7.1 Quality assessment and control for environmental sampling

Contents

Introduction

Any question of environmental sampling that relies on analysing only part of the universe of interest will result in errors and uncertainty. “Researchers who ponder such matters may almost despair in making any decisions involving measurement of samples. Unfortunately, many decisions are made in ignorance or contempt of the uncertainty of the sample data. In fact, ‘representative samples’ are often used to make decisions even though no real evidence is presented to verify that the sample represents anything other than itself.”

In this paper I provide an overview of how data uncertainties can be addressed in an integrated manner and how others have addressed these issues. A standard reference for all these matters is Keith (1996)

Sources of uncertainty

At the simplest level the two sources of uncertainty are:

- How well your sample(s) represent the environment of interest, and
- How well your measurement(s) represent the samples you collect.

The majority of situations of interest to an environmental scientist involve both kinds of uncertainties.

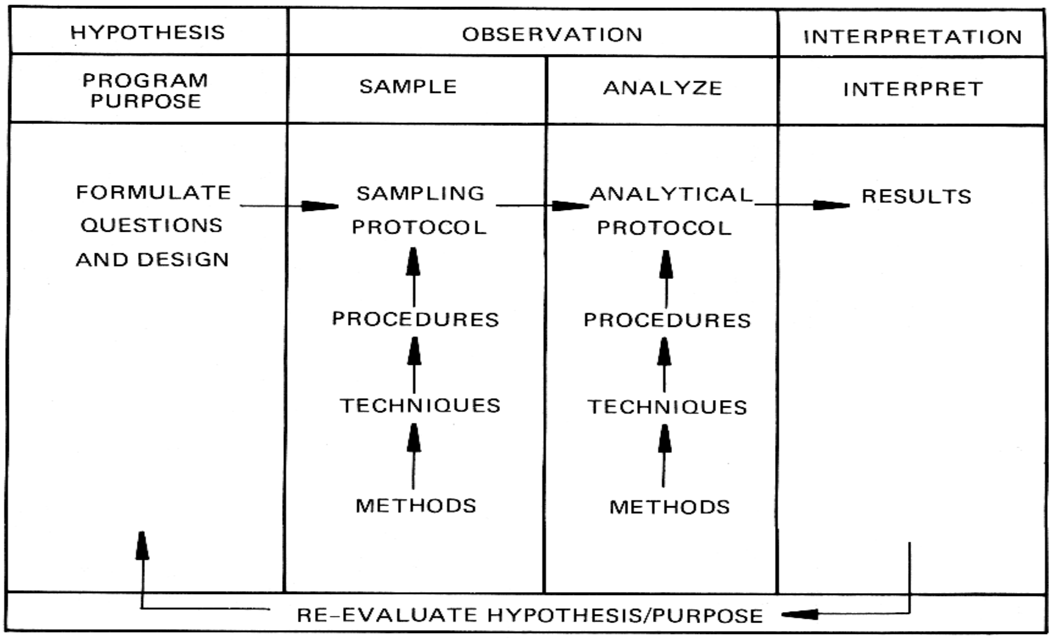
Sample uncertainty

Sample uncertainty may contain systematic and random components arising from population and sampling considerations. Controlling sampling uncertainty is a key part of experimental design.

Measurement uncertainty

Measurement uncertainty can be controlled and evaluated by an appropriate quality assurance program. It is important that measurement variance is known so that Type I and Type II errors can be controlled, most easily by varying the number of measurements.

The two components of uncertainty are additive so it is important to consider sampling and analysis at the same time.



Reducing Measurement Errors

Although some measurement errors are inevitable, they can often be reduced substantially. The resulting benefits to the experiment can be considerable. Following are some guidelines for achieving this goal.

Guidelines for reducing measurement errors

1. **Counting**
   - Ensure that experienced workers train new personnel.
   - Where feasible, mark or discard items previously counted to reduce double counting.
   - Anticipate undercounting. Try to assess its extent by taking counts of populations of known size.
   - Try to reduce errors by taking counts only in favourable conditions and by implementing a rigorous protocol.
2. **Physical measurements**

- Instruments should be calibrated before first use, and periodically thereafter.
- Personnel should be trained in the use of all measuring devices.
- Experienced personnel, as part of an overall quality control program, should spot-check measurements, particularly those taken by new personnel.
- Incorporate new equipment where appropriate (e.g., lasers and ultrasound, for distance measurements).

3. **Remeasurement**

- Watch for the transfer of errors from previous measurements (e.g., a mistaken birth from an item erroneously marked as dead).
- Reduce errors in relocating the site of previous measurements through more careful marking, use of modern electronic GPS technology, etc.
- Ensure that bias is not propagated through the use of previous measurements as guides to subsequent ones. (This issue is particularly troublesome in subjective estimates.)

4. **Visual estimates**

- Ensure that all visual estimates are conducted according to rigorous protocols by well-trained observers.
- Pay particular attention to observer bias. When bringing a new observer into the program, ensure that an experienced observer(s) backs up his/her results.
- If sites or times are to be selected as part of the collection of visual estimates, eliminate selection bias by providing a protocol for site- or time-selection. Do not, for example, let vegetation samplers pick modal sites.

5. **Data handling**

- Record data directly into electronic form where possible.
- Back up all data frequently.
- Use electronic data screening programs to search for aberrant measurements that might be due to a data handling error.
- Design any manual data-recording forms and electronic data-entry interfaces to minimize data-entry errors. In the forms, include a field for comments, encourage its use, and ensure that the comments are not lost or ignored.

Environmental sampling and quality assurance.

The traditional focus of QA/QC on laboratory procedures has been broadened to look at the comprehensive systems associated with all aspects of environmental data collection and management.

The US EPA has been a major driver of this process publishing documents and mandating QA/QC processes for all EPA work since 1984, although early problems resulted in major review and reorganisation in the early 1990s. This systems approach is outlined in:

- Quality manual for environmental programs

- Quality assurance project plans (QAPPs) with a more user-friendly version for volunteers
- Standard operating procedures (SOPs)

ANZECC

The ANZECC Monitoring Guidelines, include QA/QC in Chapter 4: Field sampling program and Chapter 5.

Chapter 4.6 Quality assurance and quality control in sampling

4.6.1 Tracking samples and field data

4.6.2 Documented sampling protocols

4.6.3 Sample blanks and other QA/QC practices

4.6.3.1 Blanks to check on field procedures, containers, equipment and transport

4.6.3.2 Duplicate samples

4.6.3.3 Sample spiking

4.6.4 QA/QC in biological sampling

4.6.5 QA/QC in data storage and access

and

Chapter 5: Laboratory Analysis

5.5 QA/QC in laboratory analyses

5.5.1 Traceability of results

5.5.2 Laboratory facilities

5.5.3 Analytical equipment

5.5.4 Human resources

5.5.5 QA/QC in Analytical Protocols

5.5.5.1 Analysis of certified reference materials and internal evaluation samples

5.5.5.2 Proficiency testing programs (interlaboratory comparisons)

5.5.5.3 Performance audits

5.5.5.4 Independent methods comparison

5.5.5.5 Recovery of known additions

5.5.5.6 Calibration check standards

5.5.5.7 Blanks

5.5.5.8 Duplicate analyses

AUSRIVAS

The **AUSRIVAS** information includes Quality Control and Assurance Programs for the NRHP in NSW.