Water Quality Parameters and Data Uses ~ Why We Sample

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Why do we sample?

The Federal Clean Water Act requires states to designate beneficial uses for all waters, and develop water quality standards to protect each use.

- Minnesota Pollution Control Agency (MPCA)
  Mission: To protect and improve the environment and enhance human health.
Use and Standards

Beneficial uses: Identification of how people, aquatic communities, and wildlife use our waters

- Numeric Standards- Allowable concentration of specific pollutants in a water body established to protect beneficial uses
- Narrative standards- statements of unacceptable conditions in and on the water
- Anti-degradation protections - Extra protection for high-quality or unique waters and their existing uses
The value of sampling…

The MPCA, its partner agencies and organizations conduct water quality monitoring (sampling) to:

- provide information about the status of the state’s water resources
- identify potential or actual threats to the quality of surface water
- identify options for protecting and restoring waters that are impaired
- evaluate the effectiveness of implemented management plans
Parameters monitored …
Water Temperature

Units: Degrees Celsius (°C)

- Affects the solubility of dissolved oxygen
- Affects the percent of ammonia that is in the un-ionized form
- Affects the biological communities
Dissolved Oxygen

Units: mg/L, Percent Saturation
- Warm water standard: 5 mg/L
- Cold water standard: 7 mg/L
Dissolved Oxygen

https://www.water-research.net/index.php/dissolved-oxygen-in-water
pH

Measure of the acidity or alkalinity of water

- Decomposition of plant material lowers pH
- Low pH: Unhealthy to fish and aquatic organisms

Standard:
Cold Water: 6.5 to 8.5
Warm Water: 6.5 to 9.0
Specific Conductivity

Units: Microsiemens per centimeter (1000 µS/cm) or Millisiemens per centimeter (1.000 mS/cm)

- Ability of water to pass an electrical current
- Ions in solution (dissolved minerals like Na+, Cl-, Ca+, Mg2+, SO4-2 and Cl-) allow electrical current to travel through water
- Specific conductance can be increased by tile drainage, groundwater discharge, weathering, pollution, evaporation
- Conductivity in streams is affected by:
  - Geology
  - Temperature

Water Level (Stage) and Flow

- Water level units: feet
- Flow units: cubic feet per second (cfs)
- Cross-section area (ft²) x velocity (ft/sec)
- Stage/Flow correlations (Rating Curve)
- Necessary for Load Calculations (tons/year)
- Calibration of hydrology models/assessments
- Total Maximum Daily Load (TMDL) calculations
Rating Tables and Curves

- A rating table or curve shows the relationship between stage and discharge at a cross section of a river.
- In most cases, data from streamgages are collected as stage data.
- To aid in modeling streams and rivers, the data needs to be expressed as stream flow using rating tables.

https://www.nws.noaa.gov/os/hod/SHManual/SHMan040_rating.htm
Total Suspended Solids

- Units: mg/L
- Dry weight, per volume, of particles trapped by a filter

High TSS = Muddy looking water; Low TSS = Clear water

- Sediment can cover sand, pebbles, rocks, etc. Fish prefer spawning on courser substrates and egg maturity

  Sources: All types of erosion, storm water runoff, wastewater discharge
Turbidity

- Units: NTU/NTRU/FNU
- Measurement of the amount of cloudiness in the water caused by suspended particles
- Old standard was 25 NTU
- Correlates with TSS

- Lab turbidity = NTU
- Turbidimeter = NTRU
- Field turbidity = FNU
Transparency Secchi Tube and Secchi Disk

- Units: cm (streams) or m (lakes)
- Measure of water clarity
- Correlates with TSS in rivers
- Water clarity in lakes is affected by algal blooms and other suspended particles
- Higher # = Clearer Water
- Subjective, but cheap and simple. Data is still usable for identification of significant problems
Total Phosphorus

Total Phosphorus (TP) includes the amount of phosphorus in solution (reactive) and in particulate form. Only a portion of the TP is readily available for use in algae growth.

- Units: mg/L
- Essential nutrient for plant (and algae) growth in most lakes
- Can cause large algae blooms (eutrophication)
- Eutrophication can reduce dissolved oxygen levels and increase DO Flux
Ortho Phosphorus (OP)

The form of phosphorus that is readily available for use by algae and other aquatic plants for growth.

- Dissolved, inorganic phosphorus
- OP represents a fraction of TP
- High % of OP may indicate stagnant conditions
- OP is released from sediment in anoxic conditions
- Examples of sources:
  - partially treated and untreated sewage; runoff from agricultural sites; and application of some lawn fertilizers
Nitrogen

- Total Kjeldahl Nitrogen: Total concentration of organic nitrogen and ammonia
- Inorganic Nitrogen forms: Nitrates (NO3), Nitrites (NO2), and Ammonia (NH3) and Nitrogen gas (N2)
- Organic nitrogen is found in the cells of all living things and is a component of proteins, peptides, and amino acids.

Schematic diagram of the relative amounts of different N forms commonly found in MN surface waters with elevated N levels.
The presence of *E. coli* in water is a strong indication of sewage or animal waste contamination, hence *E. coli* are used as indicators for water contamination.

*E. coli* in a stream or lake increases the risk of gastrointestinal illness from recreation activities involving contact with the water.

**Standards:**
- 1260 MPN/100mL acute standard
- 126 MPN/100mL monthly geometric mean

[https://www.pca.state.mn.us/water/bacteria](https://www.pca.state.mn.us/water/bacteria)
[http://msu-water.msu.edu/red-cedar-river-watershed/surface-water-monitoring-on-the-red-cedar-river](http://msu-water.msu.edu/red-cedar-river-watershed/surface-water-monitoring-on-the-red-cedar-river)
Index of Biological Integrity

An index of biological integrity (IBI) is a score that compares the types and numbers of fish and macroinvertebrates observed in a waterbody to what is expected for a healthy waterbody.

- Fish (F-IBI)
- Macroinvertebrates (M-IBI)

- Intolerant species (sculpin, tricoptera) increases the IBI score
- Dominance of tolerant species (common carp, oligochaetes) decreases the IBI score
- IBI focuses on **number** and **abundance** of species

[Source](https://fishbio.com/field-notes/wildlife-ecology/bugging-out)
What is the data used for?

- **Watershed Pollutant Load Monitoring**: Assess regional differences in pollution contribution
- **Determine impairments**: Stream reaches and lakes that fail to meet the water quality standards
- **Stressor Identification**: “Stressors” impacting the biological community and begin identification of pollutant sources and priority management zones
- **Total Maximum Daily Load or TMDL**: Calculation of the maximum pollutant load a water body can assimilate and still meet standards
- **Watershed Restoration and Protection Strategy or WRAPS**: Recommendations to restore impaired waters and protect unimpaired waters
- **One watershed one Plan (1W1P)**: Watershed and local stakeholders prioritize restoration and protection actions
- **Watershed Modeling**: Calibrating Models
  - Efforts continue throughout the process and are adjusted as needed to achieve the clean water goals
References

- https://www.pca.state.mn.us/water/bacteria
- http://www.combat-fishing.com/invertebratespectrumozarkstream.JPG
Questions?

Next ….

- Standard Operating Procedures – Corey Hanson, RLWD.