METHODS and EQUIPMENT

3-legged stool
On Site Chemistry

• On site (in situ) measurements
  – pH
  – Dissolved O₂
  – Conductivity
  – Water temperature
  – Turbidity

• Various probes & meters
  – Horiba U-10, YSI
On Site Chemistry

- pH – acid to basic
- Dissolved O₂ – nearly all organisms require oxygen
- Conductivity – measure of salts
- Water temperature – affects other attributes (i.e. dissolved O₂)
- Turbidity – clarity of the water has many implications
Lab Chemistry

- Collect water in appropriate containers
- Rinse containers, lids 3x
- Transport to lab appropriately
  - On ice
  - On dry ice
  - In dark bottles, wrapped in foil, etc.
Lab Chemistry

- **Carbon**
  - Dissolved organic carbon
  - Total organic carbon

- **Nitrogen**
  - NO$_3$+NO$_2$
  - NO$_2$
  - NH$_3$
  - Total N
  - Organic N

- **Phosphorous**
  - PO$_4$
  - Total P
  - Organic P

- **Oil, Grease, PAHs**

- **Pesticides**
  - Herbicides
  - Insecticides
  - Breakdown products
Rural Chemistry

• Untreated animal wastes, fertilizers, etc.
  – Nitrogen &/or phosphorous in excess.
  – Algae growth – when die release methane, ammonia, etc.
  – Toxic to fish & macroinvertebrates.
  – More common in lakes and wetlands.

• Sediment
  – Field erosion, riparian loss, etc.

• Habitat loss
  – To cropland, development
Urban Chemistry

- Excess N & P from yards not cows
- Herbicides
- Dumping – oil, batteries, etc.
- Personal Care Products
  - Estrogen, etc.
  - Caffeine as indicator
Chemistry Summary

• Chemistry is a “photo.”
• Flowing water creates a “moving impairment.”
• Results can depend on when you sample.
• Water chemistry alone cannot tell the whole story...
Biological Aspects

• Chemistry is like a “photo.”

• Organisms are like a “movie.”
  – Long-term exposure to water quality.
  – Effect of impairment observable.

• Macroinvertebrates
  – Larval forms often spend months or years in the water.
  – Some adults live an entire season or more.
Macroinvertebrates

- Insects
- Mollusks
- Crustaceans
- Oligochaetes & Platyhelminthes

- Microinvertebrates
  - Zooplankton
Macroinvertebrate Sampling

- **Equipment**
  - D-net – mesh size important
  - Surber sampler, etc.
  - Artificial substrates

- **Sampling - timed**
  - Random placement
  - Targeted habitat

- **Preserved in the field**
  - ETOH or formalin

- **ID in lab with keys**
Fish Sampling

• Electroshocking or Seining
• Target the habitat
• Entire reach or timed
Fish

• Identify large in field and release.
• Return small to lab.
  – Preserve in the field with 10% formalin.
  – IDs with keys.
• Tissue – freeze, mercury, etc.
Algae

• Biological RESPONSE to nutrients
• Measured in the chemistry lab
  – Chlorophyll a (estimate of biomass)
• Identified in the biology lab
  – Taxonomy (sensitive taxa, richness)
Cyanobacteria

- AKA Blue-green algae
- Anabaena, Aphanizomenon, and Microcystis (Annie, Fannie, and Mike)
- Deplete oxygen
- Release toxins
Algae Collection

- Phytoplankton – in the water
  - Scoop water
- Periphyton – attached to rocks etc.
  - Scrape and aspirate
- Chlorophyll
  - Preserve on ice in dark
- Identification
  - Preserve with Ethanol, Lugol’s, Formalin
Physical Habitat (P-Hab)

• Physical characteristics of the stream
  – Rate of flow
  – Depth: Thalweg, Bankfull, Incised
  – Width: Wetted, Bankfull
  – Bank angles
  – Substrate
  – Riparian
  – Fish Cover
  – Channel characteristics
## Substrate Size

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Size Range (mm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock (Smooth)</td>
<td>&gt;4000</td>
<td>Smooth surface rock bigger than a car</td>
</tr>
<tr>
<td>Bedrock (Rough)</td>
<td>&gt;4000</td>
<td>Rough surface rock bigger than a car</td>
</tr>
<tr>
<td>Large Boulders</td>
<td>&gt;1000 to 4000</td>
<td>Meter stick to Car size</td>
</tr>
<tr>
<td>Small Boulders</td>
<td>&gt;250 to 1000</td>
<td>Basketball to Meter stick size</td>
</tr>
<tr>
<td>Cobbles</td>
<td>&gt;64 to 250</td>
<td>Tennis ball to basketball size</td>
</tr>
<tr>
<td>Gravel (Coarse)</td>
<td>&gt;16 to 64</td>
<td>Marble to tennis ball size</td>
</tr>
<tr>
<td>Gravel (Fine)</td>
<td>&gt;2 to 16</td>
<td>Ladybug to marble size</td>
</tr>
<tr>
<td>Sand</td>
<td>&gt;0.06 to 2</td>
<td>Gritty – up to ladybug size</td>
</tr>
<tr>
<td>Fines</td>
<td>&lt;0.06</td>
<td>Silt Clay Muck (not gritty btw fingers)</td>
</tr>
<tr>
<td>Hardpan</td>
<td></td>
<td>Hardpan Firm, consolidated fine substrate</td>
</tr>
<tr>
<td>Wood</td>
<td>Regardless of Size</td>
<td>Wood &amp; other organic particles</td>
</tr>
<tr>
<td>Other</td>
<td>Regardless of Size</td>
<td>Concrete, metal, tires, etc.</td>
</tr>
</tbody>
</table>
Substrate Embeddedness

• Fraction of a particle’s volume that is surrounded by (embedded in) sand or finer sediments on the stream bottom.
• 100% = sand & fines (silt, clay, muck).
• 0% = hardpan and bedrock.
Riparian Zone

• Riparian vegetation
  – Canopy (> 5 meters in height)
  – Understory (0.5 to 5 meters in height)
  – Ground cover (< 0.5 meters in height)

• Human influence

• Canopy coverage of stream
  – Densiometer

Mulvey et al. (1992)
We stopped here during the workshop
Measurements

• Quantitative
  – Surber sampler

• Semi Quantitative
  – D-net

• Qualitative
  – Species list
Measurements

• Quantitative
  – Surber sampler
  – Turbidity meter

• Semi Quantitative
  – D-net
  – Categories of clarity

• Qualitative
  – Species list
  – Muddy/clear
2 Basic Sampling Designs

- Unbiased measure of everything
  - Transects
    - 1\textsuperscript{st} placement random.
    - Measure no matter where they land.
  - Methodical
    - Tedious, lengthy, lots of forms.

- Targeted habitat
  - Focus on bug or fish or both
    - Rapid
    - Cheap
Transects

X = Random coordinates

Glide
Pool
Run
Riffle

Direction of stream flow
Targeted Habitat

- Glide
- Pool
- Run
- Riffle

Direction of stream flow
Riffle/Run Stream

Riffle  Run
Pool/Glide Stream

Glide

Pool
Variations on Protocols

- Historically states and other entities all had their own protocols.
- Much historic data is not comparable or at least has limited comparability.
- Recently – greater push to standardize methods between states and entities.
Protocols

• EPA Environmental Monitoring & Assessment Program (EMAP)
• EPA’s recent National Surveys
• Rapid Bioassessment Protocol (RPB)
• Bugs: Habitat Diversity Index (HDI, Huggins)
• Fish: Ohio Qualitative Evaluation Index (QHEI)
• Stream Visual Assessment Protocol (SVAP)
EMAP

- Wadeable streams (order 1-3)
- Mid-1990’s
- Academic, State and Federal scientists
- 1 day visit, crew of 4
- Estimate status, extent, changes, and trends of condition on *regional* basis with known confidence.
- Monitor indicators of pollutant exposure.
- Statistical summaries to managers & public.
NDEQ

- EMAP
- Nebraska Stream Classifications For The 2004-2005 Stream Biological Monitoring Program Project Report
  - April 2007, Ken Bazata
EPA National Surveys

• Giant manual – lots of forms
• Regional training – lots of crews
• Good, fair, bad
  – 2006 – wadeable streams
  – 2007 – lakes
  – 2008/2009 – rivers & streams
  – 2011 – wetlands

2007 - http://water.epa.gov/type/lakes/lakessurvey_index.cfm
Rapid Bioassessment Protocols (RPB)

- Developed by EPA.
- Semi-quantitative.
- Designed to provide basic aquatic life data for water quality management purposes.
- Cost-effective, quick turn-around.
- Environmentally benign methods.
- Basic collections of macroinvertebrates, fish, periphyton, water chemistry.

http://water.epa.gov/scitech/monitoring/rsl/bioassessment/index.cfm
Habitat Diversity Index

- Macroinvertebrates
- Developed for Kansas
- Assess riffle, run, pool
  - Depth
  - Substrate
  - Algal Mats
  - Macrophytes
  - Organic debris
- 3 minutes sampling BUGS among habitats
Qualitative Habitat Evaluation Index

- Fish
- Developed for Ohio
- Assess riffle/run & pool/glide
  - Substrate: type and quality
  - Instream cover: type and amount
  - Channel morphology: sinuosity, etc.
  - Riparian zone: width, quality, erosion
  - Quality: proportion, depth, velocity
Stream Visual Assessment Protocol

- Developed in NJ by USDA
- Score 1 poor to 10 excellent
- Check observed land use
- Yes/no questions
Recap

• Three major components
  – Chemistry
  – Biological
  – Physical Habitat
• Variations in how they’re put together.
• Standardization of protocols is important.
• Participating groups **MUST** follow assigned protocols to increase comparability!!!