How does sediment affect fish and macroinvertebrates?
How does sediment affect fish and macroinvertebrates?

• Suspended sediment (TSS): breathing, vision
• Sediment on streambed: egg development, living space
Suspended sediment (TSS)

Setting an effective TMDL for suspended sediment:

easy to say, but fish provide a moving target
What is a TMDL?
Total Maximum DAILY Load

1) Problem identification
2) Target values
   MPCA standard 25 NTU or ~ 46 mg/l
3) Source assessment
4) Link targets and sources
5) Allocate among inputs
6) Develop monitoring and evaluation plans
Excess suspended sediment often results in:

1) Reduced diversity/altered species composition
2) Altered size and age structure
3) Temporal variability in abundance
What causes these changes?

Suspended sediment directly affects fish through:

1) Behavioral changes
2) Sublethal and lethal effects
Past research:

1) Model suspended sediment loads in two basins

2) Quantify sediment load:
   - concentration
   - duration

3) Estimate effects on fish
Chippewa River Land Use

80% in cultivation and includes a portion of Montevideo

Study area: 17,994 ha
Wells Creek Land Use

60% in cultivation and 25% wooded

Study Area: 16,264 ha
Methods

1) ADAPT model
   Agricultural Drainage and Pesticide Transport
   50-year simulation

2) Survey farmers in each study area

3) Streambank erosion
   20% in Wells Creek
   40% in the Chippewa River
Effects of sediment on fish
Newcombe and Jensen (1996)

**Sublethal** - Reduction in feeding rate or success, coughing and increased respiration, moderate habitat degradation, and impaired homing

**Lethal** - Reduced growth, reduced density, increased predation, and mortality
# Sublethal Thresholds (mg/L SS)

Newcombe and Jensen (1996)

<table>
<thead>
<tr>
<th></th>
<th>Salmonids</th>
<th>Non-salmonids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 day</strong></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>2 day</strong></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>6 day</strong></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>14 day</strong></td>
<td>1</td>
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</table>
### Lethal Thresholds (mg/L SS)

Newcombe and Jensen (1996)

<table>
<thead>
<tr>
<th></th>
<th>Salmonids</th>
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</thead>
<tbody>
<tr>
<td>1 day</td>
<td>2981</td>
<td>8103</td>
</tr>
<tr>
<td>2 day</td>
<td>1097</td>
<td>403</td>
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<td>55</td>
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<tr>
<td>14 day</td>
<td>403</td>
<td>3</td>
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Sediment Delivery

Mean event duration

Chippewa River = 2.9 ± 3.8 days
Wells Creek = 1.5 ± 1.1 days

Maximum event duration

Chippewa River = 35 days
Wells Creek = 14 days
## Duration of sediment delivery

<table>
<thead>
<tr>
<th>Days</th>
<th>Wells Creek</th>
<th>Chippewa River</th>
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</thead>
<tbody>
<tr>
<td>≥ 1</td>
<td>827</td>
<td>489</td>
</tr>
<tr>
<td>≥ 2</td>
<td>337</td>
<td>417</td>
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<tr>
<td>≥ 6</td>
<td>15</td>
<td>111</td>
</tr>
<tr>
<td>≥ 14</td>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>
Mean days exceeding 46 mg/L TSS

Chippewa River = 31.9 \pm 22.4

Wells Creek = 29.5 \pm 13.5
Mean annual events

- Wells Creek
- Chippewa River

lethal

sublethal

salmonids
non-salmonids
Conclusions

1) ~ 25 events/year with physiological stress to fish (lethal or sublethal)

2) Sediment often delivered over a period of several days

3) Duration of event as critical as concentration and complicates setting TMDL
Particle size of streambed

Fine particles (clay) to boulders or bedrock

- Fish and aquatic macroinvertebrates use a range of particle sizes
  Trout generally prefer large particle sizes to maintain position and feed

- Fine sediment deposited on the streambed is a major cause of changes in species structure and abundance and may lead to local extinction
Particle size of streambed

Causes of changes in species structure and abundance

• Microhabitat scale: fine sediment fills interstitial spaces
  - reduces habitat for invertebrates
  - covers eggs

• Macrohabitat scale: fine sediment reduces habitat diversity
  - streambed uniform
  - shift to few, abundant organisms
Grazing in riparian areas

Examine relationships between channel morphology and grazing as related to streambank erosion, in-channel habitat, and benthic macroinvertebrates.
Grazing in riparian areas

- Three treatments:
  - non-grazed (NG),
  - conventionally grazed (CG), and
  - managed grazed (MG)

- Drainage area range from < 1 km² to > 120 km²
- 4 watershed metrics,
- 5 riparian management metrics,
- 21 channel response metrics
  - (including channel stability index), and
- a benthic macroinvertebrate index of biotic integrity
Grazing in riparian areas

• Important variables from analysis
  - soil compaction
  - vegetation (trees and grass)
  - vegetation height
  - channel stability index
  - size of streambed substrate ($D_{84}$)