Motivation:

Which streams are most sensitive to disturbance by human activities?

"Significant adverse environmental impact“...degradation of environmental quality including biological and ecological aspects of the affected water resource NR 820.12 (19)

Objectives:

1. Model stream flow duration curves.
2. Model fish species distributions.
3. Predict changes to fish communities that would result from flow alterations.
Flow Model

Dynamic
- Land Use*
- Precipitation*
- Groundwater withdrawals

Static
- Soils and Geology
- Topography
- Watershed area

*Recent past and predicted future

Stream flow
5, 10, 50, 90, 95% exceedance flow
Annual, seasonal, April, August
At the statewide scale, no effect of groundwater withdrawals on stream flows could be detected.

- Most gaged watersheds have low withdrawal
- Highest watershed-average withdrawal rates are from deep aquifers
### Tenmile Creek, (Cool-Cold Mainstem)

**Details**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Community</td>
<td>Cool-Cold Mainstem</td>
</tr>
<tr>
<td>Stream Name</td>
<td>Tenmile Creek</td>
</tr>
<tr>
<td>River System</td>
<td>Tenmile Creek</td>
</tr>
<tr>
<td>WBIC</td>
<td>1382700</td>
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<tr>
<td>Watershed Area (sq km)</td>
<td>251.37</td>
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<td>Temperature Class</td>
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<td>Hydro ID</td>
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<td>Hydro Code</td>
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<td>Maximum daily mean temperature (°C)</td>
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<tr>
<td>June - Sept mean flow (cfs) (1983-2011)</td>
<td>53.122572</td>
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<tr>
<td>Annual 5% exceedance flow (cfs) (1984-2011)</td>
<td>98.954962</td>
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<tr>
<td>Annual 10% exceedance flow (cfs) (1984-2011)</td>
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<td>Annual 25% exceedance flow (cfs) (1984-2011)</td>
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<td>Annual 50% exceedance flow (cfs) (1984-2011)</td>
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<td>Annual 75% exceedance flow (cfs) (1984-2011)</td>
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<td>Spring 90% exceedance flow (cfs) (1983-2011)</td>
<td>38.941024</td>
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</tbody>
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**Diagram:**

[Map of Tenmile Creek, (Cool-Cold Mainstem)](image)
Fish Model

Dynamic
- Land Use
- Stream flow
- Temperature

Static
- Soils and Geology
- Stream size
- Stream gradient

The Fish Model includes dynamic factors such as Land Use, Stream flow, and Temperature, and static factors such as Soils and Geology, Stream size, and Stream gradient.
Species Distribution Models

- Random Forest
- Presence/Absence
- 616 fish surveys used to build models
- Environmental predictors:
  - Watershed area
  - Water temperature (modeled)
  - Flow yield (modeled)
  - Channel gradient, sinuosity
  - Land cover
  - Geology/soils
  - Climate
Tenmile Creek fish community

- Brook trout
- Brown trout
- N. Brook lamprey
- Black bullhead
- Central mudminnow
- Mottled sculpin
- Brassy minnow
- Common shiner
- Bigmouth shiner
- Pearl dace
- White sucker
brook trout

August Median Flow Yield (cfs/sq mi)
Mean July Temperature (C)

Flow / temp niche (95% abundance)
Limitations

• Need hydrogeological models to simulate groundwater/surface water interactions
• Cannot model flow intermittency
• Temperature response to flow change is approximate
• Fish response in terms of occurrence, not abundance
• Policy still needs societal values
Summary

Flow models

• Fill gap between USGS low flow and flood frequency models
• Predict flow duration curves at all Wisconsin streams
• Can be used to simulate pre-settlement and future flows

Fish models

• Predict fish community in all Wisconsin streams
• Can be used to identify streams that are biologically sensitive to changes in flow, temperature, land use, and climate.