## 5. USING A HYDROLOGICAL INDEX

The previous section outlined the various approaches that could be used to hydrologically 'calibrate' the site, i.e. establish the historical flow regime characteristics of the site. The end product of the calibration process should be a 1-day flow duration curve for each month of the year, derived through whatever is considered to be the most reliable and accurate approach applicable to each individual biomonitoring site.

One of the difficulties will always be collecting real-time information with which to update and extend the time-series and derive the index values for both the sampling time and the antecedent conditions. This problem applies whether or not the time series generation approach is based on extrapolations from nearby streamflow gauges, or using a method based on rainfall. It will be necessary for the biomonitoring team to establish the feasibility of accessing such data in near real-time and for them to establish the required contact procedures. Farmers are frequently useful sources of rainfall information, but it is important to recognise the need to use the same source of rainfall data to calibrate the 'model' as that which it is intended to use in real-time.

It should also be noted, however, that a different 'model' could be used for the calibration and the real-time index estimation. For example, to hydrologically calibrate the site, a simple monthly rainfall-runoff model may be used, in conjunction with a regionalised procedure to convert monthly duration curves to daily duration curves. The channel at the site could then be hydraulically calibrated and a stage gauge plate installed. The estimation of index A may then involve updating the monthly rainfall data and re-running the model, while the estimation of index B may involve reading the gauge plate during the site visit and estimating the flow using a stage-discharge rating curve.

### 5.1 Index A - Estimating antecedent conditions for the 3 months prior to sampling

The estimation of ***Index A*** would mainly be a matter of updating the flow time-series using the 'model' for the past three months so that the antecedent conditions could be identified. It has been suggested that the index could be based on duration curve percentage point ranges (Table 1), converting different ranges of percentage time equalled or exceeded to index values between 0 and 5. An index value of 0 would then imply a flow that is equalled or exceeded at least 80% of the time (a low flow), while an index value of 3 would imply a flow that is somewhat higher than the median flow. A high index value would therefore suggest uncommonly high flows, while a low index value would imply uncommonly low flows. ***The % point ranges given in Table 1 are initial suggestions which should be refined for each site after discussions between the biomonitoring specialists and the hydrologist.***

To quantify an index for the three month period, the index for flow 3 months ago could be weighted by 0.1, the index for flow 2 months ago weighted by 0.3 and last months flow by 0.6. This would generate a final index value of between 0 and 5. As there will be flow variations within each of the last three months it will be necessary to decide what flow value is to be used to estimate the index values. ***This might also depend upon individual site characteristics and should also be determined after discussions between the specialists concerned.*** However,

logical suggestions might be the mean or median flow for the month, or something like the mean of the lowest 10 (say) flows, which might avoid the problem of getting quite high index values if a short duration, but high peak flow occurs. The final choice might also depend upon the method used to generate the data and the expected accuracy of individual daily flow estimates.

Table 1 Suggested index values for duration curve percentage point ranges.

| Index Value | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|
| % Point range | <20 | 20 - 30 | 30 - 50 | 50 - 70 | 70 - 80 | > 80 |

### 5.2 Index C - Estimating flow conditions at the time of sampling

The need to establish a stage-discharge rating curve at a hydraulically calibrated cross-section close to the biomonitoring site has already been referred to. The estimation of ***Index C*** would be based on the observation of stage at the site, or an adjacent gauging site, and conversion to a flow rate using the stage-discharge rating curve in both cases. If a stage-discharge rating curve is not available, it will be necessary to carry out time-consuming discharge measurements during each visit. The index value could then be estimated in a similar way to Index A using Table 1.

### 5.3 Index B - Estimating antecedent flood conditions for the 3 months prior to sampling

***Index B*** presents a somewhat more difficult problem as many of the simpler methods for generating daily time series do not usually give reliable estimates of flood flows. In particular, the conversion of monthly to daily duration curves based on regional values are unreliable for flows that are equalled or exceeded less than about 5% of the time. Even when the method using an existing flow gauge that has similar flow characteristics to the site being sampled is used, there are still difficulties as many of South Africa's flow gauging structures are not rated for high flows. In the absence of a better approach, it may be possible to use daily rainfall from a selection of gauges within the catchment area and base an index on catchment average rainfall, converted to an annual return period (using a reference source such as Adamson, 1981 - which provides information on the depths of rainfall associated with 1:2, 5, 10, 20, 50, 100 and 200 year return period events for a large number of stations country-wide). However, the relationship between extreme rainfalls and extreme runoff is not really as simple as such a method suggests.

Consideration should also be given to the antecedent period over which the search for a 'recent' flood is to be based. If this is to have any substantial ecological 'significance', the period may vary from site to site depending upon the local characteristics. Equally, a large flood with a high return period that occurred quite some time before the sampling visit, may have a larger influence on the biota and physical channel form than a smaller flood that occurred recently. ***It is therefore very difficult for a hydrological specialist to recommend an approach without further input from the ecological and geomorphological specialists.***