Input variables

The implementation, application limits and field measurement protocol of statistical habitat models are very similar, with some variations depending on the model. In particular, estimating the hydraulic geometry of reaches, by measuring widths and depths at two flow rates, is the main input variable common to all statistical software. Input variables of models are provided by the user as variables or input files. However, for Estimhab with HABBY or with Excel, some input variables are entered when running the model.

Reach choice

The models perform simulations at the scale of stream reaches, a study ideally comprising several reaches. The choice of reaches depends on the objective of the simulation. However, the application of the models assumes that the reach reflects the diversity of geomorphic units occurring along the river (riffles, runs, pools). On average along rivers, riffle-pool sequences follow each other every 6-7 times the bankfull width. Consequently, we recommend applying the method to reaches with a length > 15 times the bankfull width of the river. We recommended to carry out a summary mapping on a larger scale before choosing representative reaches. Choosing long reaches > 15 times the width does not pose a problem. On the other hand, choosing shorter reaches should only be done if necessary (eg: short bypassed section, description of a shorter fishing site): it will then be necessary to justify that the reach still contains a diversity of geomorphic units.

Estimating reach hydraulic geometry

Principle

The hydraulic geometry of the stream reach (depth-discharge, width-discharge relationships) is the essential input variable for statistical models. These relationships follow "power" laws, which means that knowing the average depth and width of the reach at two very different flow rates is sufficient for the application of the models. Most of the field measurements therefore consist in estimating, at 2 different flows (Q1 and Q2), the average water depth (H1 and H2) and the average wetted widths (W1 and W2) of the reach. These field measurements make it possible to estimate the hydraulic geometry of the reach. They are used to fill in an input file (see example file "*qhw" supplied with HABBY or the R versions) which contains the 6 values.

Choosing 2 discharge rates Q1 et Q2 for field mesurements

If we could "choose" …. The average width and depth at any flow rate are extrapolated from the measurements made at Q1 and Q2, after adjustment of power laws linking the width and depth to discharge (so-called "hydraulic geometry" laws). The extrapolations must be correct both in the simulation range and up to the median natural flow Q50 of the river. Simulations of uncertainties on the choice of measurement discharges suggest using discharges that are as contrasted as possible, with the following rules:

1. Q2 > 2*Q1
2. the simulation will be between Q1 / 10 et 5 * Q2
3. the natural median flow Q50 is also between Q1 / 10 and 5 * Q2
4. the two discharge Q1 and Q2 remain lower than bankfull flow.

It is at low flow rates that hydraulic conditions change quickly and measurements are easy, so the ideal is to choose Q1 as low as possible and Q2 closer to Q50. The time spent between the two measurement campaigns is not problematic … as long as there is no morphogenic flood.

Measuring Q1 et Q2

To estimate Q1 and Q2, if there is a gauging station in the immediate vicinity and negligible contributions between the reach and the gauge, we can refer to it. Otherwise, Q1 and Q2 must be measured in a suitable section (as rectangular as possible, with moderate-high velocities, not necessarily in the reach). Results of models are very sensitive to the estimation of Q1 and Q2, which must therefore be accurate (error < 10%).

Other hydrologic estimations

The modelling discharge range must be entered for all models (see example file “*deb” which contains two flow rate values indicating this range). It should be consistent with Q1 and Q2 values as mentioned above.

Only Estimhab requires other hydrological characteristics of the section as an input variable (the median natural Q50 flow). Nevertheless, an e-flow study without knowledge of the reach hydrology makes no sense (e.g. mean discharge, high and low flows characteristics). The flow history is necessary for the interpretation of simulations, considering the life cycle of aquatic species. As for Q50, the estimation of these hydrological characteristics is a crucial point of the impact study. It is essential to describe clearly the methods used for hydrological estimations, their validation and their uncertainty.

Estimating substrate characteristics

Not all statistical software requires this, but we recommend estimating the particle size distribution regardless of the software used. In practice, we recommend measuring, at one of the two measurement rates, the size of the elements of the substrate. The field measurement protocol proposed below makes this possible.

Specificities

Estimhab

- Q50: In addition to the field measurements, the estimate of the median daily flow of the river (Q50) under natural conditions (e.g. if there was no water use) is also part of the model's input variables. Estimhab is less sensitive to the estimation of Q50 than those of the measuring discharges Q1 and Q2, but it must nevertheless remain accurate (error < 20%). We can use a nearby gauging station. Otherwise, it is necessary to extrapolate from another station, carry out repeated field measurements, or use relevant hydrological models. The extrapolation of flows from a neighbouring station is often delicate and can generate significant errors, which is why we strongly recommend accompanying it with adequate additional measurements (we do not describe the methods that can be used here). It is essential to describe clearly the methods used for hydrological estimations, their validation and their uncertainty.
- Substrate size (from field measurements): Estimhab uses the average size of the particles measured in the reach.

Stathab

Substrate (from field measurements) : Substrate sizes are entered into stahab as a grain size distribution file (see example file “*gra”) containing the frequencies (sum = 1) of 12 classes of substrate (detritus, clay, fine sand, coarse sand, < 1, <2, <3, <6, <12, <25, <100, >100, in cm)

Depth Distribution at one measuring discharge (from field measurements) : It is a less intuitive file (see example file “*dis”) that Stathab needs. It contains a depth frequency distribution at one of the measurement discharge. Its 22 lines corresponding to the sampling rate Q (Q1 or Q2), to the average depth at Q (H1 or H2) and to the frequencies (sum = 1) of 20 regular depth classes ranging between 0 and 5H (in other words, the width of each depth class is H/4).

Stathab() : also requires definitions of depth and velocity class bounds (see “bornh” and “bornv” example files) used for calculations of hydraulic variable distributions.

Stathab_steep

Slopes : compared to the implementation of Estimhab, additional field measurements are necessary or optional for Stathab_steep (see example file “*ii”). The input data consists of 3 values influencing the hydraulic distributions, of which only the first is obligatory:

- the average slope of the reach (expressed in %),
- the cumulative height of waterfalls (cumulative height of falls whose height is > 20 cm) along the reach. This is estimated in the field by reach along the thalweg.
- the length of the station (m)

Particle size measurements are not necessary for the implementation of Stathab_steep. However, they are useful for other statistical hydraulic models, and more generally essential for describing the habitats of species. We therefore recommend carrying them out.

FSTress

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