Temperature TMDL Models

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Pend Oreille River TMDL
Watershed Advisory Group

October 26, 2006
What is an environmental model?
- A mathematical tool
- Uses statistics and/or fundamental principles
- Replicates observed data (calibration)
- Gives us the “Big Picture”
  - Identifies the causes of pollution problems
  - Shows what’s happening “in between” the observed data (both in time and space)
- Project trends into the future (growth)
- Allows “what if” scenarios for restoration
What kinds of models are there?

- **One-dimensional**
  - Fully mixed (up to downstream only)

- **Two-dimensional**
  - Vertical layers, but mixed laterally

- **Three-dimensional**
  - Segments in all three dimensions
What kinds of models are there?

- **Steady-State**
  - Constant over time
  - Summer low flow
  - Average daily

- **Dynamic**
  - Changing over time
  - (hourly, daily, monthly...)

![Graph showing temperature changes over time](image)
What kinds of models are there?

- Simple spreadsheet models
  - “rTemp”, “Shade”
- Complex spreadsheet/Visual Basic models
  - “Qual2kw”
- Simple “stand-alone” models
  - “SSTEMP”
- Highly complex
  - “CE-QUAL-W2”
What parameters do we model?

- Dissolved Oxygen
- Bacteria
- Nutrients
- Toxics
- Sediments
- Temperature
Temperature TMDL Models

Illustration of physical processes governing temperature

- longwave (longat + back)
- solar (Jsnt)
- convection (conv)
- evaporation (evap)
- groundwater (Jsed)

Stream
Temperature TMDLs – current methods

- Characterize current conditions
  - Assess water temperatures
  - Assess channel structure and measure flows
  - Assess shade
  - Collect weather information
Temperature TMDLs – current methods

- Characterize current conditions
- Assess water temperatures
StowAway TidbiT Temperature Logger
FLIR (Forward-Looking Infrared) Imagery
- Assist Model Calibration
- Cold water refugia
- Identify Cool Groundwater inputs
- Public Outreach
- Measure temperature between monitoring sites

Pend Oreille River, Elevated Water Temperature and Milfoil on the Right Bank, RM 81.77
GIS analysis of remote sensing data
Temperature TMDLs – current methods

- Characterize current conditions
  - Assess water temperatures
  - Assess channel structure and measure flows
Temperature TMDL Models

Tributary stream surveys
Temperature TMDLs – current methods

- Characterize current conditions
  - Assess water temperatures
  - Assess channel structure and measure flows
  - Assess shade
Temperature TMDL Models

Hemispherical Photography
Calculator for topographical and riparian vegetation shading
Temperature TMDLs – current methods

- Characterize current conditions
  - Assess water temperatures
  - Assess channel structure and measure flows
  - Assess shade
  - Collect weather information
Collect weather data for model input

Agrimet weather station (Seven Bays)

Weather data from: Spokane Airport

Temperature(red)/ Dewpoint(blue) (Fahrenheit)
Temperature TMDLs – current methods

- Model current conditions (calibrate)
- Evaluate human impacts
- Model system potential conditions (‘natural’)
- Model “worst case” scenarios (‘critical’)
- Set heat load targets to meet the standards
- Evaluate alternative restoration activities
Temperature TMDLs – current methods

- Model current conditions (calibrate)
Temperature TMDL Models

Temperature Model (Qual2kw)
Steady-state Output: daily temperature range by river mile

*Little Klickitat River (7/31/2000)*
Steady-state Output: daily temperature range by river mile
Dynamic Output: site-specific water levels by date
Dynamic Output: site-specific temperatures by date

Figure 68: Comparison between model predictions and temperature data at Albeni Falls Dam.
Temperature TMDLs – current methods
- Model current conditions (calibrate)
- Evaluate human impacts
Natural influences on temperature

- Amount of shade (soil type and native veg)
- Upstream natural lake
- Channel width and depth
- Channel bed material (rock, sand, muck)
- Amount of groundwater inflow
- Air temperatures
- Relative humidity
- Wind (especially on lakes and wide rivers)

Water temperatures in streams tend to respond quickly to local conditions
Potential human impacts on temperature

- Decreased shade
- Wider, shallower channel (tributaries)
- Finer, more heat-absorbent bed material
- Wider, deeper channel (reservoirs)
- Temperature changes from upstream
  - Depth and timing of reservoir releases
- Warm wastewater discharge (‘point source’)
- Fewer cool water inflows
  - Tributaries and ground water
Temperature TMDLs – current methods
- Model current conditions (calibrate)
- Evaluate human impacts
- Model system potential conditions (‘natural’)

Temperature TMDL Models
Simulated Temperature at Ice Harbor Dam 1990
Temperature TMDL Models

Frequency of Predicted Temperature Excursions
Temperature TMDLs – current methods

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- Evaluate human impacts
- Model system potential conditions (‘natural’)
- Model “worst case” scenarios (‘critical’)
- Set heat load targets to meet the standards
Effective shade and temperature improvement scenarios (Mill and Yellowhawk Creeks)
Effective shade and temperature improvement scenarios (Icicle Creek)
Temperature TMDLs – current methods

- Model current conditions (calibrate)
- Model system potential conditions (‘natural’)
- Model “worst case” scenarios (‘critical’)
- Set heat load targets to meet the standards
- Evaluate alternative restoration activities, such as:
  - Restore riparian vegetation and shade
  - Reduce erosion and restore channel structure
  - Operational or structural changes in dams
  - Increase minimum and decrease maximum flow
  - Reduce point source temperatures
Questions?

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