A Water Quality Assessment of Representative Trout Streams on Minnesota’s North Shore of Lake Superior

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Lake Superior Landuse and Bathymetry

Depth in meters
- 0 to 67
- 67 to 152
- 152 to 237
- 237 to 322
- 322 to 408
- No Data

Legend:
- Agriculture
- Bare ground
- Cloud shadow
- Clouds
- Conifer
- Conifer/hardwood
- Developed
- Grass/brush
- Hardwood
- Hardwood, early seral
- Missing data
- Water

Map Produced by: Natural Resources Research Institute, University of Minnesota-Duluth, 1999.
The North Shore is Changing

Cumulative Impacts ??
Data / Information Need

• Resource agencies are lacking the data to effectively:
  – Assess current water quality conditions
  – Detect trends over time
  – Assist in stream protection / remediation efforts

• 2 of 27 streams have streamflow data
• Last comprehensive water quality study done in 1970’s
Tourism, Development, and Water Quality on the North Shore

• Tourism a major sector of our economy
  – $275 Million spent (2000) in the North Shore Area

• Tourism, Population, Development Steadily Increasing

• Tourism Closely Tied to the Quality of the Natural Environment (Lake Superior, Streams, Inland Lakes)
• MPCA and cooperators asked

“What is the condition of north shore streams, given our changing landscape?”
The North Shore Streams

- Dynamic Hydrology (i.e. flashy)
- Support Cold / Cool Water Fisheries
- Steep Slopes
- Thin, highly erodible clay soils
- Minor increases in pollution can cause perceptible declines in water quality
Site Selection

- 27 Minnesota Streams Flow into Lake Superior
- Representative Streams Studied
  - More developed: Duluth – Two Harbors
  - Less developed: Two Harbors to Grand Portage
  - Designated Trout Streams
  - Variations in drainage size, characteristics
  - Site close to watershed outlet
  - Safe, cost effective monitoring
Monitoring Procedure

• Standard, established protocol for assessing non-point source pollution
• Determine annual “loading” of nutrients and sediments (erosion)
• Continuous streamflow monitoring and statistically defined water quality sampling
• 20 samples annually
  – 75% @ high flow events (snowmelt, big rains)
• Computer model computes total loading rates (tons / year) and “flow weighted mean concentrations” based on relationship between flow and concentrations
Knife River After a Rain Storm

(Photo courtesy of St. Paul Pioneer Press)
French River 2002 Hydrograph (DNR Data)

Mean Daily Flow (cfs)

Avg. Flow (cfs)

Sample

4/10/2002
5/10/2002
6/9/2002
7/9/2002
8/8/2002
9/7/2002
10/7/2002
Findings

- Sediment and nutrient levels were highest in the Duluth – Two Harbors Region, water quality improved farther up the Shore
  - Landuse change (development)
  - Natural watershed differences
- High flow events contribute most pollution
- Water quality impacts in the Poplar River
- Water quality declined since the 1970’s, except in relatively pristine Brule River
2002 Flow Weighted Mean Concentration- Total Phosphorus

TP (ug/L)

Duluth  Canadian Border

Amity  Talmadge  French  Sucker  Poplar-Down  Poplar-Up  Brule
Excessive Nutrients = Excessive Algae Levels
Poplar- Upstream site after significant rainfall, 7/30/01

• Total Suspended Solids = 2.4 mg/L
• Turbidity = 2.8 NTU
• Total Phosphorus = .013 mg/L
Poplar Downstream site after significant rainfall, 7/30/01

- Total Suspended Solids = 370 mg/L
- Turbidity = 890 NTU
- Total Phosphorus = .549 mg/L
Total Mercury vs. TSS in the Poplar River, 2002

\[ y = 0.0732x + 3.0101 \]

\[ R^2 = 0.85 \]
Mercury Sampling in the Poplar River, 2002

• Strong correlation between Hg and TSS
  – Found in other river basins by S. Balogh @ MCES
• Sediment sources are Hg sources
• Mercury levels exceed State standard at both sites
• Implications to fisheries / fish consumption advisory?
Water Quality Trends

Flow Weighted Mean Total Suspended Sediment 2002 vs. 1970's

Flow Weighted TSS (mg/L)

- French
- Sucker
- Poplar-Down
- Brule

Legend:
- '73-'75 FWM TSS (mg/L)
- 2002 FWM TSS (mg/L)
2002 and 2003 Flow Weighted Mean Total Phosphorus Concentrations

T. Phos. (ug/L)

- Amity
- Talmadge
- French
- Sucker
- Poplar-Down
- Poplar-Up
- Brule

2002 T. Phos.
2003 T. Phos.
Take Home Messages

• NS Streams are sensitive resources, tied to quality of tourism experiences

• NS Streams have responded to landuse changes, evident water quality impacts

• Monitoring must continue, requires a strong commitment of many agencies.
  – Good information yields good water management decisions
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