FINAL

EnviroLink Project Task NLRC19

Adequacy of Monitoring Programme Design: Puwera Stream: Assessing the Benefits of Implementing the Clean Streams Accord

Graham McBride, NIWA, Hamilton
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I have been requested by Northland Regional Council to assess the adequacy of the design of a newly-commenced monitoring programme.

Background

The Northland Regional Council has received funding from the Ministry for the Environment for "Establishment of a Tier 2 monitoring baseline by Northland Regional Council to assess the environmental benefits of the Clean Stream Accord" (as have three other Councils). To do so, they have selected a stretch of the Purewa Stream, 8 km southwest of Whangarei, at which two sites are to be sampled fortnightly for a range of water quality variables. There is considerable dairying activity between the sites with, as yet, minimal implementation of the Best Management Practices contained in the Accord. It is intended to sample for one year.

Findings

The sampling sites and monitoring frequency are appropriate. In particular, I endorse the fortnightly paired-sampling in a fixed schedule, such that samples will be taken regardless of flow conditions (unless safety issues demand otherwise). The list of variables is also appropriate, and consistent with the Accord.

The major question concerns the adequacy of the intended monitoring period (one year), given that its results will be compared with those from a future monitoring programme on this stream once the Accord has been substantially implemented.

I find that one year's sampling is insufficient to provide enough data to be able to reliably detect important differences that the Accord's implementation may be expected to confer.

Rationale

Fonterra has been funding a water quality monitoring programme in 5 "typical" dairy catchments (Wilcock 2006). Mostly these studies have single sites, but for some periods there have been two sites, between which dairying takes place. Of these the Toenipi (Waikato) and Waiokura (Taranaki) are suitable for comparison with the Purewa. I examined the difference in means between the upstream and downstream sites on these streams for each of two years (the period over which comprehensive

sampling was carried out for both upstream and downstream sites). I then examined the differences between these results between the two years, i.e., differences of differences! That was done because the analysis of these data will have to use a (very simple form of) *BACI* design (Before-After-Control-Impact). Such designs do have some optimal features, because in considering changes in upstream-downstream differences (i.e., Control – Impact), any influence that affects *both* sites is effectively removed.[1] This can considerably increase the statistical power of the analysis. The key statistic to consider is therefore the percentage change in median differences between the years, in the Before category. If this is in some sense "large", multi-year sampling will be necessary in both the Before and in the After periods.

For key nutrients and *E. coli* this percentage between-year change can be as much as 180%, though more typically is on the order of 100% or less.

Given this magnitude of differences between years, it is very unlikely that the programme will deliver sufficient data in one year to be able to confer sufficient power on the future analysis of the data (once post-Accord-implementation data are also to hand) to be able to reliably detect important differences (using procedures in McBride 2005). My colleague Judi Hewitt (proficient in the nuances of analysis of BACI designs) confers with this finding.

Of further note is that the implementation of the Accord may commence soon, in which case conditions will change during the baseline monitoring. This is not necessarily a problem, because one can analyse the record (e.g., sampling in years 1, 2, 4, 5) as a trend—although sampling every year would be optimal.

References

Manly, B.F.J. (2001). *Statistics for Environmental Science and Management*. Chapmana & Hall/CRC, Boca Raton.

McBride, G.B. (2005). *Using Statistical Methods for Water Quality Management: Issues, Problems and Solutions*. Wiley, New York

Wilcock, R.J. (2006). Dairy farming and sustainability: a review of water quality monitoring in five contrasting regions of New Zealand. Proceedings of Water2006, Auckland, August.

[1] There is also an assumption that the distribution of changes between upstream and downstream sites would not change over time in the absence of the Accord (Manly 2001: 15–16)