History Rhymes: Data Rich But Information Poor (Newsletter)*

January 15, 2015

The 1986 paper by Ward et al.[1] focused on regional water quality planning rather than permit compliance yet their thesis, that monitoring programs are designed and implemented without regard to a management "why," remains true today.

Too many project permit compliance monitoring requirements are not based on location-specific conditions or well defined management concerns. Standard lists of chemical constituents are found in state statutes based on EPA lists. These form the basis for water discharge permits regardless of location or permitted activity. Sampling locations and frequencies are standardized rather than specific to isolating anthropogenic effects from natural variability. Data analyses are limited to summary statistics and bar or line charts for a constituent's concentration history at a site. The permit holder submits reports as required by the regulator and, if no concentration exceeds the designated maximum, the reports are filed. Both permittee and regulator have complied with statute. However, this does not mean that the purpose of the permit—maintenance of specific designated beneficial uses—has been achieved.

A major problem common to all environmental statutes and regulations is the ambiguity of linquistic variables such as "quality," "degradation," and "significant." Since these terms are not directly measurable they are open to different interpretations. A serious shortcoming of water chemistry monitoring regulations is the lack of guidance for appropriate data analyses and interpretation.

A solution to both these problems allows regulators to base decisions on project- and site-specific information of the measured effects of the composition of discharged waters on designated beneficial uses.

Robust, technically sound, and legally defensible monitoring programs need to explicitly define their purpose. This means for each project or location the specific designated benefitial use(s) must be defined as well as the chemical constituents of concern, and why they are of concern. Monitoring locations

[1]Ward, R.C, J.C. Loftis, and G.B. McBride. 1986. The "Data-rich but Information-poor" Syndrome Water Quality Monitoring. Environmental Management 10:291-297.

should be at the permit boundary; if streams are tributaries then samples upstream of the confluence on the receiving water must be collected at the same time. Potential explanatory variables such as current velocity or discharge, water and air temperatures, bank cover in the sampled reach, substrate composition, and biota (benthic macroinvertebrates, fish, and plant presence/coverage) should be measured at the same time.

Raw data from field and laboratory measurements should be stored in a database, not a spreadsheet; when properly designed the former prevents duplicate data, catches data input errors, and maintains data integrity.

Statistical analyses use multiple models and must go beyond descriptive summaries (such as mean and variance). Environmental chemical data are not normally distributed (e.g., presence of outliers at the right tail; concentrations never less than zero) so non-parametric models should be applied. Correlations are not causative; therefore, appropriate regression models (e.g., quantile regression) are part of the analysis. Biological data are counts which require Poisson or logistic regression models, not linear ones.

The analyses need to separate anthropogenic from natural variability. This supports informed operational and regulatory decisions based on quantified anthropogenic changes in observed designated beneficial uses, not natural variability which cannot be regulated.

Existing monitoring programs can be tweaked to make them more effective while new ones can be well-designed from the beginning. Benefits are seen by permit holders, regulators, and society.

—

All newsletters, white papers, and other technical resources can be freely downloaded from `http://www.appl-ecosys.com/publications/`.