominant bed material(s) of sand, gravel, cobble and/or boulder.
- *Alluvial with dominant type(s)*: alluvial bed, with dominant bed material(s) of sand, gravel, cobble and/or boulder.

Using the cross-sectional diagram (Figure 1), indicate the presence of each feature on the left and right-hand banks of the site. Features are described below.

- *High terrace (rarely inundated):* relict floodplains which have been raise above the level regularly inundated by flooding due to lowering of the river channel.
- *Terrace (infrequently inundated):* area raised above the level regularly inundated by flooding.
- *Flood bench (inundated by annual flood):* area between active and macro-channel, usually vegetated.
- *Side bar:* accumulations of sediment associated with the channel margins or bars forming in meandering rivers where erosion is occurring on the opposite bank to the bar.
- *Mid-channel bar:* single bar(s) formed within the middle of the channel; flow on both sides.
- *Island (vegetated)*: island formed within the middle of the channel that is vegetated; flow on both sides.
- *Secondary or lateral channel:* a second channel that flows adjacent to the primary channel.
- *Flood plain (inundated by annual flood):* a relatively level alluvial (sand or gravel) area lying adjacent to the river channel which has been constructed by the present river in its existing regime.
- *Hillslope abutting on to the active channel*

Figure 1 Cross-sectional diagram showing relevant channel features.



GUIDELINE FOR SECTION C: FIELD-BASED DATA FOR EACH SITE VISIT

1 GENERAL SITE VISIT INFORMATION

Water level at time of sampling: Note - the active channel is the channel that is regularly inundated such that channel form is maintained and is free of established terrestrial vegetation.

Water level	Description
Dry	No water flowing.
Isolated pools	Pools that have a trickle of water between them, but no evident flow.
Low flow	Water well within the active channel; water probably not touching the riparian vegetation.
Moderate flow	Water within the active channel; water likely to be touching riparian vegetation in places.
High flow	Water filling the active channel; water completely into riparian vegetation.
Flood	Water above active channel.

Velocity and discharge estimates: Optional measurement of water surface width and stream velocity for the calculation of discharge. Measure velocity at 1 metre intervals across the stream/river, recording each associated depth (m).

Significant rainfall in last week: Indicate the presence and extent of any rainfall event preceding the site visit that is likely to have raised the water level. Rainfall data may be obtained from the South African Weather Service (http://www.weathersa.co.za/). Recent rainfall maps may be viewed at http://www.weathersa.co.za; for long-term records send an E-mail to info2@weathersa.co.za and give the latitude and longitude of the locality. The bureau will send a list of nearby stations, if any, from which you can choose the most relevant.

Canopy Cover: Estimate the extent of cover of riparian vegetation over the stream: Open, Partially open or Closed canopy.

Impact on channel flow: Organic debris, either from upstream imported during flood events or local, can impede the flow of water in the river and alter stream habitat. Rate impacts on a scale of 0 to 3, as follows: 0 - no impact, 1 - limited impact, 2 - extensive impact, 3 - channel blocked.

Water chemistry – data should be recorded in this section if doing the full RHP assessment.

Instrument positioning: Instruments should be positioned in clearly-flowing points of the river where possible, otherwise location of meter and hydraulic biotope type be specified.

Samples collected? Details of the filtering, freezing, preservation and analysis method should be recorded, as well as the institute responsible for analysing the sample.

Variables measured: pH, conductivity, temperature, dissolved oxygen, % O_2 saturation are routinely measured. The value and units should be recorded.

Water turbidity: Indicate the "colour" and degree of visibility through water column or of the riverbed (it is more difficult to assess substratum composition if the river is turbid).

- *Clear:* water transparent, riverbed visible.
- *Discoloured:* water clear, but with a definite tinge to it, usually brown, green or cloudy (riverbed still visible).
- *Opaque:* water cloudy, riverbed not visible.
- *Silty:* usually after a rainfall event, when silt loads are elevated.

Record turbidity (NTUs) if a turbidity meter is used; record Secchi depth (m) if a Secchi disc is used.

2 STREAM DIMENSIONS

Estimate the width of the macro-channel, active-channel and water surface width, and the height of the left and right bank using the categories provided.

Macro-channel width: The outer channel of a compound channel; bank top is well above "normal" flood levels but may be inundated infrequently (e.g. once in 20 years).

Active channel width: The area of the channel(s) that has been inundated at sufficiently regular intervals to maintain channel form and to keep the channel free of established terrestrial vegetation.

Water surface width: The width of wetted section of the river from bank to bank at 90° to the direction of flow (i.e. the actual water width).

Bank height: The height from surface of water to top of bank. Estimate left (facing downstream) and right banks separately.

Deep-water physical biotope: Average depth of dominant deep-water area that is > 0.5 m deep (e.g. pool or deep run). The average is a rough estimate. Record the type of biotope e.g. pool, backwater, etc.

Shallow-water physical biotope: Average depth of dominant shallow-water area that is < 0.5 m deep (e.g. riffle, run). Record the type of biotope e.g. cobble riffle, bedrock rapid, cascade, etc.

3 SUBSTRATUM COMPOSITION

Estimate the abundance of each substrate type for the stream bed and bank using the following scale: 0 – absent; 1 – rare; 2 – sparse; 3 – common; 4 - abundant; 5 – entire. Size classes for each substratum type have been modified from the Wentworth grade scale and are given below. Units are in mm.

Material	Size class (mm)
Bedrock	
Boulder	> 256
Cobble	100 – 256
Pebble	16 – 100
Gravel	2 – 16
Sand	0.06 – 2
Silt / mud / clay	< 0.06

Degree of embeddedness of substratum (%):

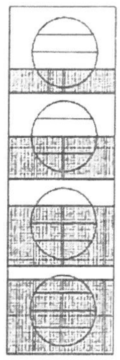
This refers to the deposition of fine grains around coarse particles (e.g. sand around cobbles). Estimate the extent to which boulder/cobble/gravel particles are embedded in the surrounding fine sediments such as small gravel, sand, silt and/or mud.

0-25

26-50

51-75

76-100



4 INVERTEBRATE BIOTOPES

Record the **general river make-up**, i.e. pool, run, riffle or a combination thereof. This provides an indication of biotope diversity.

Biotopes have been grouped into two types, namely SASS biotopes and specific biotopes. They relate to the type of habitat available for habitation by aquatic organisms as well as the hydraulic conditions in some instances. SASS biotopes are based on those described in the SASS5 protocol (Dickens and Graham 2002). For stones in and out of current, it is important to record if the substrate is bedrock.

Estimate the abundance of each SASS and specific biotope type using the following scale: 0 – absent; 1 – rare; 2 – sparse; 3 – common; 4 - abundant; 5 – entire. *Specific biotopes* provide further details of the types of biotope within each SASS biotope. Descriptions of some of these have been extracted from Rowntree and Wadeson (1999, 2000). Details of the biotopes are given below:

SASS biotopes		Description
Stones In Current	SIC	Stones in flowing water, may include bedrock
Stones Out Of Current	SOOC	Stones out of any perceptible current (with visible silt seen accumulating on stone surfaces), may include bedrock
Marginal Vegetation In Current	MV-IC	Emerged and submerged vegetation in fast current; at the river's edge or on the edge of in-channel islands
Marginal Vegetation Out Of Current	MV-OC	Emerged and submerged vegetation out of any perceptible current; at the river's edge or on the edge of in-channel islands
Aquatic Vegetation	AQV	Submerged or partially submerged vegetation within the channel, normally in flowing water
Gravel	G	Stones <2cm in diameter
Sand	S	Sand grains <2mm in diameter
Silt/mud/clay	M	Particles <0.06mm in diameter

SASS Biotope	Specific biotope	Description
SIC	Riffle	Occur over coarse alluvial substrates from gravel to cobble; undular standing waves or breaking standing waves.
	Run	Occur over any substrate e.g. gravel, cobble, boulder; ripple flow but surface of water not broken.
	Boulder rapid	A rapid-like feature made up of large immobile boulders.
	Bedrock	Large sheets of rock.
	Chute	Typically occur in boulder or bedrock channels where flow is being funneled between macro bed elements; smooth boundary turbulent flow exhibiting flow acceleration.
	Cascade	Occur over a substrate of boulder or bedrock. Small cascades may occur in cobble where the bed has a stepped structure due to cobble accumulations. Free falling flow, contact with substrate largely maintained
SOOC	Backwater	A morphologically defined area along-side but physically separated from the channel, connected to it at its downstream end; barely perceptible or no flow.
	Slackwater	An area of no perceptible flow which is hydraulically detached from the main flow but is within the main channel; barely perceptible or no flow.
	Pool	An area with direct hydraulic contact with upstream and downstream water; barely perceptible flow.
	Bedrock	Large sheets of rock.
MV		Grasses, reeds, shrubs, sedges, etc. which are adjacent to the river bank. Also includes floating macrophytes such as water hyacinth, parrot's feather, etc.
AQV		Sedges, moss, trailing grasses, filamentous algae, etc. which are submergent or partially submergent, normally in flowing water.
GSM		Gravel, sand or mud present in backwater, slackwater and/or in-channel, i.e. in main flowing part of the channel.

5 INVERTEBRATES - SASS (SOUTH AFRICAN SCORING SYSTEM) ASSESSMENT

Note: do not complete details (shaded section) on SASS sheet if doing a full RHP assessment. The standard SASS5 sampling protocol is to be used (Dickens and Graham 2002). The procedure is as follows:

- Kick stones in current (SIC) and bedrock for 2 minutes if stones are loose, maximum 5 minutes if stones immovable. <u>Note that the above times refer to actual kicking time, and not to time spent crossing the river.</u>
- Kick stones out of current (SOOC) and bedrock for 1 minute.
- Samples collected both in and out of current are combined into a single Stones (S) biotope sample.
- A total length of approximately two meters of vegetation must be sampled, spread over one or more locations, especially where different kinds of marginal vegetation are present (e.g.

reeds plus grasses) in different flow velocities, and aquatic vegetation for a 1m^2 area.

- Samples collected in and out of current and aquatic vegetation are combined into a single Vegetation (Veg) biotope sample.
- Stir and sweep gravel, sand, mud (GSM) (both in and out of current) for 1 minute total.
- Samples collected in and out of current are combined into a single Gravel, Sand & Mud (GSM) biotope sample.
- Hand picking and visual observation for 1 minute - record in biotope where found (by circling estimated abundance on score sheet).

For each of the 3 major biotopes (Stones, Veg, GSM), tip net contents into tray, remove leaves and twigs, score for 15 minutes per biotope but stop if no new taxa seen after 5 minutes. Estimate abundances as follows: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000.

6 INVERTEBRATE BIOTOPES SAMPLED - INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

IHAS attempts to account for the variability in the amount and quality of SASS biotopes which are sampled by the SASS practitioner. This modified version is based on that of McMillan (1998) but has been reduced to include "Habitats Sampled" only. The "Stream Characteristics" components have been excluded since these data are captured elsewhere in the RHP field-data sheet. The scoring system has also been omitted as the method still requires validation.

The aim of the present IHAS assessment is to record details about the SASS biotopes sampled, both to provide immediate information on SASS biotopes assessed and to begin the process of testing and validating the method. In the present version habitats have been divided into stones in current, vegetation and other (stones out of current, gravel, sand, mud). Several aspects are assessed in each and in each case the appropriate number/description is circled.

7 FISH

Fish habitat segments

The reference unit is the fish habitat segment (Kleynhans 1999b), that refers to a portion of a stream in which the fish community remains "generally homogeneous due to the relative uniform nature of the physical habitat" (Ramm 1988). The boundaries of a fish habitat segment can be expected to vary according to the temporal and spatial variability (natural and human-induced) of environmental conditions in a segment. The purpose of defining fish habitat segments are to provide a basis that can be used to specify reference biological conditions in such segments with regard to the indigenous fish species that can be expected to occur, their frequency of occurrence and general health and well-being. In addition, it is potentially possible to define reference habitat conditions that can be expected to occur at a broad level.

Normally, fish sampling should be done during low flow conditions (base flow conditions, usually during the dry season).

FISH HABITATS

Record the general fish habitats available, i.e. slow-deep, slow-shallow, fast-deep and fast-shallow that relate to the broad hydraulic conditions that may be available for different fish species (Kleynhans 1999b, Jordanova *et al.* 2004).

For each velocity-depth class, the presence of features that provide cover for fish (i.e. refuge from high flow velocity, predators, high temperatures, etc.) are taken into consideration (Kleynhans 1999b):

- **Overhanging vegetation:** Thick vegetation overhanging water by approximately 0.3 m and not more than 0.1 m above the water surface. Marginal vegetation is included here.
- **Undercut banks and root wads:** Banks overhanging water by approximately 0.3 m and not more than 0.1 m above the water surface.

CALCULATING DISCHARGE

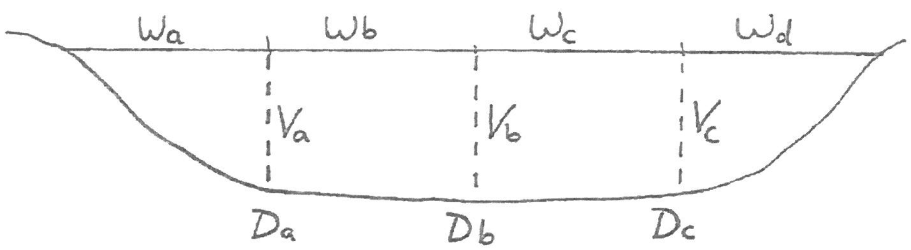
Discharge (flow) in South African rivers is monitored through a national network of 780 gauging weirs. Discharge (D) is given as:

$\mathbf{D} = w * d * v$ where: $\mathbf{D}$ is measured in $\mathbf{m^3\ s^{-1}}$, and the units referred to as cumecs
w is wetted width of the channel, measured in **m**
d is water depth, measured in **m**
v is current velocity in $\mathbf{m\ s^{-1}}$

When calculating total discharge from measurements on bank-to-bank cross-sections, the above formula for discharge is modified as follows:

$$D = w_1 d_1 v_1 + w_2 d_2 v_2 + ...+ w_n d_n v_n$$

In this equation each $w_n d_n v_n$ represents the area of a two-dimensional rectangular segment of the cross-section, multiplied by the mean velocity of water flowing across that segment. When discharge is measured in the field, width, depth and velocity are recorded at equal intervals across the stream cross-section. These measures then provide the dimensions of the edge of each rectangle. To calculate the cross-sectional area at the stream edge, a triangular cross section is calculated and multiplied by the first or last velocity reading. Thus if discharge variables are collected in the following way:



then $D = w_1 d_1 v_1 + w_2 d_2 v_2 + w_3 d_3 v_3 + w_4 d_4 v_4$

where $w_1 d_1 v_1 = Wa((Da)/2)Va$

and $w_2 d_2 v_2 = Wb((Da+Db)/2)((Va+Vb)/2)$

Because of the variation in velocity within a stream, many points must be taken within a transect in order to obtain a true estimate of discharge. When calculating discharge from field depth and width measures, make sure that you convert from cm to m.