The Importance of Quality Assurance/Quality Control in Bioassessment and Physical Habitat Protocols

Beverly H. van Buuren, Amara F. Vandervort, and Megan V. Kilner

The 13th Annual Meeting of the California Aquatic Bioassessment Workgroup
University of California Davis
November 29, 2006

The Quality Assurance Research Group
Moss Landing Marine Laboratories
EPA Decision Making Process

information
QA/QC Role in Information

- Information = Data
- QA/QC helps define the type of information
- QA/QC asks:
  - What type of information do we need to make a decision?
  - What application will we use?
- In other words: What are our information needs?
Applications for Bioassessment and Physical Habitat

- Surface Water Ambient Monitoring Program
  - Status and Trends
  - Identifying Problems
  - Evaluating Restoration (before and after)
  - Future uses: upstream/downstream of discharge point

Currently in California

- Establish reference conditions
- Prepare water quality assessments -- 305(b) report
- Establish numeric targets for Total Maximum Daily Loads
- Measure and document success or failure of: Best Management Practices, restoration projects, permit requirements, remediation efforts

Future uses in California

- 303(d) listing & de-listing decisions
- Biocriteria, Tiered Aquatic Life Use

What type of information will support these?

FOR EXAMPLE:
- What type of information do we need to assess status and trends?
- What type of information do we need to assess a discharge point?

Are the information needs similar or unique?

Status & Trends EXAMPLE:
May require more samples in order to assess seasonal variability, not just annual

Discharge EXAMPLE:
May require corresponding chemistry samples in order to be used in regulatory context
Is QA/QC important in chemistry protocols?

- **Scientific**
  - Interferences, precision, bias (accuracy), sensitivity, representativeness, completeness, comparability

- **What do QC samples provide in terms of data interpretation?**
  - QC grounds the data in a useful, documented manner - e.g., replication helps us assess homogeneity issues, representativeness, equipment, bias

- **What does QA provide in terms of applications?**
  - Systems for limiting error – e.g., training programs and auditing of success/failure

- **Application in California – Comparability Mandate**
  - Assembly Bill 982 - Comparable data of known and documented quality
  - Allows state to leverage data
State of California’s Surface Water Ambient Monitoring Program (SWAMP)

- SWAMP QA Team assisting SWAMP Bioassessment Committee in development of comprehensive QA program - *Comparability*

- Sample Collection and Analysis Protocols
- Measurement Quality Objectives
- System for Assessment of Training
- System for Assessment of Data
What Others Have Found

- Majority of errors result from taxa being missed during sample sorting (Dines & Murray-Bligh 2000)

- Importance of identifying exact location of sampling area (Murray-Bligh 1999)

- “very little information…concerning QA/QC for collection of habitat data” (AusRivAS 2004)

- Seasonality more important than protocol or method (Lorenz & Clarke 2006)
# Examples of QC in Protocols

<table>
<thead>
<tr>
<th>Example Measurement Quality Objectives – Bioassessment Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field</strong></td>
</tr>
<tr>
<td>Field Duplicates</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Subsampling</strong></th>
<th><strong>Frequency</strong></th>
<th><strong>Performance Criteria</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Organism Recovery</td>
<td>Taxonomist evaluates recovery at the end of sample processing for all samples.</td>
<td>Organism Recovery $\geq 95%$ (475 BMIs).</td>
</tr>
<tr>
<td>Remnant Evaluation</td>
<td>All samples are evaluated</td>
<td>The remnant should contain fewer than 10% of the total organisms sampled.</td>
</tr>
</tbody>
</table>
## Examples of QC in Protocols

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach Length</td>
<td>A minimum of 50% of the reach length must be accessible</td>
</tr>
<tr>
<td>Area Sampled</td>
<td>A minimum of 50% of the total sampling area must be accessible for BMI and periphyton collections</td>
</tr>
<tr>
<td>Mesh Size of Sampling Net</td>
<td>500 micron</td>
</tr>
<tr>
<td>Number of Organisms Per Sample</td>
<td>A minimum of 250 BMI must be collected for each reach</td>
</tr>
</tbody>
</table>
QA/QC Issues in Protocols

- Expertise of field crew and laboratory

- The protocols are somewhat subjective and have more variables that may introduce bias or error

- There has been a lot written on QA/QC in bioassessment and physical habitat
  - implementation does not appear comprehensive
  - check-box approach
"Clean hands" then submerges the sample bottle, and allows the bottle to partially fill with sample. "Clean hands" screws the cap on the bottle, shakes the bottle several times, and empties the rinsate away from the site. After two more rinsings, "clean hands" holds the bottle under water and allows bottle to fill with sample. After the bottle has filled (i.e., when no more bubbles appear), and while the bottle is still inverted so that the mouth of the bottle is underwater, "clean hands" replaces the cap of the bottle. In this way, the sample has never contacted the air.
Bioassessment Physical Habitat Examples

- Excavate the area by **kicking** or using a tool to loosen the substrate... **prevent** substrate from filling net... **maintain a consistent** sampling effort at each area.

- Holding the net in position on the substrate, **visually define** a square quadrant that is one net width wide and one net width long upstream of the net opening.

- Sometimes the net will become so full of material from the streambed that it is **no longer effective** at capturing benthic macroinvertebrates.
Define information needs and use QA/QC

QA/QC is an important component of bioassessment and physical habitat protocols because:

- Our protocols are subjectively written
- Our protocols require expertise
- Our applications for data require that we assess implications of bias, interferences, precision, representativeness
- We need a documented process in order to use data in decisions

SWAMP QA Team assisting SWAMP Bioassessment Committee in developing comprehensive QA program
Components of Total Study Error

**Total Study Error** (Total Variability)

- **Field Variability**
  - Inherent Variability
    - Stratification
    - Homogenization
  - Sampling Design
    - Sampling Frame Selection
    - Sampling Unit Definition
    - Selection Probabilities
    - Number of Samples
  - Physical Sampling Collection
    - Support Volume/Mass
    - Sample Delineation
    - Sample Extraction

- **Measurement Variability**
  - Sample Handling
    - Preservation
    - Packaging
    - Labeling
    - Transport
    - Storage
  - Analysis
    - Preparation
    - Subsampling
    - Extraction
    - Analytical Determination
    - Data Reduction

The Quality Assurance Research Group at Moss Landing Marine Laboratories

Beverly H. van Buuren  
bvanbuuren@mlml.calstate.edu

Amara F. Vandervort  
avandervort@mlml.calstate.edu

Will Hagan  
whagan@mlml.calstate.edu

Megan V. Kilner  
mkilner@mlml.calstate.edu

Jennifer L. Parker  
jlparker@mlml.calstate.edu

Eric J. von der Geest  
evondergeest@mlml.calstate.edu