



# Trinity River RBM10 Water Temperature Model

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# Why is Water Temperature Important?

EVERY aquatic biological process is driven by water temperature

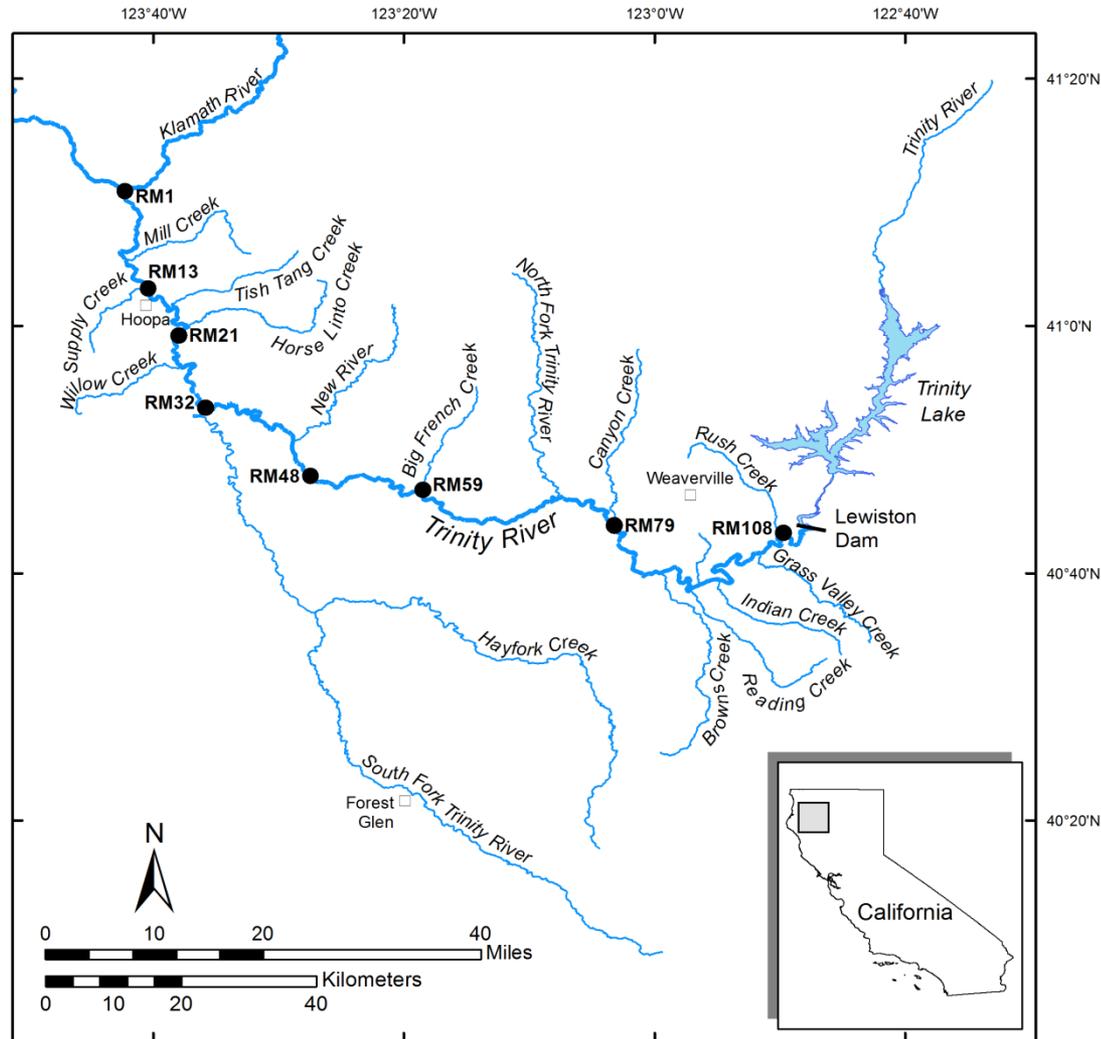
# Overview

- Model structure
- Calibration and Validation
- Alternative management scenarios

# River Basin Model-10

- 1-D daily averaged model,  
based on a heat budget formulation
- Existing RBM10 models
  - Columbia River (Yearsley and others, 2001)
  - Klamath River (Perry and others, 2011)
- Extent of Trinity River model
  - Lewiston Dam (RM 112) to Klamath R.

# Calibration Locations



# Key Components

- River geometry
- Meteorological data
- Boundary conditions
  - Tributary flows and temperatures

# River Geometry

- HEC-RAS
  - Source: CDWR, 2014 (upper 40 miles)  
WEI, 2007 (lower 72 miles)
  - 1,953 channel cross-sections
- 31 segments spanning 112 miles:  
mean length = 3.6 miles

Continuity equations:

$$W_x = a_W Q^{b_W} \quad \text{and} \quad A_x = a_A Q^{b_A}$$

# Meteorological Data (1980-2013)

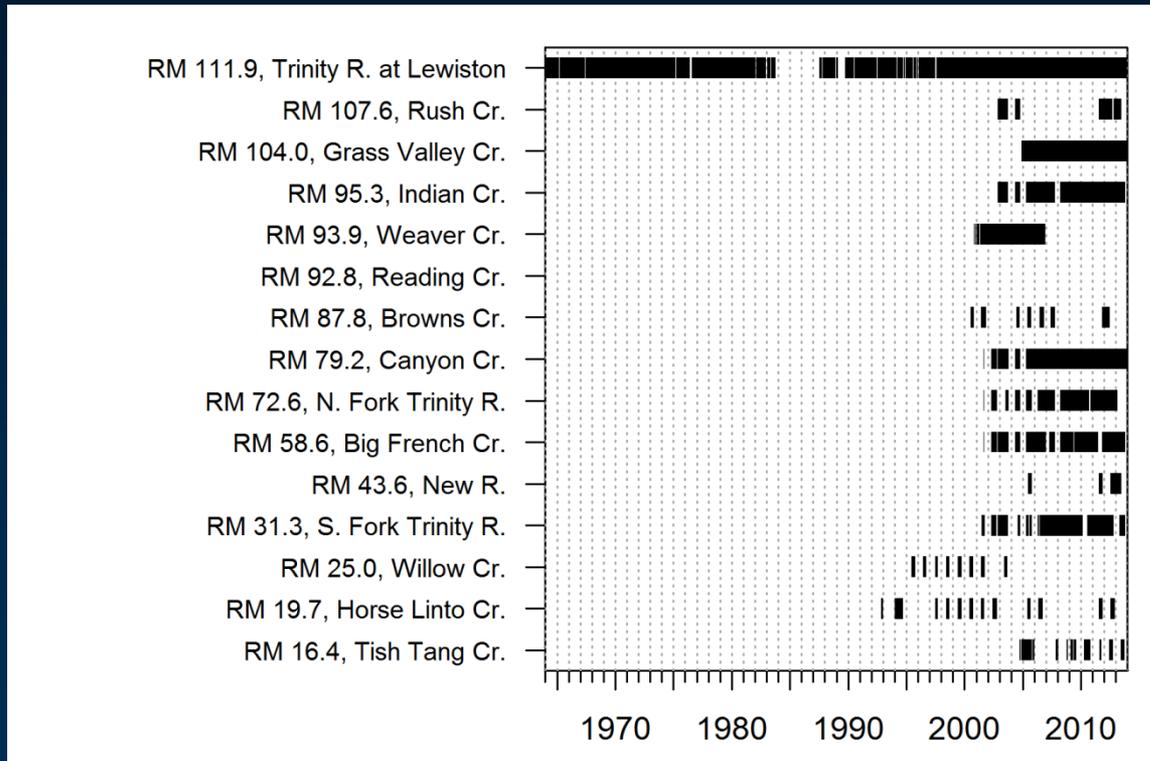
- Daily meteorological inputs:
  - shortwave solar radiation
  - longwave solar radiation
  - vapor pressure
  - air temperature (min and max)
  - wind speed
  - cloud cover
- Partitioned into 8 meteorological reaches

# Boundary Conditions

- Lewiston Dam and 14 major tributaries
- Time series of daily stream flow and water temperature
  - Observed and estimated water temperature
- Tributary flow estimated from Hoopa minus Lewiston gauge data.

# Observed Tributary Water Temperature

## Extent of measured data



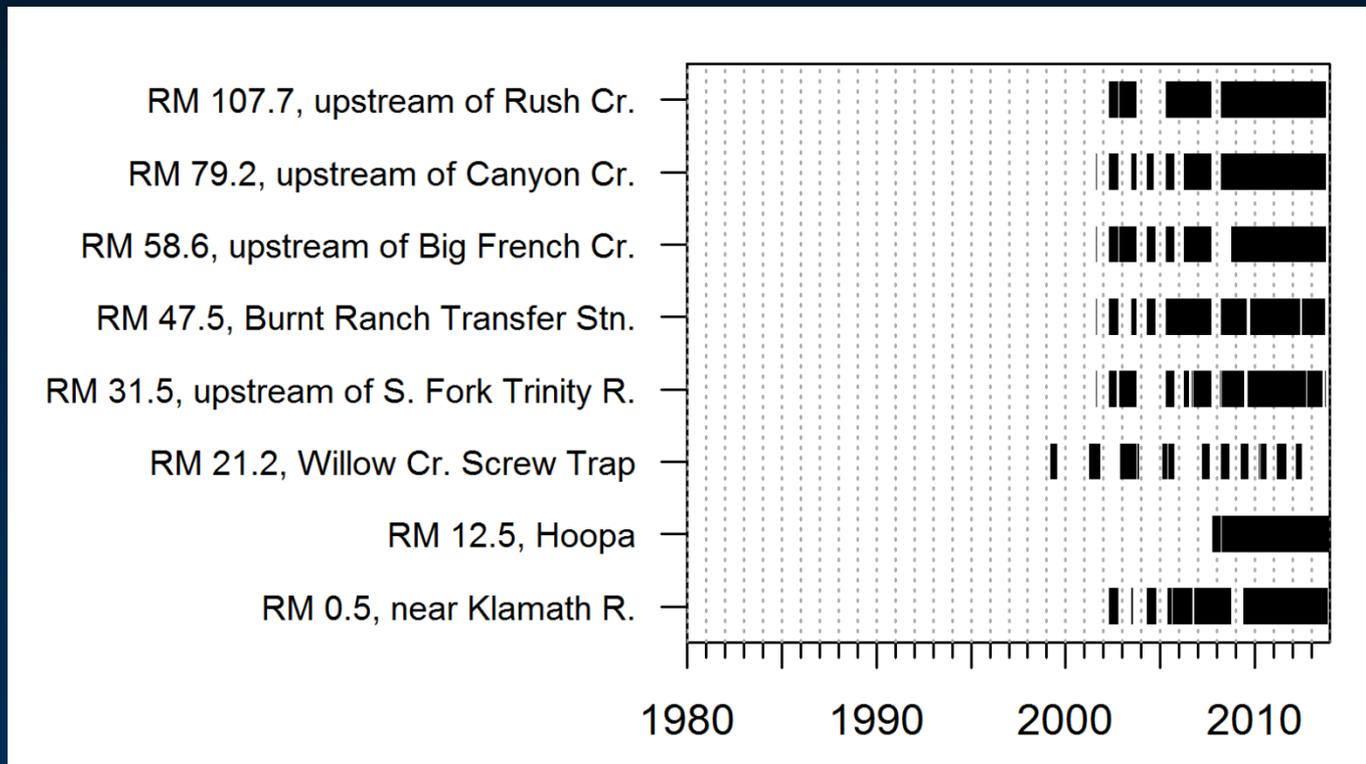
Data gaps filled by regression with weekly air temperature

# Calibration Parameters

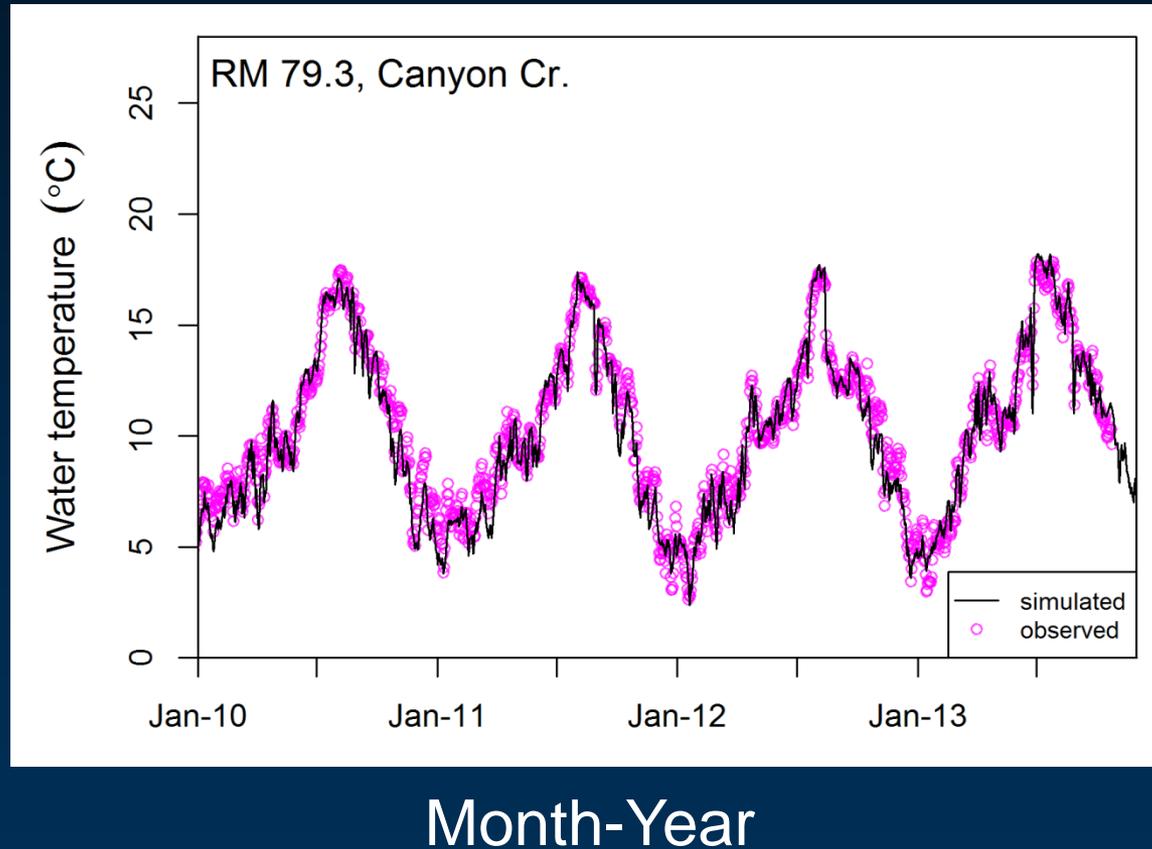
- Two types:
  - evaporation coefficients
  - rate of heat flux at water surface.
- Estimate parameters  
    minimize sum of squares
- Reach-by-reach, upstream to downstream

# Calibration Water Temperatures

## Extent of measured data



# Goodness of Fit



Mean absolute error, range: 0.18-0.89°C

# Conclusions

- Accurate and precise
- Useful for effects of management actions
- Now linked with Klamath R. model
- Report completed
- GUI in development



# Hydraulic Properties of Model

Continuity equations:

$$W_x = a_W Q^{b_W} \quad \text{and} \quad A_x = a_A Q^{b_A}$$

where  $W$  is wetted channel top-width,  
 $A$  is cross-sectional area,  
 $x$  is the river mile,  
 $Q$  is the volume of discharge,  
 $a$  and  $b$  are parameters to be estimated.

# *k*-fold Cross Validation

- Mean absolute error, range: 0.18-0.89°C
- No change in GOF
- Good out of sample predictions