Klamath River TMDLs -

Water Quality Modeling Technical Analysis Update

Item 10

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Santa Rosa, CA

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Outline of Presentation

I. Overview of comments on model

II. Overview of team’s response

III. Use of models for TMDL development and establishing water quality standards

IV. Model revisions & results

V. Specific comments & responses

VI. Next steps

Project Team Consensus

Klamath River TMDL models are scientifically sound and good tools for TMDL development and establishing water quality objectives

Comments on model submitted to Regional Water Board by:

- US Bureau of Reclamation
  - ✓US Geological Survey, with Watercourse Engineering
- PacifiCorp
- Others

Range of Comments on Model

Models are satisfactory for setting TMDLs

Models need *major* revisions for setting TMDLs

Overview of Critical Modeling Comments

- Code modifications
- Parameter values for different scenarios
- Model set up
- Boundary conditions

Overview of Critical Modeling Comments

- Model calibration
- Quantification of model uncertainty
- TMDLs based on single model year
- Model documentation

Team Response to Comments

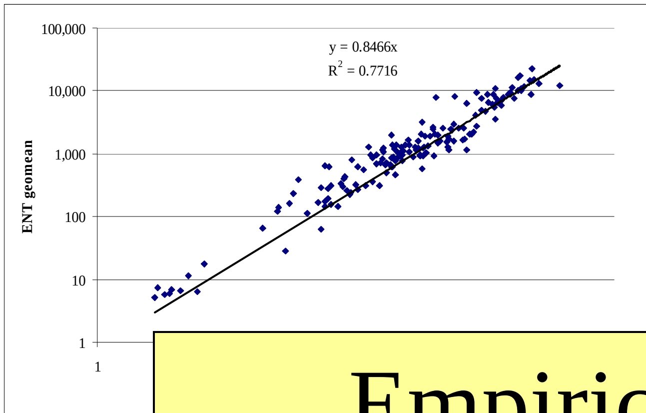
1. Written response to All comments
2. Increased documentation
   - ✓ Klamath River Model for TMDL Development Report
   - ✓ Model scenario technical memos
   - ✓ Staff Report
3. Model revisions and scenario reanalyses

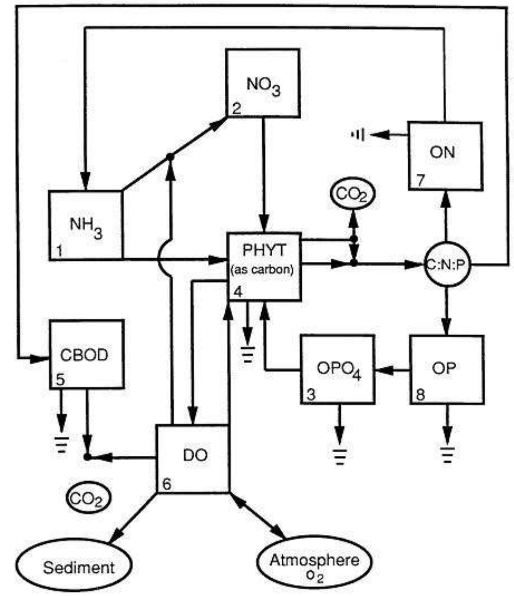
What Is a Model?

- A theoretical construct,
- together with assignment of numerical values to model parameters,
- incorporating some prior observations drawn from field and laboratory data,
- and relating external inputs or forcing functions to system variable responses.

* Definition from: Thomann and Mueller, 1987

Model Basis



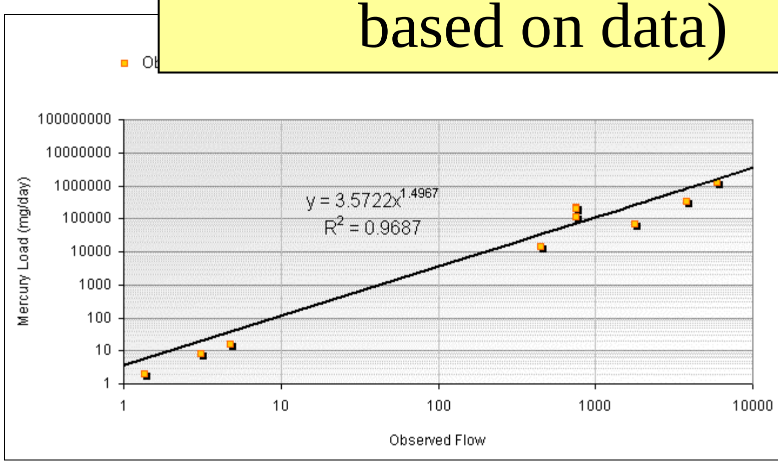


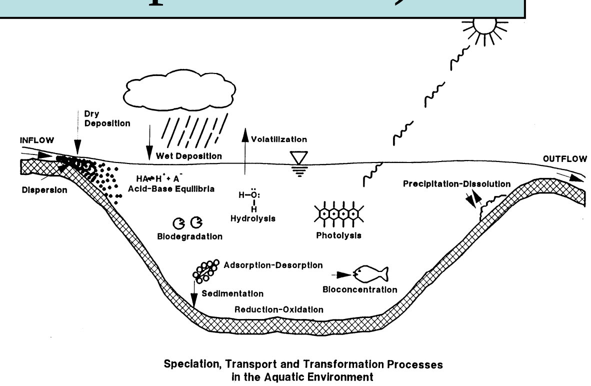
Empirical Formulations

(statistical relationships based on data)

Deterministic Models

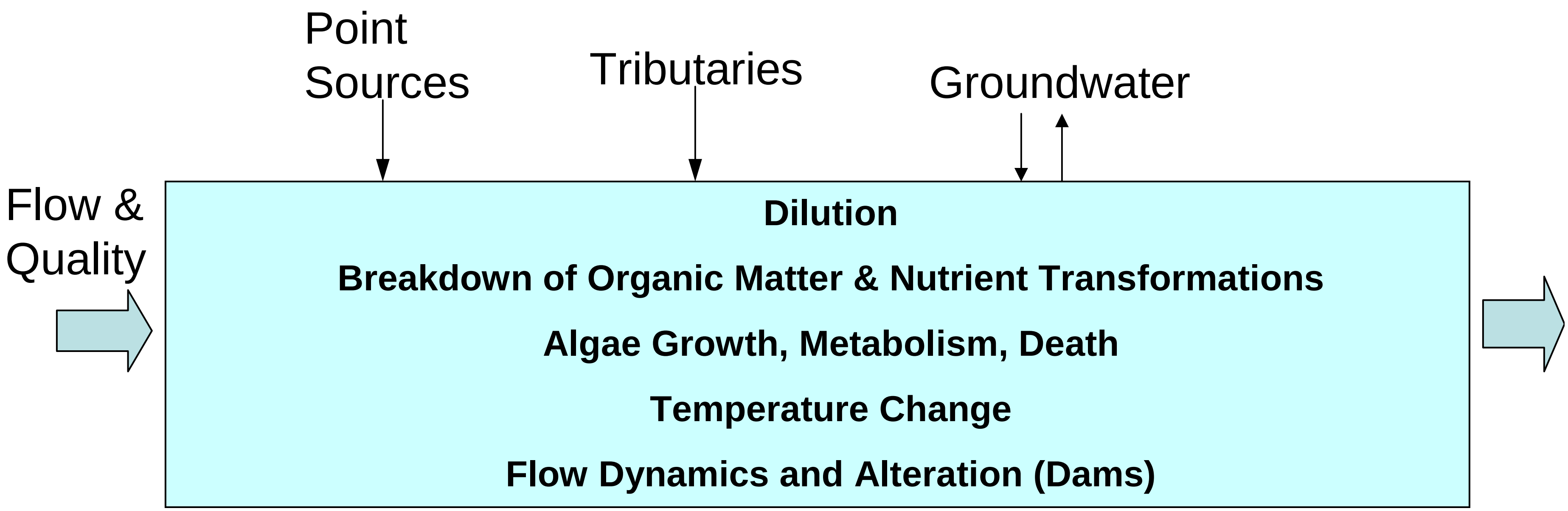
(biological, chemical, physical processes)





Klamath Model Processes

- Flow and constituents entering the river
- Physical, chemical, biological processes within the river



Modeling Process

Phase I
SCIENCE

Phase II
SCIENCE

Phase III
SCIENCE
& POLICY

Model Development

- Data gathering (historic, field monitoring)
- Model input preparation and configuration

Model Evaluation

- Calibration / Corroboration (predicted vs. measured conditions)
- Peer review

Model Application

- Analysis of TMDL Alternatives – Compliance Scenarios

Regulatory Modeling Practice

- **Development and application of Klamath River TMDL models consistent with "Guidance on the Development, Evaluation, and Application of Environmental Models" (EPA 2009)**
- **Klamath highlights:**
  - ✓ **Peer review**
  - ✓ **Transparency**
  - ✓ **Project team collaboration**

Uncertainty in Modeling Analysis

Data limitations

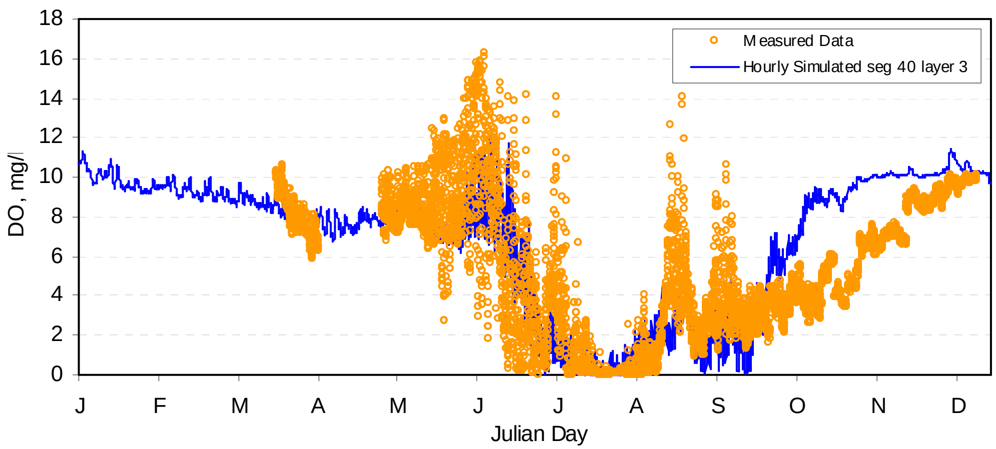
Science limitations

\+ Cost & Time Constraints = Model Uncertainty

Klamath River TMDL Model – Assessment of Accuracy

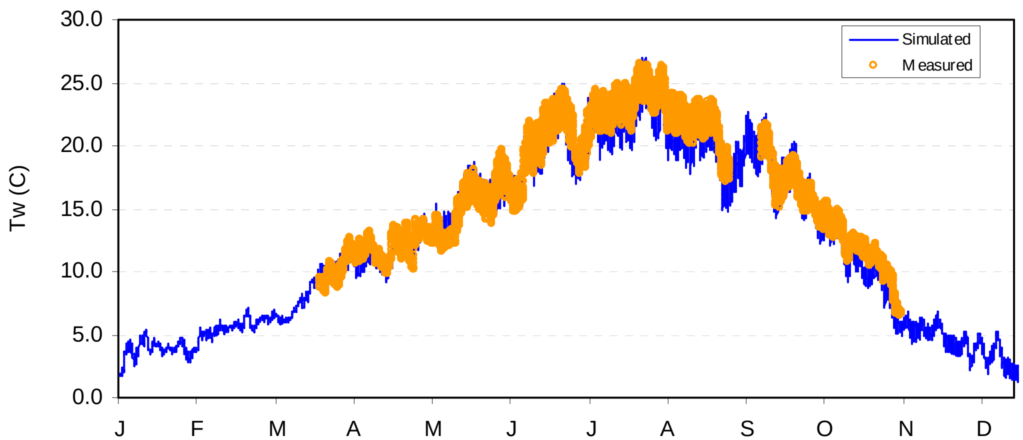
- There are many measures of model performance
- Two categories for Klamath TMDL model:
  - ✓ Qualitative comparison of time series plots
  - ✓ Calculation of error statistics

Example Calibration Results



Miller Island (2000)
Dissolved Oxygen

Model successfully captures trends, magnitudes, and unusual variability

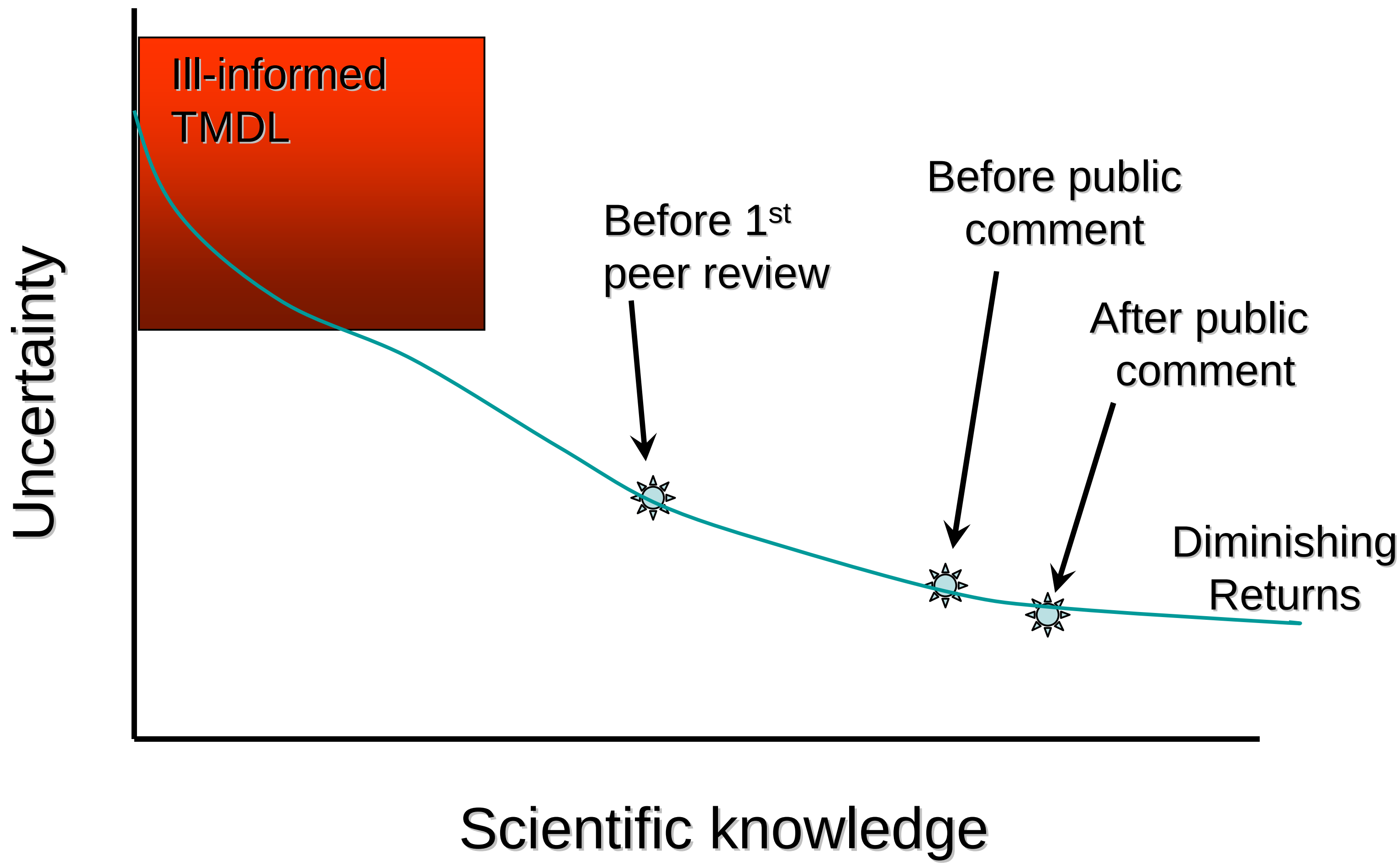


Seiad Valley (2000)
Temperature

Supporting Lines of Evidence

- Literature review
- Expert consultation
- Site specific empirical analyses
- Spreadsheet model tools

Improving Model Quality



Model Revisions - Overview

- All phases of modeling process require many technical judgments by modelers
- Klamath TMDL project team includes agency and consultant modelers
- Conducted several rounds of external peer review, plus expert review during comment period
- Updated the model at all stages of review

Post Public Comment Model Revisions - Overview

- A few fixes
- Several updates
- A number of small clean ups
- Increased documentation

Primary Model Revisions

- 20% reduction in surface solar radiation in the Lake Ewauna CE-QUAL-W2 code
- Inconsistencies among kinetic parameters for model runs
- Elevation datum for Lake Ewauna and J.C. Boyle Reservoir
- Upper Klamath Lake natural boundary condition for organic matter and algae

Additional Model Revisions

- Improved resolution of atmospheric pressure representation and updated DO boundary conditions for the Iron Gate to Turwar reach
- Made DO boundaries consistent for scenarios based on saturation %
- Used a consistent EXH2O value for the reservoirs
- Healthy/unhealthy periphyton parameters were made consistent with those for the healthy/unhealthy phytoplankton
- Updated Scott River natural flows and temperatures
- Modified the Jenny Creek boundary condition
- Updated initial conditions
- Deactivated the turbulence-enhanced reaeration for the no-dams scenarios
- Updated the distributed flow temperature for Lake Ewauna
- Computed error statistics

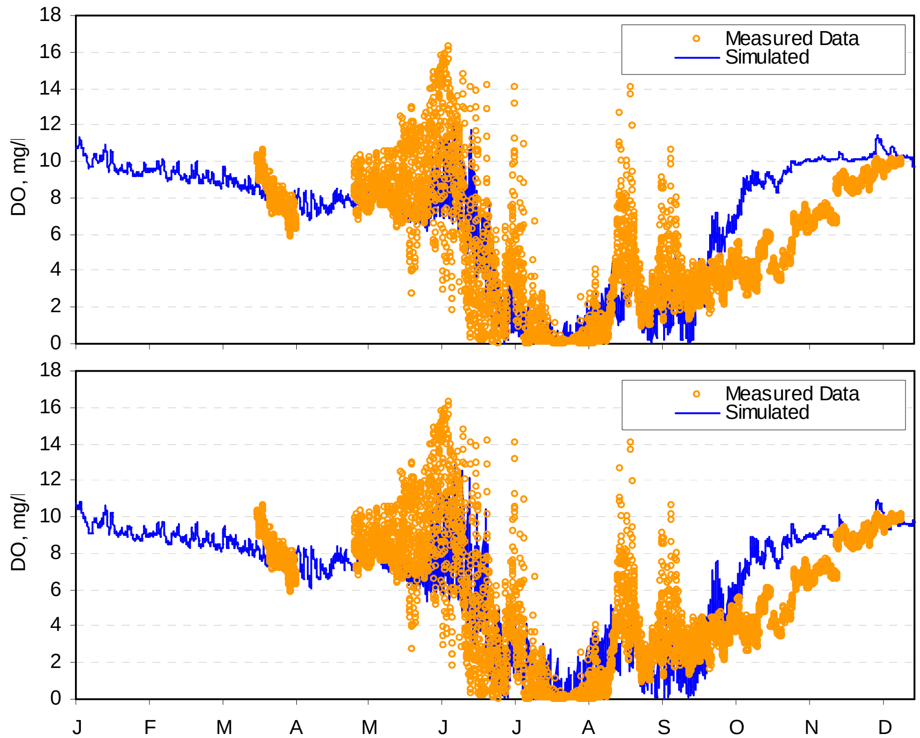
Sequence of Updates

- Existing calibration (2000)
- Existing corroboration (2002)
- Baseline (natural) condition
- Oregon allocation
- California allocation
- Oregon TMDL dam evaluation
- California TMDL dam evaluation and reservoir chlorophyll-a target compliance

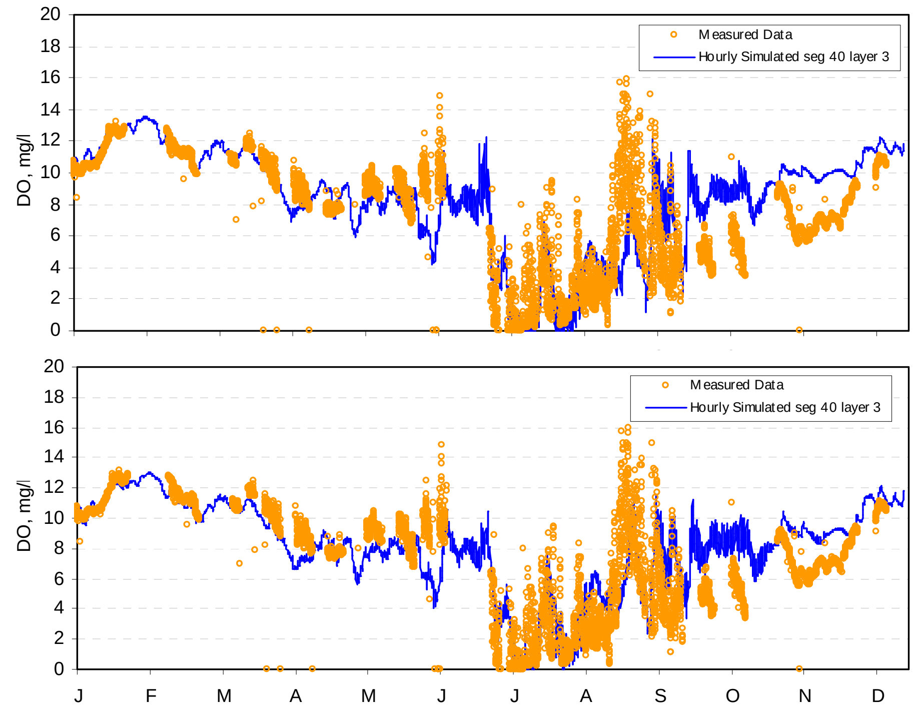
Summary of Findings

- 2000 calibration and 2002 corroboration models still reasonably reproduce observed water quality
- Predicts similar water quality patterns to previous model
- Variation in magnitudes of some parameters compared to previous model
- Allocations not significantly affected

Example Calibration/Corroboration Results Dissolved Oxygen



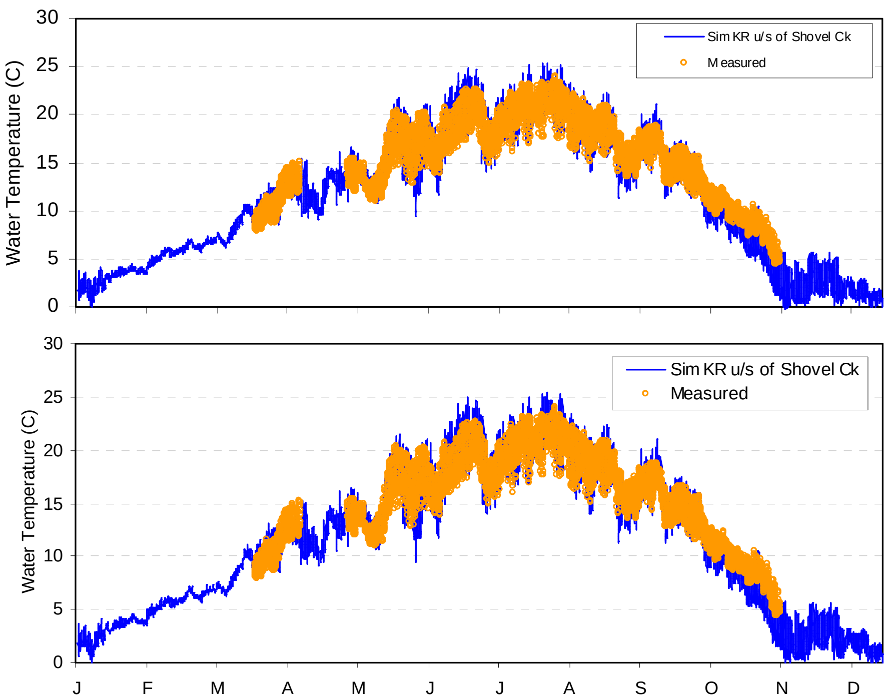
Dissolved Oxygen
Klamath River at Miller Island - 2000



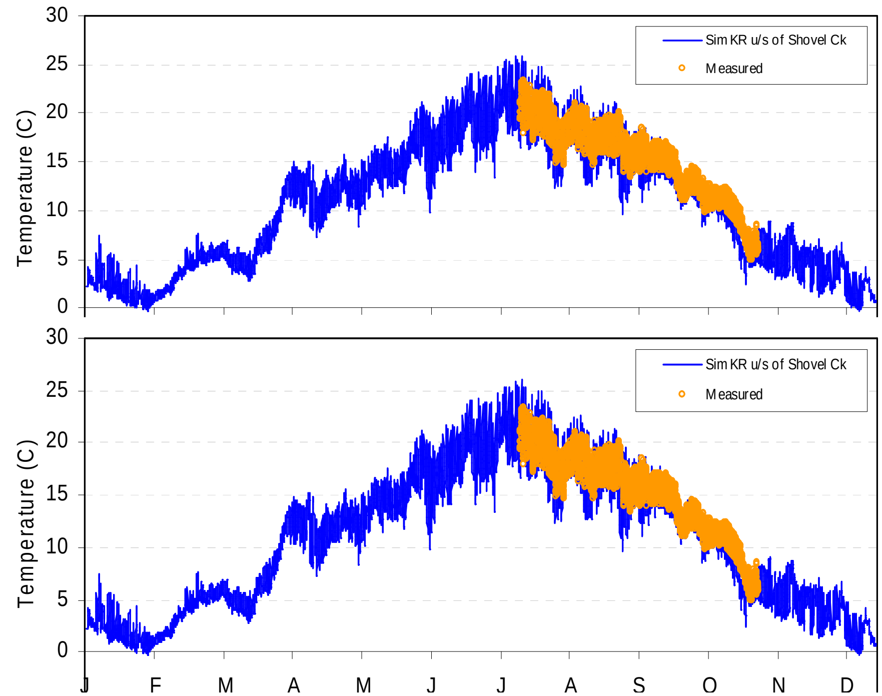
Dissolved Oxygen
Klamath River at Miller Island - 2002

NEW (TOP)
OLD (BOTTOM)

Example Calibration/Corroboration Results Temperature



Temperature
Klamath River U/S of Shovel Creek - 2000



Temperature
Klamath River U/S of Shovel Creek - 2002

NEW (TOP)
OLD (BOTTOM)

Summary of Findings:
Oregon Allocations

- **Model revisions did not significantly affect allocations and targets**
- **Point source and nonpoint source allocations still achieve water quality targets**

Comment: It is inappropriate to base the TMDL on a single model year

Response:

- ✓**The year chosen has significant within-year variability in a highly managed and variable system**
- ✓**TMDLs frequently developed using a single "design" year**
- ✓**The year chosen included periods of critical low flow and poor water quality**

Comment:

Water quality compliance condition at Upper Klamath Lake (UKL) is unrealistic

Response:

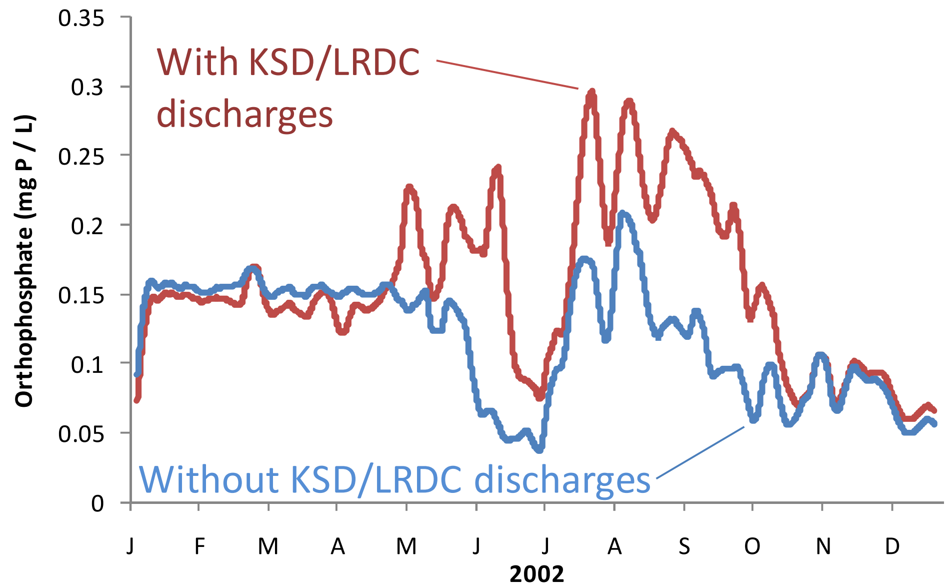
- ✓ **Based on Oregon’s UKL TMDL**
- ✓ **Used single year that represents median condition of 8 years**
- ✓ **Presented in Oregon’s Klamath River TMDL**

Comment:

Lost River Basin is a nutrient sink

Response:

- ✓Klamath Straits Drain (KSD) and Lost River Diversion Channel (LRDC) load reductions needed to meet Oregon WQ criteria for Klamath River
- ✓KSD and LRDC increase nutrient concentrations in Klamath River



Summary of Findings
California Allocations

- **Draft allocations predicted to achieve standards:**
  - ✓ **Temperature & proposed DO objectives met**
  - ✓ **Chlorophyll-a target met in reservoirs**
- **Stateline allocations and targets consistent with Oregon allocations**
- **Klamath Hydroelectric Project facility:**
  - ✓ **Nutrient load reductions required, but less than under previous model**

Comment: Stateline and Klamath Hydroelectric Project allocations & targets are unachievable

✓Stateline allocations and targets:

- Consistent with Oregon TMDL allocations

✓KHP allocations and targets:

- Consistent with achieving standards
- Flexibility in Implementation Plan
- Accounting & Tracking Program (KlamTrack) will facilitate offsite pollutant reduction measures
- Centralized treatment
- PacifiCorp continuing to assess in-reservoir water quality control techniques

Conclusions

- All comments are being addressed
- Project team concludes:

(1) Klamath TMDL models are scientifically sound and good tools for TMDL development and establishing objectives

(2) Allocations and targets not significantly changed by model reruns

(3) Additional analysis will bring diminishing returns for determining implementation actions

ODEQ Next Steps

- **Early 2010: Release Oregon's Draft TMDL for public comment.**
- **60-day: public review**
- **Response to public comment**
- **Issue as Department order**
- **Submit to EPA for approval**

Regional Water Board
Next Steps

- **Late Dec 2009: Release revised Staff Report and Basin Plan amendment**
- **45-day public review**
- **Jan 27, 2010: Regional Water Board Workshop on revised Implementation Plan (in Yreka)**
- **March 24-25, 2010: Regional Water Board Hearing on Klamath TMDLs (in Klamath)**