Dealing With Uncertainty in Watershed Assessments
Last week...But do your data measure up?

- What are the data quality objectives?
- Do you have a comprehensive picture?
- How old are your sampling results?
- Can you move forward with what you have?
Data quality objectives

• Quantify or qualify how good data must be to achieve the goals of monitoring / assessment
• Described in terms of data quality indicators:
  – precision
  – accuracy
  – representativeness
  – comparability
  – completeness

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Accuracy</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved oxygen</td>
<td>+/- 1 mg/L</td>
<td>0 – 17 mg/L</td>
</tr>
<tr>
<td>pH</td>
<td>+/- 0.2 pH units</td>
<td>0 – 14 pH units</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>+/- 10%</td>
<td>0 – 5 mg/L</td>
</tr>
<tr>
<td>Nitrates</td>
<td>+/- 10%</td>
<td>0 – 50 mg/L</td>
</tr>
<tr>
<td>Turbidity</td>
<td>+/- 10 NTU</td>
<td>0 - &gt; 100 NTU</td>
</tr>
</tbody>
</table>
Low bias and high precision

- Both needed to reflect true water body condition
- Can vary from “true” field values (biased), or vary in reliability
- Addressed by following protocols, using field blanks, spiked samples in lab
Completeness, representativeness, and comparability

• Collecting all samples planned
• Collecting samples that represent “true condition(s)” of the water body
  – During various seasons, flows?
  – Following sampling protocols?
• Confidence in comparing different data sets
  – Use similar data quality objectives
  – Avoid differences in methods, accuracy, precision
Comprehensiveness

- Do you have a clear picture of the problems?
  - Land use, cover, and watershed activities indicate likely pollutants
  - Biological assessments provide excellent screening info
- DO, pH, temp are primary parameters
- Nutrients*, conductivity, pesticides, herbicides, bacteria, and metals help to refine and focus the results

* Algae precursors???
Age and applicability

- **Data age considerations**
  - Stable land use & cover make older data (5-7 yrs) more useful
  - Developing watersheds require newer data (2-4 years old)
  - Rapidly developing watersheds may be difficult to characterize
  - Note new or altered NPDES discharger info
Volunteer derived data

- Credibility is improved when:
  - Volunteers are trained by professionals
  - Sampling and analytical procedures match accepted protocols
  - Sampling is conducted under a Quality Assurance Project Plan
Volunteer (red) vs agency (black) data during 1989 - 2005
### Table 8: Summarized Criteria for Use Support Assessment.

**Aquatic Life Use Support - Rivers and Streams**

<table>
<thead>
<tr>
<th>Conventional inorganics</th>
<th>Fully Supporting</th>
<th>Not Supporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved oxygen, pH, sulfates, chlorides were evaluated for the exceedance(s) of Indiana’s WQS. For any one pollutant, the following assessment criteria are applied to data sets consisting of three or more measurements.</td>
<td>For dissolved oxygen, one/more samples may be &lt;4mg/L, but no more than 10% of all measurements are &lt;5mg/L. For other conventional inorganics, criteria are exceeded in &lt;10% of measurements.</td>
<td>For dissolved oxygen, one/more samples &lt;4mg/L and more than 10% of all measurements are &lt;5mg/L. For other conventional inorganics, criteria are exceeded in &gt;10% of measurements.</td>
</tr>
</tbody>
</table>

**Nutrients**

Nutrient conditions were evaluated on a site by site basis using the benchmarks described below. In most cases, two or more of these conditions must be met on the same date in order to classify a waterbody as impaired. This methodology assumes a minimum of three sampling events.

- Total Phosphorus: One/more measurements >0.3 mg/l
- Nitrogen (measured as NO₃ + NO₂) -- One/more measurements >10.0 mg/l
- Dissolved Oxygen (DO) -- Measurements below the water quality standard of 4.0 mg/l or measurements that are consistently at/close to the standard, in the range of 4.0-5.0 mg/l or values >12.0 mg/l
- pH measurements -- Measurements above the water quality standard of 9.0 or measurements that are consistently at/close to the standard, in the range of 8.7-9.0
- Algal Conditions -- Algae are described as "excessive" based on field observations by trained staff.

**Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI) Scores (Range of possible scores is 0-8)**

<table>
<thead>
<tr>
<th>Fully Supporting</th>
<th>Not Supporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>mIBI ≥1.8 (for samples collected with an artificial substrate sampler)</td>
<td>mIBI &lt;1.8 (for samples collected with an artificial substrate sampler)</td>
</tr>
<tr>
<td>mIBI ≥2.2 (for samples collected using kick methods)</td>
<td>mIBI &lt;2.2 (for samples collected using kick methods)</td>
</tr>
</tbody>
</table>

**Qualitative habitat use evaluation (QHEI) (Range of possible scores is 0-100)**

The Qualitative Habitat Evaluation Index (QHEI) is used in conjunction with mIBI and/or IBI data to evaluate the role that habitat plays in waterbodies where impaired biotic communities (IBC) have been identified. QHEI scores are calculated using six metrics: substrate, instream cover, channel morphology, riparian zone, pool/riffle quality, and gradient. QHEI scores are evaluated to determine if habitat is the primary stressor on the aquatic communities or if there may be other stressors/pollutants causing the IBC.
### Table 1: Summary of Use Support - Assessed and Reported 1998 through 2007.

<table>
<thead>
<tr>
<th>Designated Use</th>
<th>Support</th>
<th>Threatened¹</th>
<th>Non Support</th>
<th>Assessed</th>
<th>Not Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rivers (miles)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Life Use</td>
<td>13,913</td>
<td>--</td>
<td>3,622</td>
<td>17,535</td>
<td>14,606</td>
</tr>
<tr>
<td>Fishable Uses</td>
<td>1,044</td>
<td>--</td>
<td>3,402</td>
<td>4,435</td>
<td>27,705</td>
</tr>
<tr>
<td>Drinking Water Supply²</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>101</td>
</tr>
<tr>
<td>Recreational Use (Human Health)</td>
<td>3,700</td>
<td>--</td>
<td>8,374</td>
<td>12,073</td>
<td>20,100</td>
</tr>
<tr>
<td><strong>Great Lakes Shoreline (miles)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Life Use</td>
<td>59</td>
<td>--</td>
<td>59</td>
<td>59</td>
<td>--</td>
</tr>
<tr>
<td>Fishable Uses</td>
<td>--</td>
<td>--</td>
<td>59</td>
<td>59</td>
<td>--</td>
</tr>
<tr>
<td>Drinking Water Supply²</td>
<td>33</td>
<td>--</td>
<td>33</td>
<td>33</td>
<td>--</td>
</tr>
<tr>
<td>Recreational Use (Human Health)</td>
<td>--</td>
<td>--</td>
<td>59</td>
<td>59</td>
<td>--</td>
</tr>
<tr>
<td><strong>Lake Michigan (acres)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishable Uses</td>
<td>--</td>
<td>--</td>
<td>154,176</td>
<td>154,176</td>
<td>--</td>
</tr>
<tr>
<td><strong>Lakes and Reservoirs (acres)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Life Use</td>
<td>3,690</td>
<td>--</td>
<td>6,625</td>
<td>10,315</td>
<td>21,826</td>
</tr>
<tr>
<td>Fishable Uses</td>
<td>7,820</td>
<td>--</td>
<td>63,663</td>
<td>71,483</td>
<td>5,084</td>
</tr>
<tr>
<td>Drinking Water Supply²</td>
<td>230</td>
<td>--</td>
<td>16,385</td>
<td>22,905</td>
<td>12,926</td>
</tr>
<tr>
<td>Recreational Use (Human Health)</td>
<td>21,922</td>
<td>--</td>
<td>983</td>
<td>22,905</td>
<td>104,662</td>
</tr>
<tr>
<td>Recreational Use (Aesthetics)</td>
<td>29,035</td>
<td>--</td>
<td>8,006</td>
<td>37,041</td>
<td>90,526</td>
</tr>
</tbody>
</table>

Source: IDEM’s Assessment Database
Let’s move on...Dealing with Uncertainty
Data Evaluation and Use

The Tyranny of False Precision

Desirable Operating Range

Paralysis by Analysis
Types of Data Needed for Watershed Characterization & Assessment

- **Physical and Natural Features**
  - Watershed boundaries
  - Hydrology
  - Topography
  - Soils and Geology
  - Rainfall and Climate
  - Habitat
  - Wildlife

- **Land Use and Population Characteristics**
  - Land Use / Land Cover
  - Existing Management Practices
  - Demographics
  - Socioeconomic Conditions

- **Waterbody Conditions**
  - Water Quality Standards
  - 305(b) Report
  - 303(d) List
  - TMDL Reports
  - Source Water Protection Areas

- **Pollutant Sources**
  - Point Sources
  - Nonpoint Sources

- **Waterbody Monitoring Data**
  - Water Quality Data
  - Flow data
  - Riparian Conditions
  - Biological & Habitat data
If you have existing data:

- What type – water quality, biota, habitat, sediment?
- Who collected it, what methods were used?
- How old is it? Have conditions in the watershed changed since it was collected?
- How do the data compare with water quality criteria?
- Can you use it to develop a watershed assessment – are there gaps?
Data gaps: when to collect more?

• Insufficient data to fully characterize water body
  – Bioassessment data without info on other parameters
  – No info on major tributaries

• Major questions regarding key pollutant source(s)
  – Sediment: stream banks, construction sites, or row crop lands?
Data gaps: when to collect more?

- Water quality data are inconsistent with what’s known about the watershed
  - Bacterial source tracking shows high human bacteria, but few (or no) known sources

- Data are more than 3-4 years old, & watershed is changing rapidly
  - Agriculture to subdivision conversion areas
Do you have enough information to begin implementation?

• As these things increase:
  – Number of pollutants
  – Complexity of loads/stressors
  – Uncertainty regarding existing information
  – Expense involved in addressing problems

• The need for more sophisticated assessment info also increases
Supplementing available data

- Windshield surveys
- Interviews with residents
- Volunteer monitoring results
- Bioassessment
- Targeted sampling
- Chemical/biological sampling

*Helps lay the groundwork for implementation!*
Visual assessment methods

- Assessment methods apply to:
  - Streams, rivers, lakes, other water bodies
  - Water body and bank / riparian areas
  - Land use and management practices

- Several protocols exist
  - NRCS Stream Visual Assessment Protocol
  - Center for Watershed Protection rapid assessments
  - Adaptations of US EPA Rapid Bioassessment Protocols and other stream and land use & management methods
Stream visual assessments

• Typical water body assessment parameters:
  – Clarity and appearance
  – Habitat structure (woody debris, substrate)
  – Sediment bars in channel
  – Colors, odors, foam, oil sheen
  – Bottom deposits, sludge, scum
  – Presence of live or dead organisms

• Bank and other parameters:
  – Vegetation type & buffer width
  – Evidence of bank erosion (roots, fallen trees)
  – Morphology (riffles, pools, alterations)
  – Fish barriers, other structures, trash
Upland visual assessments

- Based on land use types
  - Row crop, pasture, livestock, forest
  - Urban, commercial, industrial, residential, institutional, active construction

- Drainage pattern parameters
  - Impervious areas, eroded ditches, retention & detention ponds, discharge into receiving waters

- Evidence of polluted runoff & discharges
  - Material storage, sediment, illicit discharges, land application practices, wastewater treatment
Stream Visual Assessment Protocol (NRCS)

One assessment tool provides basic stream health evaluation. Scores are assigned for the following:

- Channel condition
- Riparian zone width
- Canopy cover
- Nutrient enrichment
- Salinity
- Instream fish cover
- Invertebrate habitat
- Hydrologic alteration
- Bank stability
- Water appearance
- Manure presence
- Fish movement barriers
- Pools and riffles
- Macro invertebrates

### Neighborhood Source Assessment

#### A. Neighborhood Characterization

- **Neighborhood/Subdivision Name:**
- **Neighborhood Area (acres):**
- **Homeowners Association:**
- **Residential (circle average single family lot size):**
  - Single Family Attached (Duplexes, Row Homes) **<\(\frac{1}{4}\)  \(\frac{1}{8}\)  \(\frac{1}{4}\)  \(\frac{1}{2}\) 1 acre**
  - Single Family Detached **<\(\frac{1}{4}\)  \(\frac{1}{8}\)  \(\frac{1}{2}\) 1 >1 acre**
  - Multifamily (Apts, Townhomes, Condos)
  - Mobile Home Park
- **Estimated Age of Neighborhood:** _years
- **Percent of Homes with Garages:** _%  **With Basements:** _%  **INDEX:**

- **Sewer Service:**
- **Index of Infill, Redevelopment, and Remodeling:**
  - No Evidence
  - 5-10%
  - >10%

#### B. Yard and Lawn Conditions

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Percentage</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1. % of lot with impervious cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2. % of lot with grass cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3. % of lot with landscaping (e.g., mulched bed areas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4. % of lot with bare soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Note: B1 through B4 must total 100%</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B5. % of lot with forest canopy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B6. Evidence of permanent irrigation or “non-target” irrigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B7. Proportion of total neighborhood turf lawns with following management status:</td>
<td>High:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Med:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low:</td>
<td></td>
</tr>
<tr>
<td>B8. Outdoor swimming pools? <strong>Y</strong>  <strong>N</strong>  <strong>Can’t Tell</strong>  <strong>Estimated #:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B9. Junk or trash in yards? <strong>Y</strong>  <strong>N</strong>  <strong>Can’t Tell</strong>  <strong>Estimated #:</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### C. Driveways, Sidewalks, and Curbs

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Percentage</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1. % of driveways that are impervious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2. % of driveways that are pervious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3. % of driveways that are paved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4. % of driveways that are concrete or concrete with asphalt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5. % of driveways that are asphalt or concrete</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The importance of caution & ground-truthing

Dissolved oxygen

mg / liter

days
Reality checks

- Water quality data should be linked to land use, land cover, land management, and pollutant discharges
- Water body segments below the highest risk areas should register the most impacts
- Windshield surveys can confirm your final assessment results
Questions?
Proposed management measures

• **Load reductions needed**
  – Estimate quantitatively
  – Metrics selected should make sense!

• **BMP types proposed**
  – What will lessen your ‘loads’?
  – Applicable to your situation?

• **Load reductions from BMPs**
  – How can you measure BMP impacts?
  – Use literature or actual values

• **BMP installation sites**
  – Which sites will hit the source(s)?
  – Are there critical areas to focus on?
Selecting/prioritizing/targeting BMPs

- **Importance of waterbody**
  - Drinking water source, recreational resource
- **Magnitude of impairment(s)**
  - Level of effort needed; public interest/attention
- **Existing loads (causes & sources)**
  - Magnitude, spatial variation, clustering
- **Ability of BMPs to reduce loads**
  - Sure thing, or a shot in the dark?
- **Feasibility of implementation**
  - Willing partners? Public support? Access?
- **Additional benefits**
  - Recreational enhancements, demonstration
Asking the right questions . . .

• Who can help implement the BMPs or controls?
  – Agencies, businesses, non-profits, citizens, producers

• How can they be implemented?
  – What has been done in the past?
  – How well did it work?
  – Can we do it (or adapt it) here?
Asking the right questions . . .

• When can we get started?
  – Reasonable short-term actions
  – Long-term or major actions

• How do we know if it’s working?
  – And what do we do if it’s not?
Estimate technical and financial assistance needed

- Funding sources
- Sources of technical assistance
- Regulatory or other authority
- Matching support sources
Setting times and targets

- Develop implementation schedule
  - Think about short term (< 2 yrs) and long-term (> 5 yrs) goals

- Determine how you will measure success
  - What indicators are linked to the problems you’re dealing with?

- Set interim milestones
  - What helps to show progress?
  - Can be both water quality & programmatic indicators
**Sample Implementation Plan Matrix**

**Watershed Goals**
Goal 1: Restore water quality to meet designated uses for fishing
Objective 1: Reduce sedimentation by 20 percent

<table>
<thead>
<tr>
<th>Tasks for G1/O1</th>
<th>Respon. Party</th>
<th>Total Costs</th>
<th>Funding Mechanism</th>
<th>Indicators</th>
<th>Milestones</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task 1</strong></td>
<td>Local land trust</td>
<td>$0</td>
<td></td>
<td># acres donated</td>
<td>2 7 10 10</td>
<td></td>
</tr>
<tr>
<td>Seek donation of conservation easements from property owners along Baron Creek</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/E Activities Task 1</td>
<td>Local land trust</td>
<td>$3,000</td>
<td>Sect. 319 funding</td>
<td># workshops held</td>
<td>3 3</td>
<td></td>
</tr>
<tr>
<td>Hold informational workshop with property owners</td>
<td></td>
<td></td>
<td># participants</td>
<td>40 45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop brochures on how to donate easements</td>
<td></td>
<td></td>
<td># requests for assistance</td>
<td>2 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task 2</strong></td>
<td>County park district</td>
<td>$2,000/mile</td>
<td>County general funds</td>
<td># miles purchased</td>
<td>2 4 7 5</td>
<td></td>
</tr>
<tr>
<td>Purchase greenway alongside Baron Creek</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/E Activities Task 2</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Coordinate with other water resource and land use programs

- Section 303, Water Quality Standards, TMDLs
- Section 319, NPS Program
- Section 402, NPDES Permits, CAFOs, Stormwater I & II
- Source Water Protection Plans – local water utilities
- Wetlands Protection Programs
- EQIP, CRP, BLM, USFS, USFWS
- More...
During implementation, remember:

- Plans are guides, not straitjackets
- Be aware of unforeseen opportunities
- Picking the low-hanging fruit is easy . . . BUT it helps to build a sense of progress & momentum
- If possible, work quietly for as long as you can on the most contentious issues