EPA Region 10
Temperature TMDLs

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Photo: S.F. Nooksack River
Agenda

1. Water Quality Standards & Impairments
2. Technical Challenges & Approaches
3. Climate Change Challenges
   a. Columbia River
   b. SF Nooksack
Water Quality Standards

- ESA Listings for Salmonids
- Washington, Oregon and numerous Tribal governments adopted numeric criteria recommend by EPA Guidance
  - Generally 12C – 20C
- Supplemental & Narrative Criteria:
  - Cold Water Refugia
  - 0.3 C human use allowance (Oregon)
  - Natural conditions

Photo: Sockeye salmon
Temperature Impairments & TMDLs

- 36,323 miles of temperature impaired rivers & streams
- 149,761 acres of temperature impaired lakes & reservoirs
Temperature TMDL Challenges

• General
  • Heat is not conservative.
    • Models often needed to track impacts over time and space
  • Loads are not easily tracked and units are not mass (kcal/day vs lbs/day)
  • Natural variability and climate change

• Pacific Northwest Heat Sources
  • Forest management - riparian shade loss
  • Channel impacts and water withdrawals
  • Dams – impounding rivers
  • NPDES Sources (in smaller watersheds)
Forest Lands

- Loss of riparian shade
- Sediment erosion changing stream morphology
- Loss of woody debris & hyporheic connectivity
- Models: HeatSource and QUAL2Kw
  - Small Rivers – 1 dimensional
  - Shade, point sources, groundwater, tributaries
Hydroelectric Dams

• Dams change the travel time and geometry

• Temporal shift
• Cumulative impacts from multiple dams

• Models
  • CE-QUAL-W2
    • 2 dimensional
    • Vertically stratified reservoirs
  • RBM10 – special case → Columbia River
    • 1 dimensional, long term simulation
    • Dams, point sources, tributaries and climate trend
Columbia River model outputs

Dam impacts
Climate Change

• Baked-in impact (and continuing)
• Columbia River – evidence of warming since 1960s
• Growing body of literature estimating warming of rivers
S.F. Nooksack Climate Change Studies: quantitative & qualitative assessments
<table>
<thead>
<tr>
<th>Reach or Subbasin</th>
<th>Reduced Spring Snowmelt (percent SD+HL)</th>
<th>Elevated Summer Temperature</th>
<th>Reduced Summer Low Flow</th>
<th>Increased Winter Peak Flow</th>
<th>Sediment</th>
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</thead>
<tbody>
<tr>
<td>Reaches</td>
<td></td>
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<tr>
<td>1 (RM 0-14.3)</td>
<td>Moderate (43 percent of basin)</td>
<td>High (Currently exceeds 7-DAD Max lethal limit of 22 °C)</td>
<td>High (Potentially a reach that loses surface water to groundwater recharge)</td>
<td>High (Floodplain artificially confined and incised)</td>
<td>Moderate (Floodplain artificially confined and incised, loss of floodplain sediment storage)</td>
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<tr>
<td>2 (RM14.3-18.5)</td>
<td>High (60 percent of basin)</td>
<td>High (Expected to exceed 7-DAD Max lethal limit under 7Q10 conditions with climate change)</td>
<td>Low (Floodplain unconfined)</td>
<td>Moderate (Floodplain naturally confined)</td>
<td>Moderate (Rapid channel migration - increase in bank erosion)</td>
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</tbody>
</table>
| 3 (RM 18.5-25.4)  | High (66 percent of basin)              |                             |                         | Low (Floodplain unconfined) | Moderate (Floodplain naturally confined) 
| 4 (RM 25.4-31)    | High (73 percent of basin)              |                             |                         | Moderate (Floodplain naturally confined) | Moderate (Rapid channel migration) |
| 5 (Upstream of RM 31) | High (77 percent of basin)             | Moderate (Expected to remain below lethal) |                         | Moderate (Floodplain naturally confined) | Moderate (Abundant stream-adjacent landslides and unstable slopes could increase sediment sources) |
The End

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