The Quality Assurance Mystery
The Plot

- You sample your creek, estuary, or ocean
- You measure bacteria, chemistry, bugs
- You write down your results, then plot them
The Facts?

Santa Clara River at Hwy. 101
Percent Oxygen Saturation

% Oxygen Saturation

1997
Detective QA

Should I believe the evidence in front of me?

- Is the D.O. really that low?
- Are the nitrate levels really that high?
- Do these total coliform values mean there is a risk to swimmers?
Sleuthing for the Truth

- Did we follow the procedures?
- Did we calibrate the equipment?
- Did we sample the correct site?
- Did we take replicate samples?
- Did we compare to chemical standards?
The Usual Suspects

Sample

Reagents

Indicator/Chemical

Volunteer / Analyst

Equipment

Data Errors
The Evidence

• Accuracy
• Precision
• Sensitivity
• Representativeness
• Comparability
Example of Data Error

Temperature Data

Professionals Results
Volunteers Results

\[ y = 0.7x + 3.7 \]

\[ R^2 = 0.46 \]
Temperature Data

\[ y = 0.89x + 1.4 \]

\[ R^2 = 0.89 \]
Example of Method Error: Turbidity

\[ y = 0.80x \]

\[ R^2 = 0.62 \]
Example of Method Error: Turbidity

\[ y = 0.97x \]
\[ R^2 = 0.53 \]
## Bacterial Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Illness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total coliform</td>
<td>Skin rash</td>
</tr>
<tr>
<td>Fecal coliform</td>
<td>Skin rash</td>
</tr>
<tr>
<td>E. coli</td>
<td>Earache</td>
</tr>
<tr>
<td></td>
<td>Nasal Congestion</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>Diarrhea</td>
</tr>
<tr>
<td></td>
<td>with blood</td>
</tr>
<tr>
<td></td>
<td>Gastrointestinal symptoms</td>
</tr>
<tr>
<td></td>
<td>(Type 1)</td>
</tr>
<tr>
<td>Ratio of total to fecal coliform</td>
<td>Diarrhea</td>
</tr>
<tr>
<td></td>
<td>Gastrointestinal symptoms</td>
</tr>
<tr>
<td></td>
<td>(Type 2)</td>
</tr>
<tr>
<td>Ratio of total coliform to</td>
<td>Nausea</td>
</tr>
<tr>
<td>enterococcus</td>
<td>Diarrhea</td>
</tr>
<tr>
<td></td>
<td>Gastrointestinal symptoms</td>
</tr>
<tr>
<td></td>
<td>(Types 1 and 2)</td>
</tr>
</tbody>
</table>
Detective QA

• Quality Assurance: All the things you do to ensure that your data are adequate to meet your goals
Choosing the appropriate:

- method
- indicator
- sampling sites
- quality control procedures
QA Plan
Describes all the steps you take to ensure good quality data

- program organization
- monitoring goals
- **data quality objectives**
- data sampling techniques
- methods
- training
- equipment calibration
- comparison to standards, professionals
- data management
- reporting
How to get started with QA?

- Find technical advisors
- Talk to resource managers: decide on appropriate level of effort
- Review existing QA plans
- Revise QA plan to fit your needs
- Follow QA plan
- Ask for help
## The Facts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Bias (%)</th>
<th>SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>pH</td>
<td>-2</td>
<td>5</td>
</tr>
<tr>
<td>Conductivity</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Turbidity</td>
<td>4</td>
<td>94</td>
</tr>
</tbody>
</table>

### EXAMPLES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>True</th>
<th>Average Reading</th>
<th>Range of Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>20°</td>
<td>20.4°</td>
<td>18° - 22°</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>8 ppm</td>
<td>8.3 ppm</td>
<td>7.1 - 8.9</td>
</tr>
<tr>
<td>pH</td>
<td>8.0</td>
<td>7.8</td>
<td>7.6 – 8.4</td>
</tr>
<tr>
<td>Conductivity</td>
<td>200 uS</td>
<td>210 uS</td>
<td>164 - 236</td>
</tr>
<tr>
<td>Turbidity</td>
<td>15 JTU</td>
<td>15.6 JTU</td>
<td>1-29</td>
</tr>
</tbody>
</table>