Freshwater Field Protocol Comparability

Quality Assurance Project Plan

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Approvals

Approved by:	April 19, 2001
Rob Plotnikoff, Unit Supervisor, Freshwater Monitoring Unit	Date
Approved by:	May 1, 2001
Ken Dzinbal, Section Manager, Environmental Monitoring and Trends Section	Date
Approved by:	May 21, 2001
Cliff Kirchmer, Ecology Quality Assurance Officer	Date

Organization and Schedule

The following Department of Ecology staff are members of the project planning team that developed this plan: Steve Butkus, Maggie Bell-McKinnon, Rob Plotnikoff

The following are the roles of people involved in the study:

Steve Butkus, Department of Ecology EA Program, 360-407-6742

- Responsible for project management, coordination and field sampling, data compilation, data analysis, and periodic evaluation reports.

Maggie Bell-McKinnon, Department of Ecology EA Program, 360-407-6124

- Responsible for coordination and field sampling with citizen volunteers

Other Department of Ecology EA Program staff as needed

- Responsible for field sampling

Staff from other agencies conducting water quality monitoring using field methods, including the federal and state government, counties, cities, tribes and consultants.

- Responsible for field sampling

Citizens who volunteer time to conduct water quality monitoring using field methods.

- Responsible for field sampling

This project will have an ongoing schedule as required to evaluate the comparability of field data collected by outside monitoring groups to data collected by Ecology. The following is the project timetable:

Reconnaissance: Starting in July 2001, outside monitoring groups that have contributed field data for use in water quality assessments will be contacted to coordinate when side-by-side monitoring can be conducted with Department of Ecology staff. In addition, citizen volunteer monitoring groups that would like the data they collect to be used in water quality assessments would be contacted for side-by-side monitoring with Department of Ecology staff. This reconnaissance would be ongoing for the life of the project.

Field Activities: Starting in July 2001, staff from the Department of Ecology EA Program and outside monitoring groups would meet at various sampling locations throughout the state. Side-by-side sampling will occur at all times of the year.

Data Entry: As data are collected, they will be compiled and entered into a simple spreadsheet for analysis.

Reporting: Periodic reports will be prepared as needed to evaluate the adequacy of field data for use by Ecology in conducting water quality assessments.

Background and Problem Statement

This project has been designed to help inform Ecology staff and management on the quality of field water data collected by other agencies and citizen volunteers. Water quality data collected by these groups are increasingly being used for management decisions at Ecology. Samples that require laboratory analysis will have recorded sources of error for each analytical procedure. However, there are no similar processes used for assessing the quality of data collected in the field by numerous different protocols.

Many of the waters on the Section 303(d) list are based on field data collected by groups other than Ecology. The listing policy has defined some quality assurance guidelines, but does not express specific data quality objectives. One approach to assuring that the data are comparable would be to mandate standard protocols that must be followed if the data are to be used by Ecology. However, even small differences in protocols (e.g. use of different sampling equipment) can make a large difference in the comparability of data. In addition, it will be difficult to convince outside groups to change their protocols just to satisfy an Ecology mandate.

A better approach for evaluating data comparability would be based on performance standards. With performance standards, the exact protocols would not be as important as meeting specified data quality objectives. Data collected from different protocols could then be used for different purposes with a known level of quality based on how well the data met the objectives. Different protocols could be grouped according to how they met performance standards.

Water quality data collected with various field methods include indicators for temperature, dissolved oxygen, and pH. Field measurements of these indicators cannot be evaluated for certain data quality objectives like accuracy and bias, since samples with known values (e.g. check standards or matrix spikes) are not available. Precision over different performance ranges is the most relevant data quality objective that can be tested for indicators measured in the field. As such, field methods must be evaluated with side-by-side monitoring by Ecology staff to characterize performance.

Project Description

Goals

Determine the precision of water quality data collected by different field sampling protocols used by Ecology, other agencies, and citizen volunteers.

Objectives

1. Obtain side-by-side measurements of temperature, dissolved oxygen, and pH among different groups monitoring surface waters in the state.

2. Compute statistics on the measurement precision of temperature, dissolved oxygen, and pH among monitoring staff using each protocol assessed.

3. Compute statistics on the measurement precision between Ecology's protocols for temperature, dissolved oxygen, and pH and other agencies and citizens monitoring the same indicators.

4. Conduct a categorization or cluster analysis of the performance of different measurement protocols for temperature, dissolved oxygen, and pH based on precision.

Data Quality Objectives

Bias

There are no specific levels of bias defined for the data to be obtained in this project. The project is designed to advise management on the bias measured between protocols and not to define a particular level of bias that is acceptable for different purposes. Data collected using Ecology protocols will be compared to data collected by the other protocols evaluated.

Precision

There are no specific levels of precision defined for the data to be obtained in this project. The project is designed to advise management on the precision measured between protocols and not to define a particular level of precision that is acceptable for different purposes. Data collected using Ecology protocols will be compared to data collected by the other protocols evaluated.

Resolution

The data collected by Ecology protocols will be compared to data collected by the other protocols evaluated. Using the Ecology protocols, the resolution of temperature is 0.1 degrees C, for dissolved oxygen is 0.1 mg/L, and pH is 0.1 standard units. The resolution of the other protocols evaluated will be compiled and reported.

Sampling Design

The sampling design will consist of the measurement of temperature, dissolved oxygen, and pH using the different field protocols being evaluated. Measurement data will be collected at the same time and place using different protocols. The target population is limited to freshwaters statewide at all times of the year. Side-by-side sampling will be conducted at locations already monitored. The amount of sampling will be constrained by availability of staff to conduct the comparability measurement.

Representativeness

For streams, water sampling will consist of a near surface measurement taken from where the stream appears to be well mixed vertically and horizontally. Although vertical heterogeneity of sediment associated chemical species does occur, homogeneity is assumed. For lakes, water collection will be made at a location near where the depth is greatest.

The time of day when measurements are taken will be determined by the logistics of sampling all the station locations planned for that day. No attempt will be made to sample a particular location at the same time for repeat visits.

Comparability

Water sampling will be conducted at several times during the year so that comparability of protocols can be evaluated over the range of weather and flow conditions expected in the state.

Field Procedures

The protocols used by Ecology are described in Ward et al. (2001) and Smith et al. (1998). The standard operating procedures of the protocols evaluated will be compiled and reported. The standard operating procedures used by Ecology will be shared with the monitoring staff conducting the protocols evaluated.

Laboratory Procedures

This project will only evaluate field protocols. As such, there will be no water samples collected for laboratory analysis.

Quality Control

Laboratory QC

This project will only evaluate field protocols. As such, there will be no water samples collected for laboratory analysis.

Field QC

The quality control procedures for the protocols used by Ecology are described in Ward et al. (2001). The quality control of the other protocols evaluated will be compiled and reported.

Data Management Procedures

As data are collected, they will be compiled and entered into a simple spreadsheet for analysis.

Data Review, Verification, and Validation

Once the measurement results have been recorded into the spreadsheet, they will be examined to ensure that:

- The data are consistent, correct, and complete according to the data recording sheets filled out in the field.
- Any qualifiers with the data are identified
- The protocols specified in the Freshwater Ambient Water Quality Monitoring Final Quality Assurance Project Plan (Ehinger, 1996) were followed.

Data Quality Assessment

After the data have been validated, the following steps will be conducted to assess the data quality prior to preparing the progress report:

- Review the data quality objectives and the sampling design
- Conduct a preliminary data review
- Apply the statistical tests to be evaluated
- Verify the assumptions of the statistical tests
- Draw conclusions from the data

Bias

Bias can be inferred by the precision statistics of median scaled residual. This statistic provides a relative estimate of whether a protocol produces values consistently higher or lower than a different protocol. Since samples with known values (e.g. check standards or matrix spikes) are not available, protocol accuracy cannot be determined. As such, the data collected by journey-level scientists using Ecology protocols will be compared to the other protocols evaluated.

Precision

Precision among staff and between protocols will be expressed in several different statistics: root mean square error, median absolute deviation, scaled residuals, the relative error (Reckhow et al. 1986), and the paired comparison test (Zar, 1984). The root mean square error presents an estimate of the variation in the same units as the measurement (e.g. °C). The relative error presents this variation as a percentage of the measurement mean. The median absolute deviation describes the central tendency of model performance. The median scaled residual provides a relative estimate whether the model is over or under predicting measured conditions. The paired comparison test will assess if there is a statistically significant difference between the protocols evaluated.

The sensitivity for categorization of each of these statistics will be evaluated. Sample size of each evaluation will be reported, but no minimum sample size will be defined. A final statistic for decision making use will be recommended based on the sensitivity analysis.

The project will not evaluate the precision within and among the outside monitoring groups. If available, these precision data will be compiled and reported. The precision of Ecology's protocols is presented in Hallock and Ehinger (2000).

References

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Smith, K., Hallock, D. and S. O'Neal. 1998. Water Quality Assessments of Selected Lakes Within Washington State. Publication No. 00-03-039. Washington State Department of Ecology, Olympia, WA.

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