

Algae survey methods supplementary information

RAPPER

The Rapid Assessment of Periphyton Ecology in Rivers or the 'RAPPER' survey method was originally developed to allow aquatic ecologists to use algae to quickly determine whether a section of watercourse is likely to be subject eutrophication pressures (excessive/unnaturally high levels of nutrients). However, the data collected by RAPPER also has potential for monitoring other stressors.

As taken from pages 6 and 7 of the [Rapper manual \(version 1.7\)](#):

"RAPPER (Rapid Assessment of Periphyton Ecology in Rivers) was designed to be faster to use than standard methods, allowing more sites to be assessed during the course of a day, and results to be available to decision-makers more quickly than is presently the case. It can be considered to be the ecologists equivalent of medical "triage": giving a high-level overview of a situation in order to prioritise the use of limited resources. The principle of the method is that a short length of a stream or river is surveyed and all algal growths that are visible to the naked eye are either identified in situ or sampled for subsequent identification in the laboratory. The proportion of stream or riverbed that they cover is also recorded. Identification of the dominant algae to genus is then used to predict the risk of eutrophication at the site."

Predicted risk of eutrophication is categorised as 'No risk', 'Maybe at Risk', and 'At Risk'.

The level of risk for a site in the RAPPER manual depends on whether the species recorded are:

The 'stress-adapted' and 'competitive' categories below were derived from academic studies (Grime's "CSR life-strategy theory") and have proved difficult to explain to non-specialists. Therefore, a simplified terminology developed in a "Citizen Science" version of RAPPER for Ireland has also been included:

- 'Stress-adapted': the "good guys" (i.e. taxa that thrive under low nutrient conditions = those that would be expected in a river close to its natural state)
- 'Competitive': the "bad guys" (i.e. taxa that outcompete other taxa when nutrient availability is not a growth-limiting factor = those taxa expected when a river is enriched with nutrients)
- Unknown: those taxa that either can live across a broad range of nutrients or those where we have insufficient information to make a reliable judgement.

The abundance of each taxa (recorded using cover values, see **Table 1**) is taken into consideration alongside the complete absence of 'Stress-adapted' taxa during a survey (which would automatically categorise a site as 'Maybe at Risk').

RAPPER was designed for use in small streams, and the survey method involves wading across the entire width of a 10m transect whilst checking the river bed for algal growths. The English Wye is a much larger river than originally envisaged for RAPPER, so an alternative approach has been adopted, with a 5m wide by 10m long area of channel delimited and used for surveys. The 9-point cover value scale of the original RAPPER

manual was retained as it is the same as that used by the Environment Agency for macrophyte surveys, although a simpler scale may be appropriate if this method is adapted for Citizen Science surveys in the future.

The cover value bandings, and the risk categories and thresholds used for RAPPER categorisation are detailed in **Table 1**, as taken from Rapper manual. Note: Due to cover bands offering a percentage cover range (e.g., cover value 8 = 50-75% cover), as opposed to a fixed percentage, it is possible to have total cover values for all species recorded in a survey that exceed 100% if the higher end of each cover band is used during data interpretation. Furthermore, on occasion, algae can grow over each other causing greater than 100% total coverage. The EA is now recording actual percentage cover estimates alongside the 9-point cover scale for the River Wye RAPPER surveys.

Following the advice of Martyn Kelly (one of RAPPER's developers), if data is used from surveys without the actual percentage cover of each recorded taxa, the median value of the cover value recorded is used in calculations (e.g., if *Cladophora* is recorded with a cover value of 5, which equates to 5-10%, the percentage cover is assumed to be 7.5%). The total cover is the point on the cover value scale equivalent to the sum of cover values of all taxa present.

Table 1. RAPPER 9 point-scale and associated cover bands.

Cover Value	Percent cover of stream bed	Mid-point of cover band (%)	Category
1	<0.1	0.05	Low cover
2	0.1 < 1	0.5	
3	1 < 2.5	1.7	
4	2.5 < 5	3.8	
5	5 < 10	7.5	Moderate cover
6	10 < 25	17.5	
7	25 < 50	37.5	High cover
8	50 < 75	62.5	
9	≤ 75	87.5	

Table 2, taken from the Rapper manual, details how the presence/absence and abundance of taxa categories converts into a “risk of eutrophication” category and its likely association with WFD status. Note that there are two situations under which a “maybe at risk” determination can arise. The first is when “good guys” are present, along with a moderate or high cover of “bad guys”. This situation represents a genuine “mixed message” where further investigation would be required. The second is when “good guys” are absent, but there is low cover of “bad guys”. In this case, there is not enough information on which to base a judgement. Approximate linkages with Water Framework Directive status classes are also included on this chart although these would need to be validated with additional data.

Table 2. RAPPER category scoring matrix.

Condition	Not as risk	Maybe at risk		At risk
Likely WFD status	High/Good	← Moderate →		Poor/Bad
“Good guys” (stress adapted)	Present	Present	Absent	Absent
“Bad guys” (competitive)	Low cover ≤ 5%	Moderate-high cover >5≤25%	Low cover ≤ 5%	Moderate or high >25% cover

Finally, as this is a relatively new method, it is important to note that the manual providing the methodology for this survey type is considered a ‘working document’ and further refinements to the process of site assessment may be made as the method is more widely tested.

In particular, the original brief was for a method that would help with sub-catchment scale investigations to locate nutrient-related issues, whereas the River Wye appears to show interactions of nutrient levels and climatic conditions.

Algae Bottle samples

Free-floating, typically microscopic, planktonic algae and blue-green algae (cyanobacteria) samples are collected using a sterilised 1L bottle in the mid-channel and collecting 100ml-200ml of river water. Samples are taken back to an Environment Agency laboratory and analysed microscopically using the Sedgwick-Rafter method. Following procedures and guidance outlined in the Environment Agency Operational Instruction 906_08, this analysis allows the algae type, number of cells, and number of colonies of each taxon present in 1ml of water to be determined.

The purpose of this monitoring program is primarily to identify presence and abundance of free-floating algae throughout the Wye to inform decisions around the [River Wye early warning system](#).

Amongst the free-floating algae observed, efforts are made to confirm the presence/absence of blue-green algae within each sample. Whilst the presence of blue-green algae blooms in a waterbody can be problematic, in most instances, these species are not considered harmful to human health unless cell counts per 1ml of water exceed 20,000 (as determined by the World Health Organisation). For free floating planktonic species that are not blue-green algae, whilst high proliferation may lead to changes in water clarity/pigmentation that are not aesthetically pleasing, most are not believed to pose direct risks to human health. Algae blooms do naturally occur from time to time, and it is natural for free-floating algae communities to be present in river water.