Calculating compliance with targets: modified from Swan River Trust 2004

To assess whether or not the water quality at a site is passing a target, sample data are compared with the target concentrations. Developing the sampling program – known as a compliance-monitoring scheme – and assessing the achievement of targets require the definition of three key things:

- When, where and how often samples are collected. In the catchments, compliance sampling is carried out while the rivers are flowing, between June and October.
- The statistic used to characterise quality may be any percentile value. For compliance with the nutrient targets in the catchment the 50th percentile is used. Note that compliance is not based on a single sample value, but on a set of data points obtained throughout monitoring.
- The 'compliance/breach' criterion that will be applied to the target. Taking into account sampling error, how many samples are permitted to exceed the target before it is decided that the target is breached (or met)?

In all catchments data from three consecutive years is pooled to compare both TN and TP values to the targets. Pooling three years of data minimises the impact of unusually wet or dry years and gives greater confidence that any changes in compliance are real.

The test statistic

Because of natural variation in water quality, compliance is not assessed against a single sample value, but against a key statistic derived from the set of monitoring data.

Assessing compliance with percentile water quality targets is actually about examining the rate of excursion from target levels. The excursion rate is the period in which water quality is worse than the limit established by the target, and the maximum allowable excursion rate is specified by the population statistic used.

The compliance/breach criteria

From the pooled samples collected in each catchment (about 30 for the Swan-Canning catchment) it is easy to calculate an excursion rate, which is simply the percentage of samples that exceed the target value. However, because

the sampling data is collected at intervals (as opposed to continuous monitoring) the true rate of excursion above the target value cannot be known. The excursion rate determined from the available data is an estimate of the actual excursion rate in the stream. However, statistics can be used to calculate a range around the sample excursion rate within which the actual excursion rate is likely to lie. This range of values is known as a confidence interval. For catchment compliance, decisions of compliance or breach are taken using a 95 per cent confidence interval around the sample excursion rate (see Figure 1). There is a 95 per cent probability that the true population rate of excursion lies within this range.
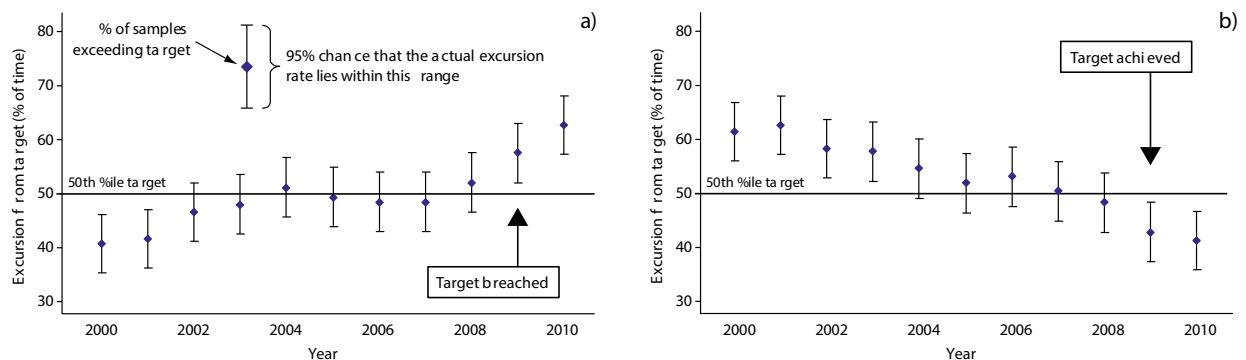

Figure 1: The confidence interval method for measuring a) breach and b) achievement (or compliance) of a catchment nutrient target.

For those catchment tributaries where water quality is currently acceptable the target is breached when the entire confidence interval lies above the target value (Figure 1a). in this case it can be safely concluded (with 95 per cent probability) that water quality has exceeded the target level. For those tributaries where water quality is currently worse than target levels the benefit of the doubt goes the other way. That is, the target is only achieved where there is a 95 per cent probability that water quality has actually improved to better than target levels (Figure 1b).

Using the confidence interval method, decision rules have been developed which specify exactly how many samples are allowed to exceed each target before the target has been breached, or met. Examples of the decision rules are given in Table 1 below. The confidence interval method results in two separate decision rules depending on whether or not current water quality is acceptable. Decision rules can be developed in exactly the same way for any number of collected samples which is necessary in practice because the number of samples collected over a monitoring period varies from year to year and from catchment to catchment (as there may be different sampling frequencies).

Table 1: Examples of decision rules for catchment nutrient targets. The rules cover compliance decisions for 50th percentile targets using 30 samples.

Prior condition	Decision rule
Water quality target met (passing target)	20 or more samples > target = water quality target no longer met (tributary fails target)
Water quality target not met (failing target)	11 or fewer samples > target = water quality target met (tributary passes target).

References

Swan River Trust 2004, *Developing targets for the Swan-Canning Cleanup Program, River Science 7*, Swan River Trust, Perth.