Longitudinal Water Quality Characteristics of the Klamath River From Iron Gate Dam to the Trinity River

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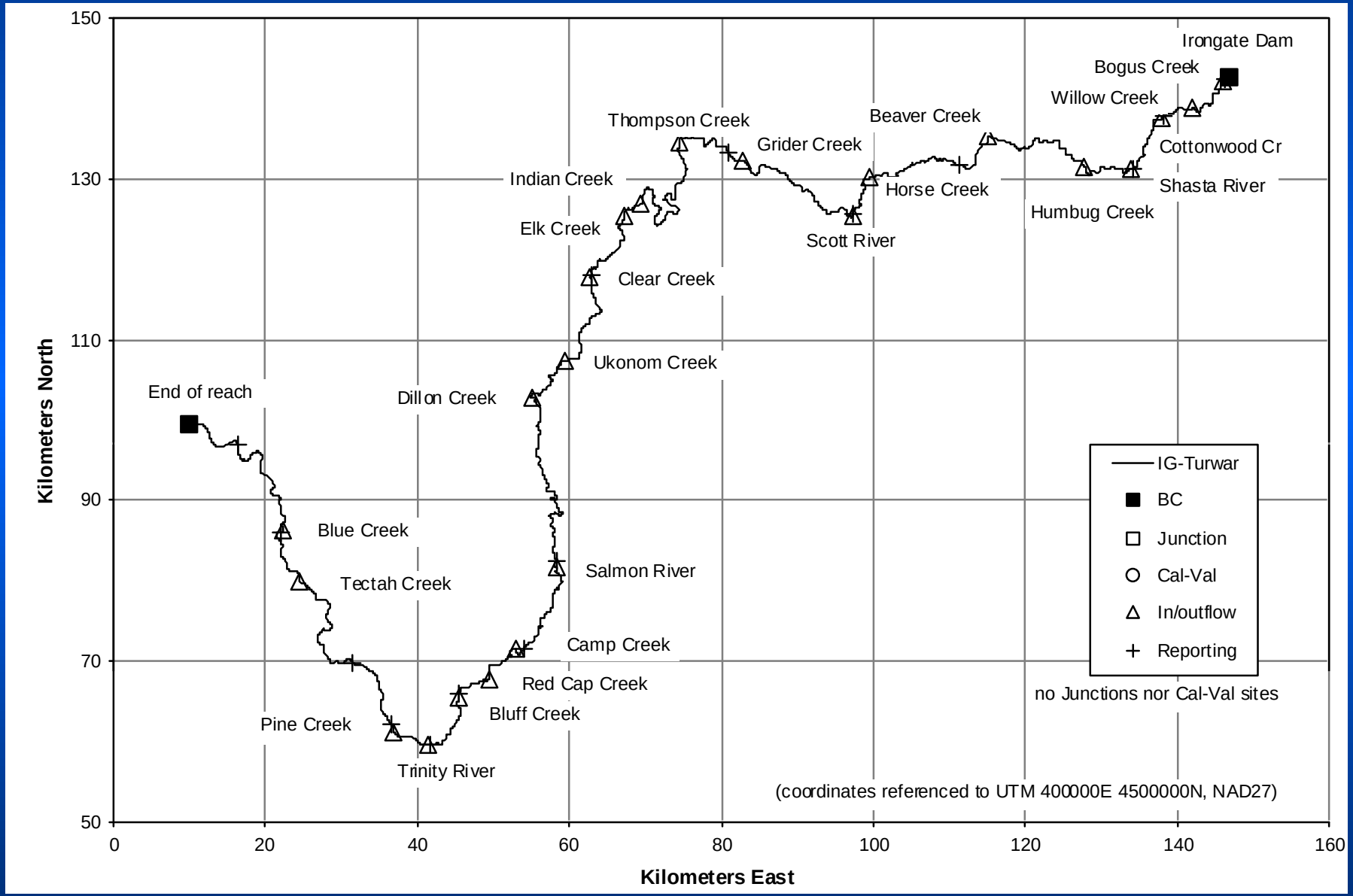
Acknowledgements

- Pat Higgins and AFS
- Federal and State Agencies
- Yurok and Karuk Tribes
- PacifiCorp
- Stakeholders
- Others

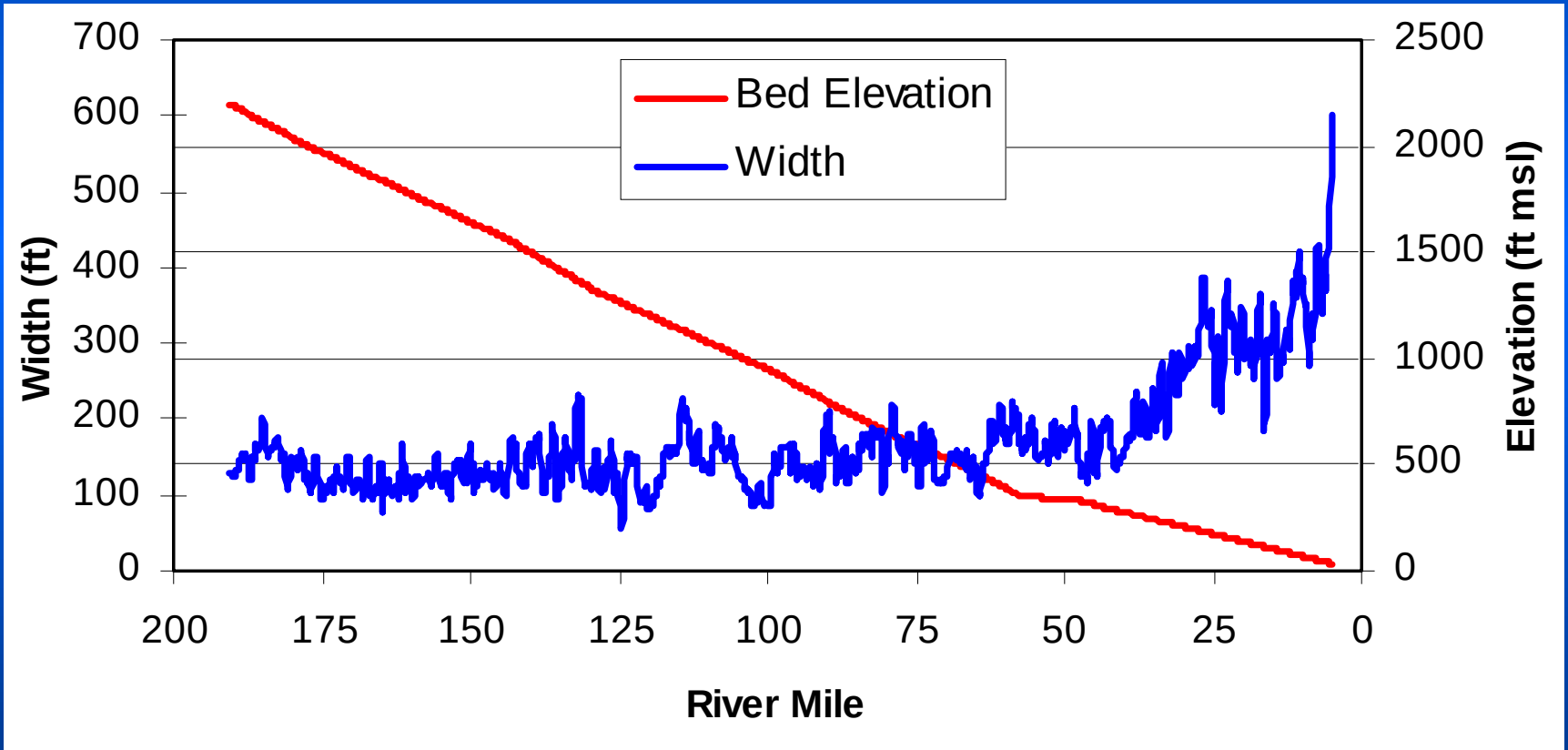
Outline

- Gradient and Channel Width
- Flow
- Water Quality
  - Temperature
  - Dissolved Oxygen
  - Nutrients
  - pH
- Benthic Algae

IGD to Turwar



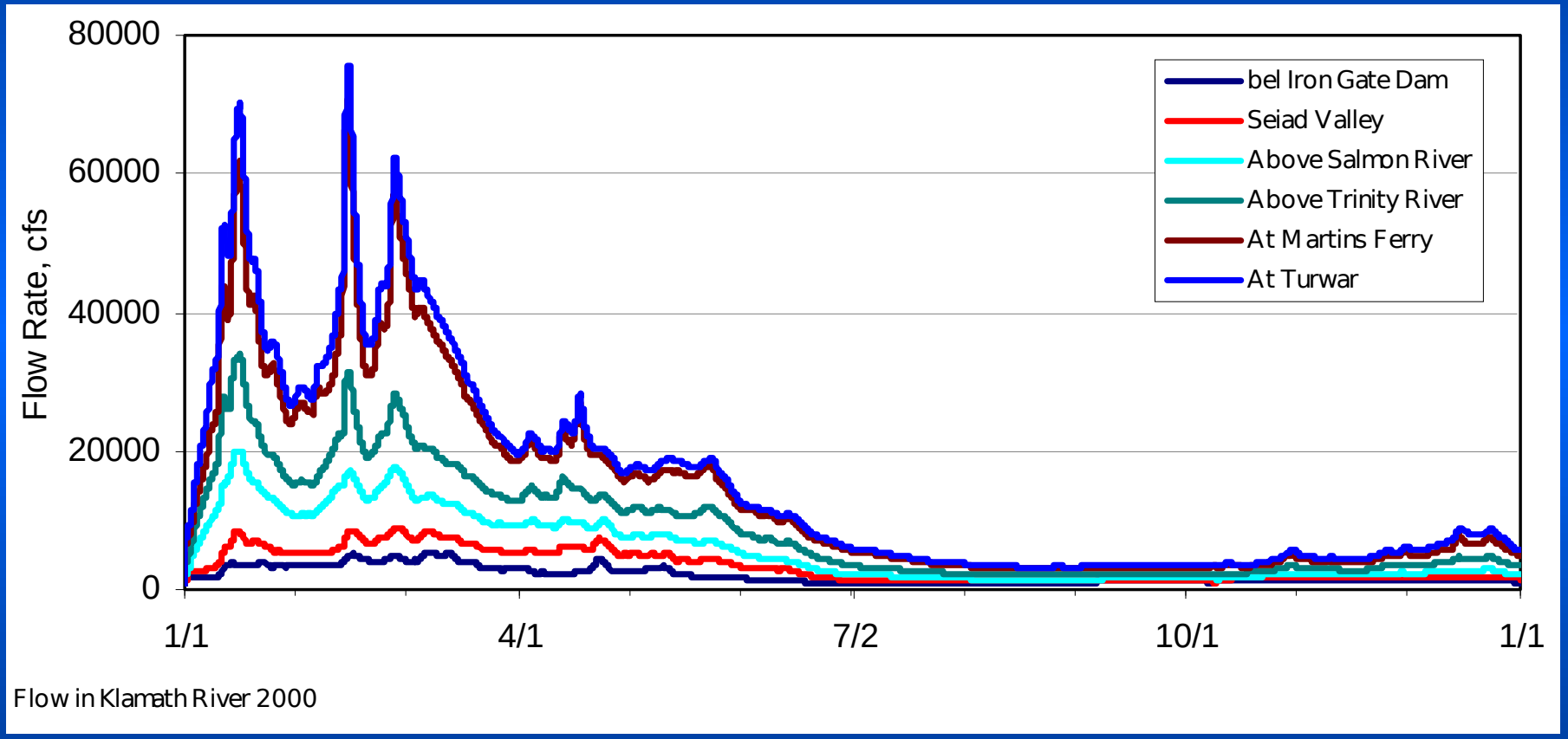
Gradient and River Width



Flow

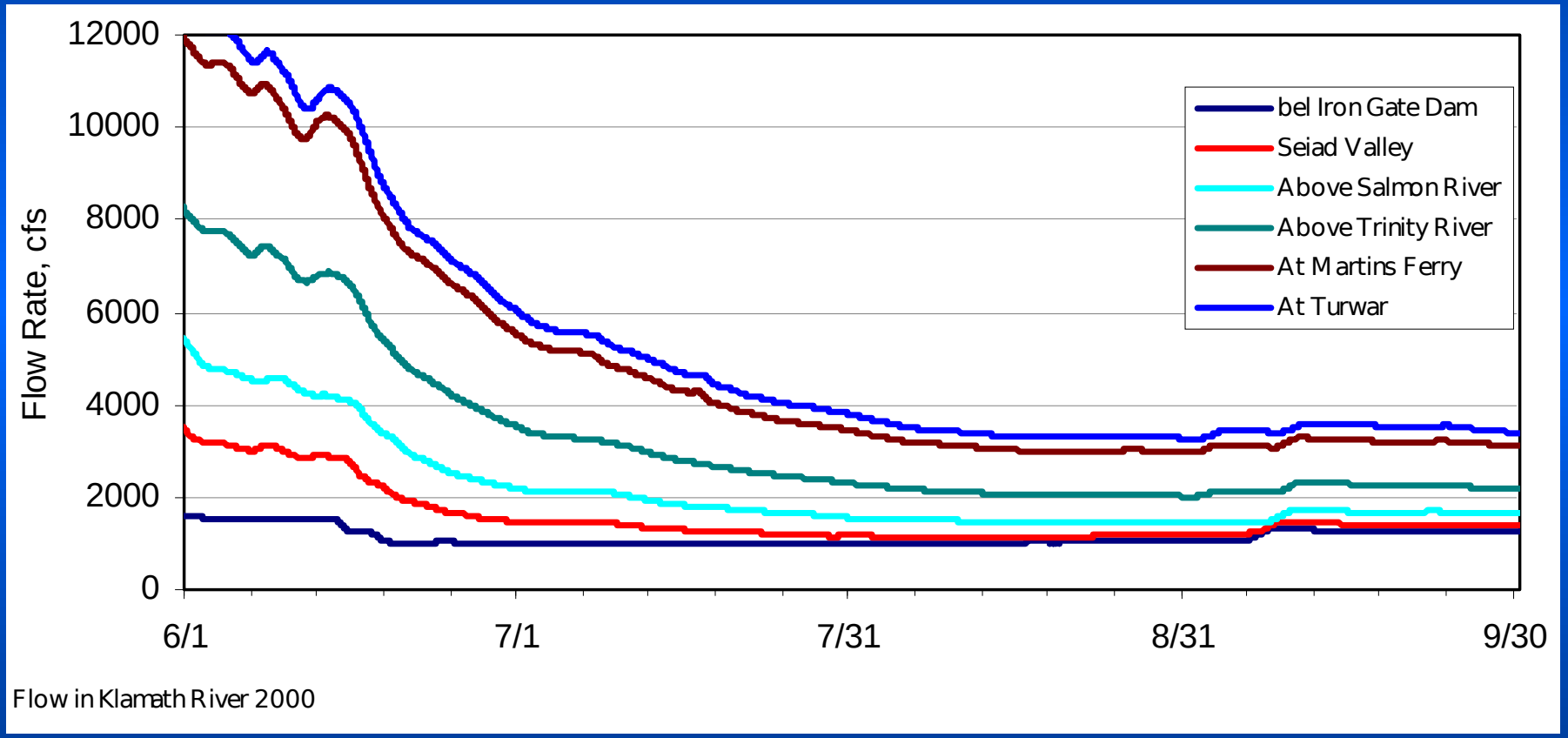
- Mean Annual Flow
  - Iron Gate Dam: 1.5 Million Acre-feet (MAF)
  - Seiad Valley: 3 MAF
  - Orleans: 6 MAF
  - Turwar: > 12 MAF
- Seasonal Flow Conditions

Annual Flow



Flow in Klamath River 2000

Seasonal Flow



Flow in Klamath River 2000

Water Quality

- Temperature
  - Winter – similar water temperature
  - Summer – warmest between Seiad and Happy Camp
- **Dissolved Oxygen**
  - Winter – no issues
  - Summer – response to algal P and R (ab Happy Camp)
  - Fall – impacts from IGD (mechanical reaeration)
- **Nutrients**
  - Summer – diminishing downstream (uptake and dilution)
- **pH**
  - Spring/summer – weakly buffered system and algae combine to elevate pH on a sub-daily basis

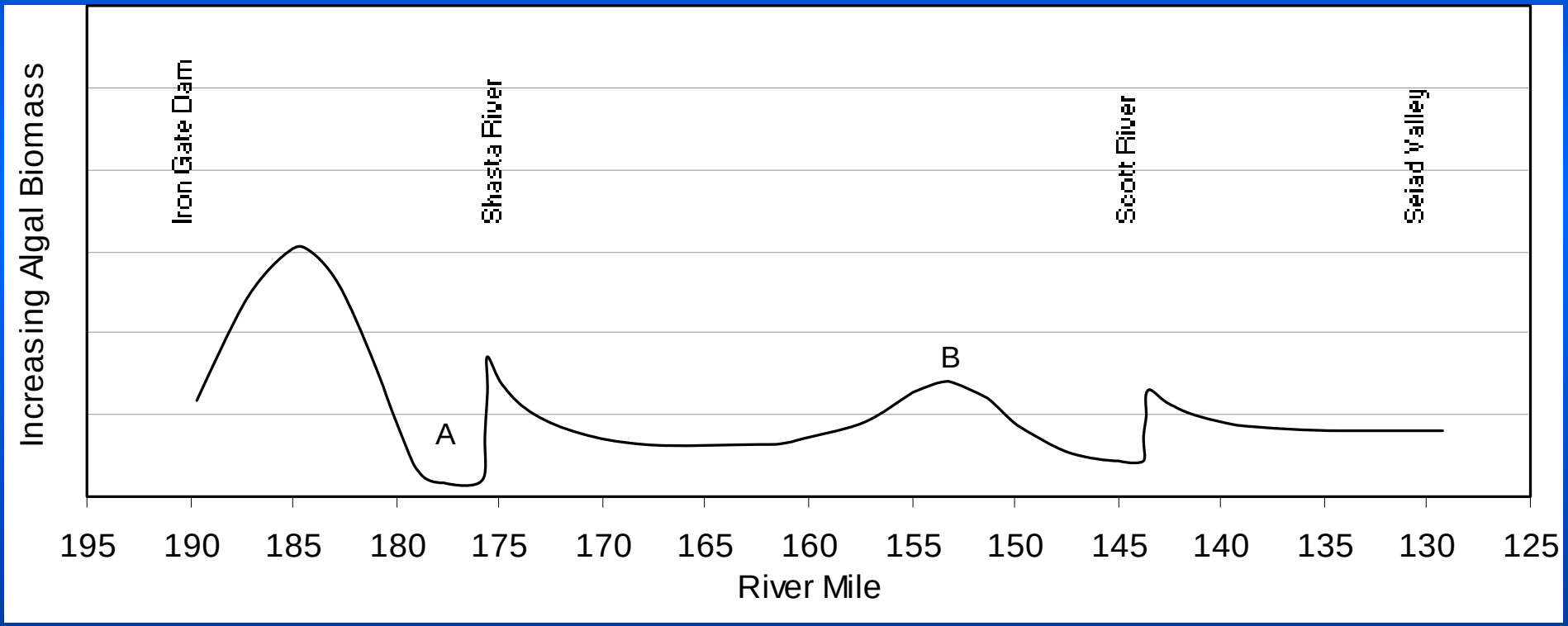
Benthic Algae Studies

- 1998-99: Model Simulations
- 2000: Field Data: June 6-30 and August 8-28
- 2001-03: Model Simulations
- 2003: Field Data: June and August
- 2003: P and R analysis
- 2004: Additional sampling

- Dynamics

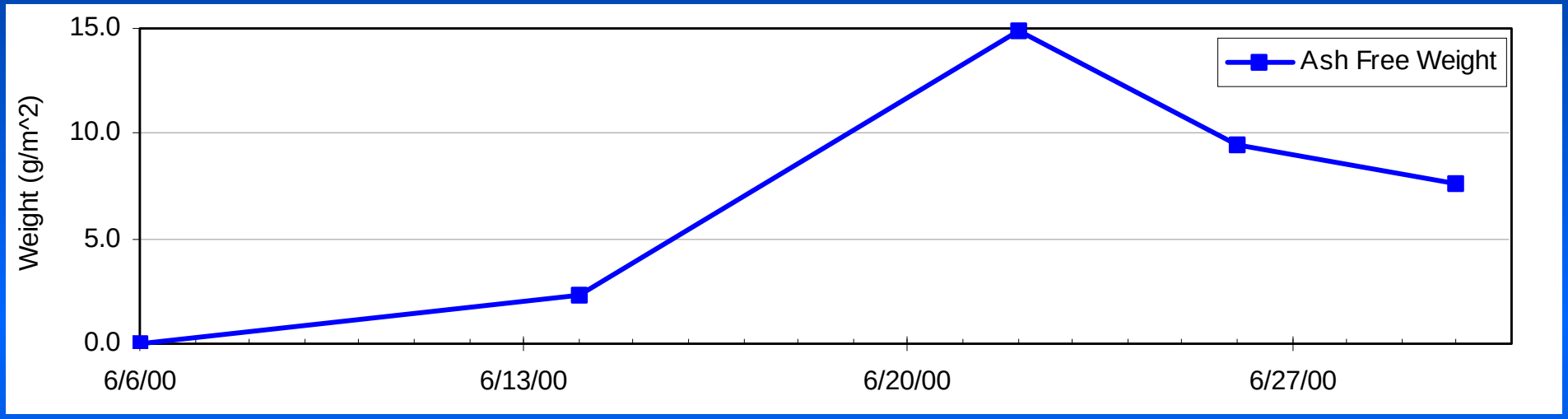
Benthic Algae – Chapter 1: The Intriguing Result

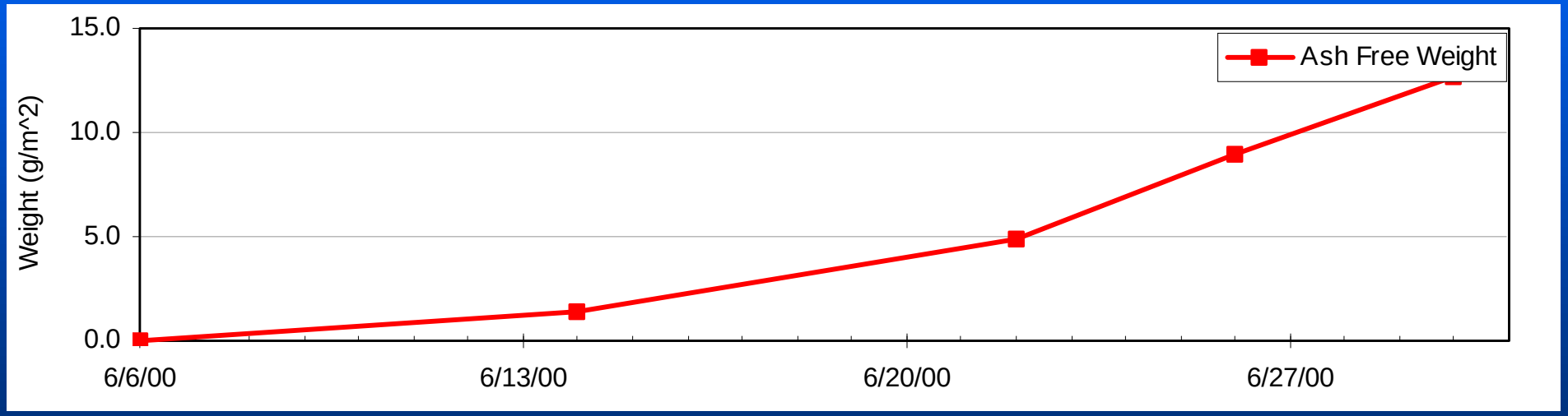
(Simulated Distribution (no field data))



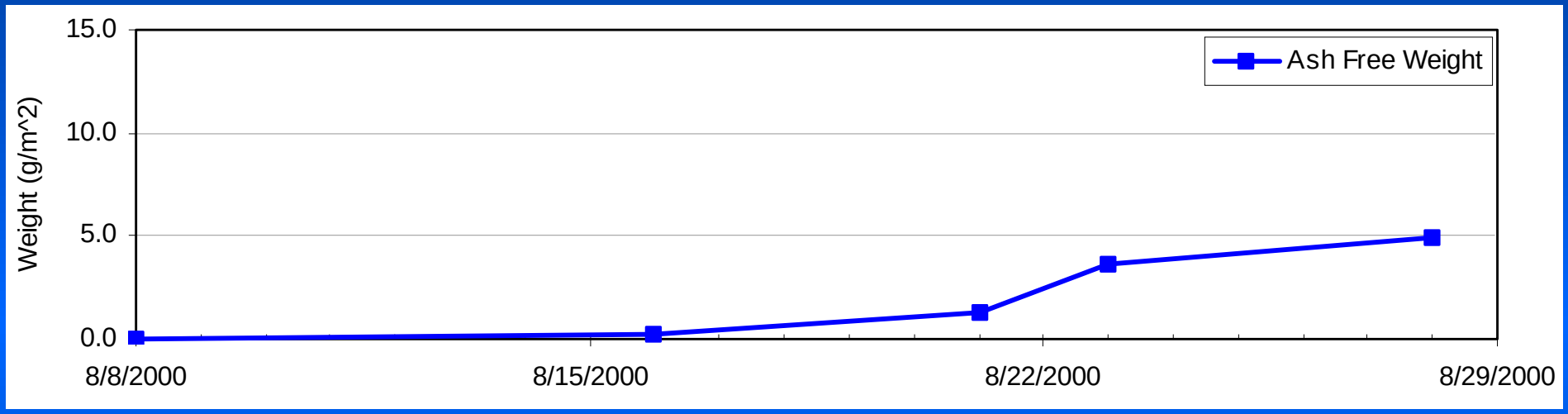
July 1

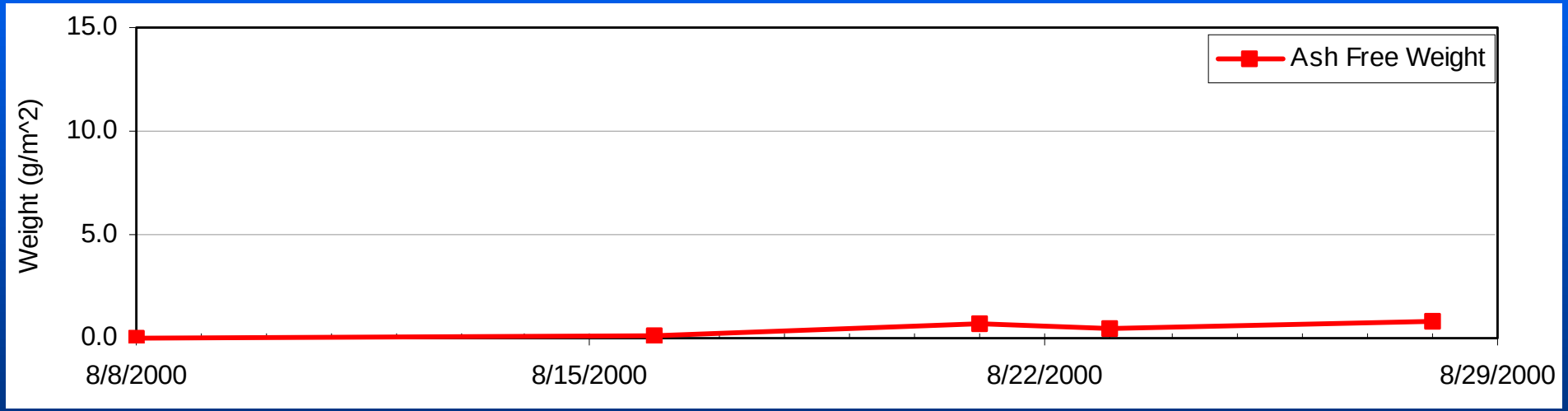
Benthic Algae – Chapter 2: First Field Data



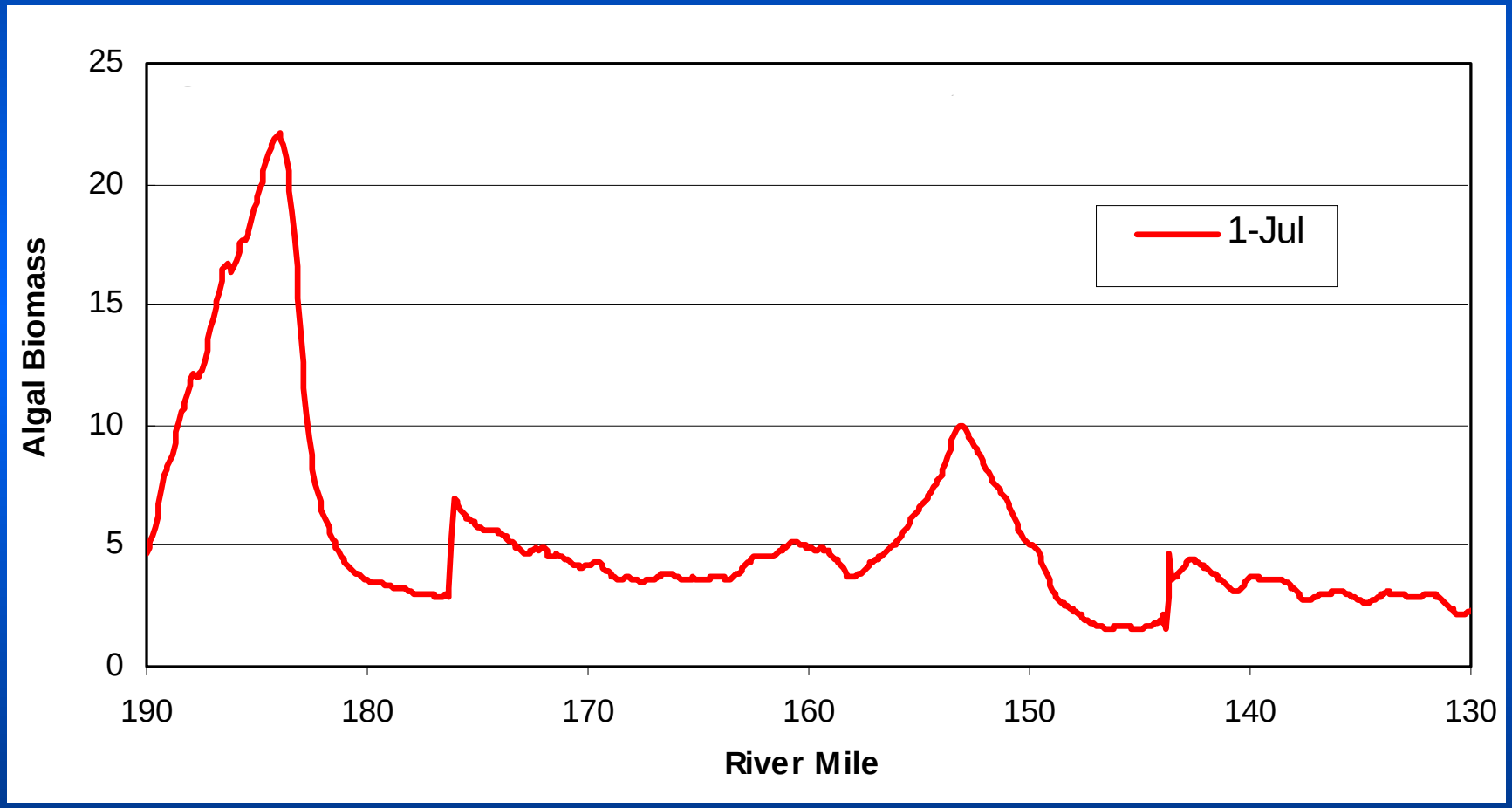


August – Algal Growth as AFDW



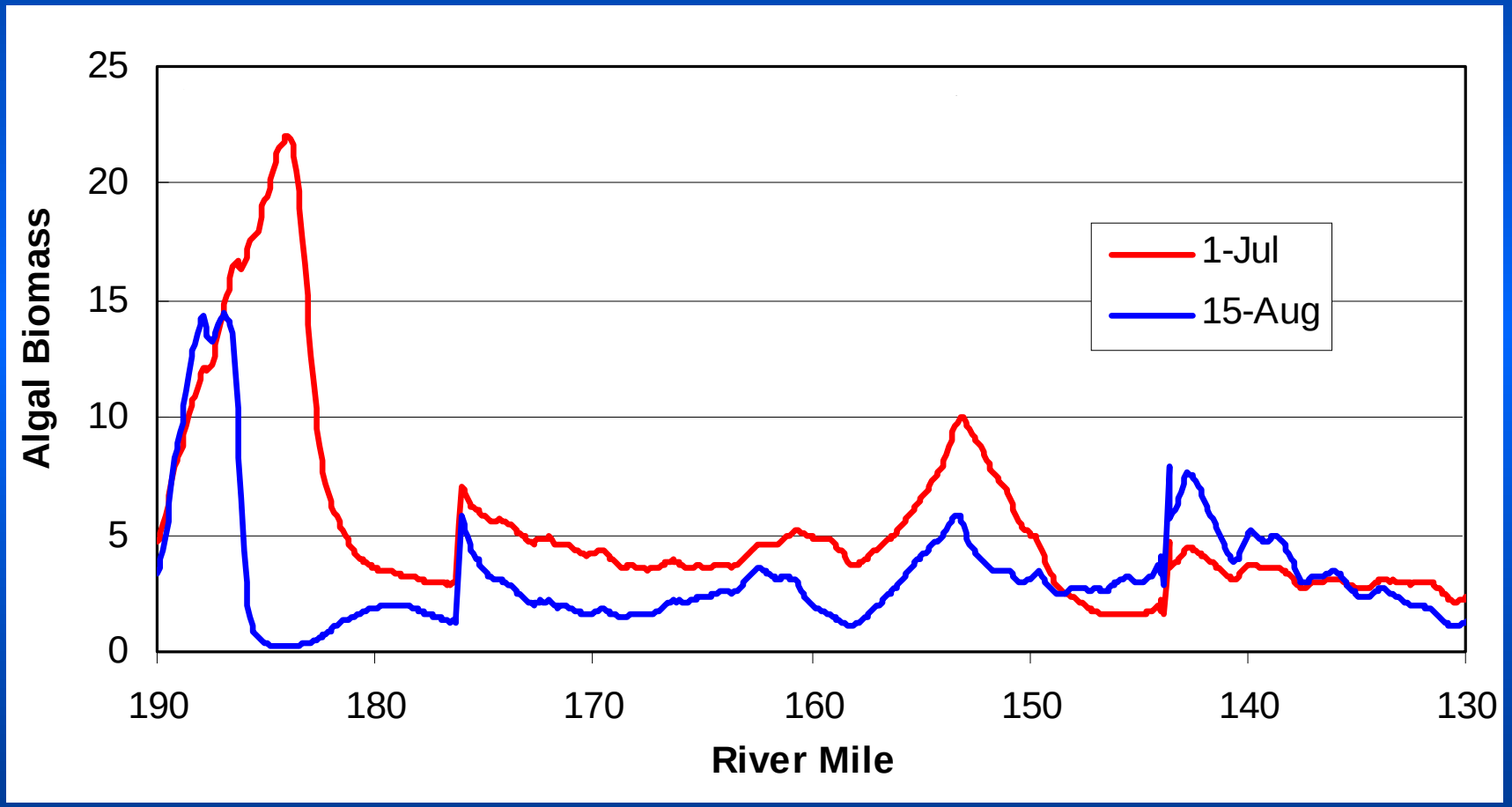


Benthic Algae – Chapter 3: Revisiting Simulated Algal Biomass



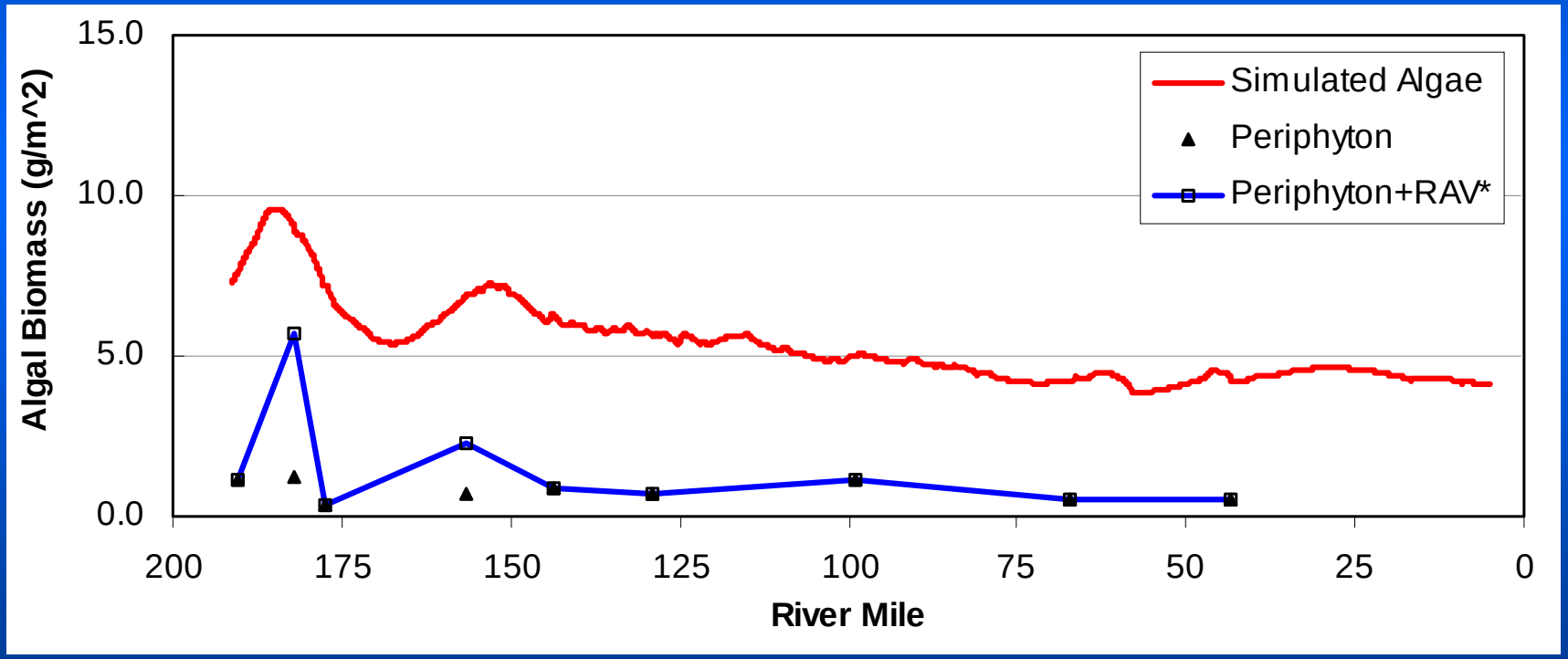
July 1

Benthic Algae – Chapter 3: (cont)



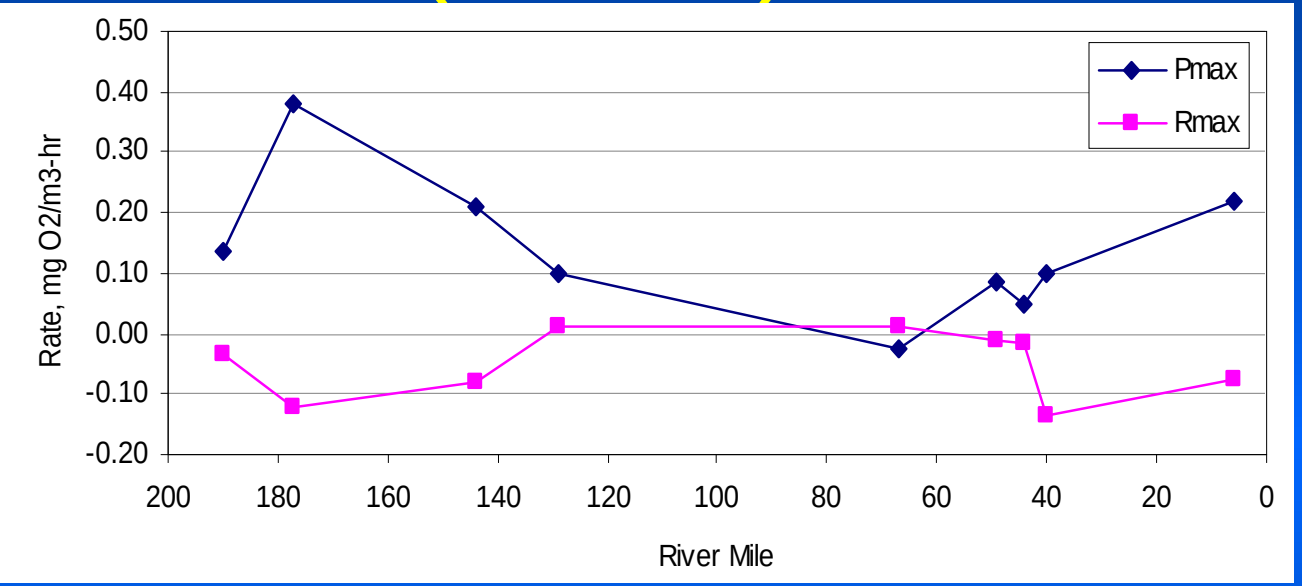
Benthic Algae - Chapter 4: Extended Data Set and Simulations – More Clues

August

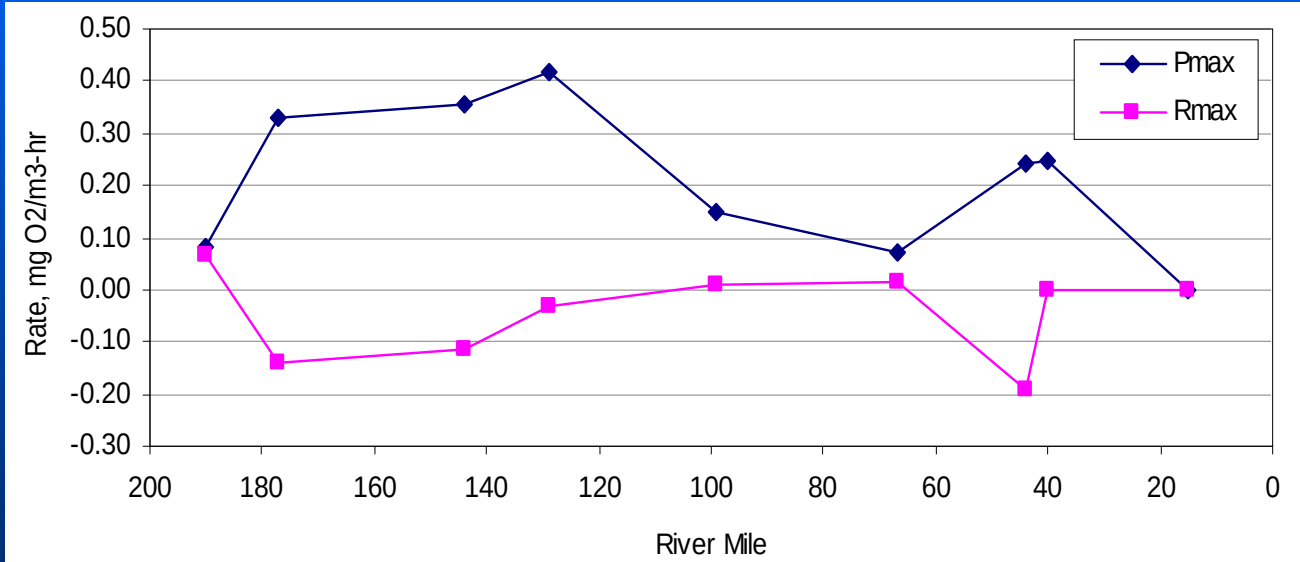


Benthic Algae – Chapter 5: P and R Studies (USGS) Add Info

June, 2003



August, 2003



Benthic Studies - Chapter 6: General Algal Species Distribution

- Species reflect water quality conditions
  - Macrophytes: *Potamogeton* sp., *Elodea*
  - Periphyton: Diatoms
- Mainstem:
  - Above Scott River – periphyton and rooted aquatic vegetation (macrophytes)
  - Below Scott River – periphyton dominates
- Basin Reaches
  - “Upper” (≈ above Happy Camp)
  - “Lower” (≈ below Happy Camp)
  - “Tributaries” (Shasta, Scott, Salmon Rivers)

Macrophytes (nr Cottonwood Ck)



Periphyton (Seiad Valley)



Watercourse

Periphyton
(Klamath River ab Trinity River)



Major Species Attributes

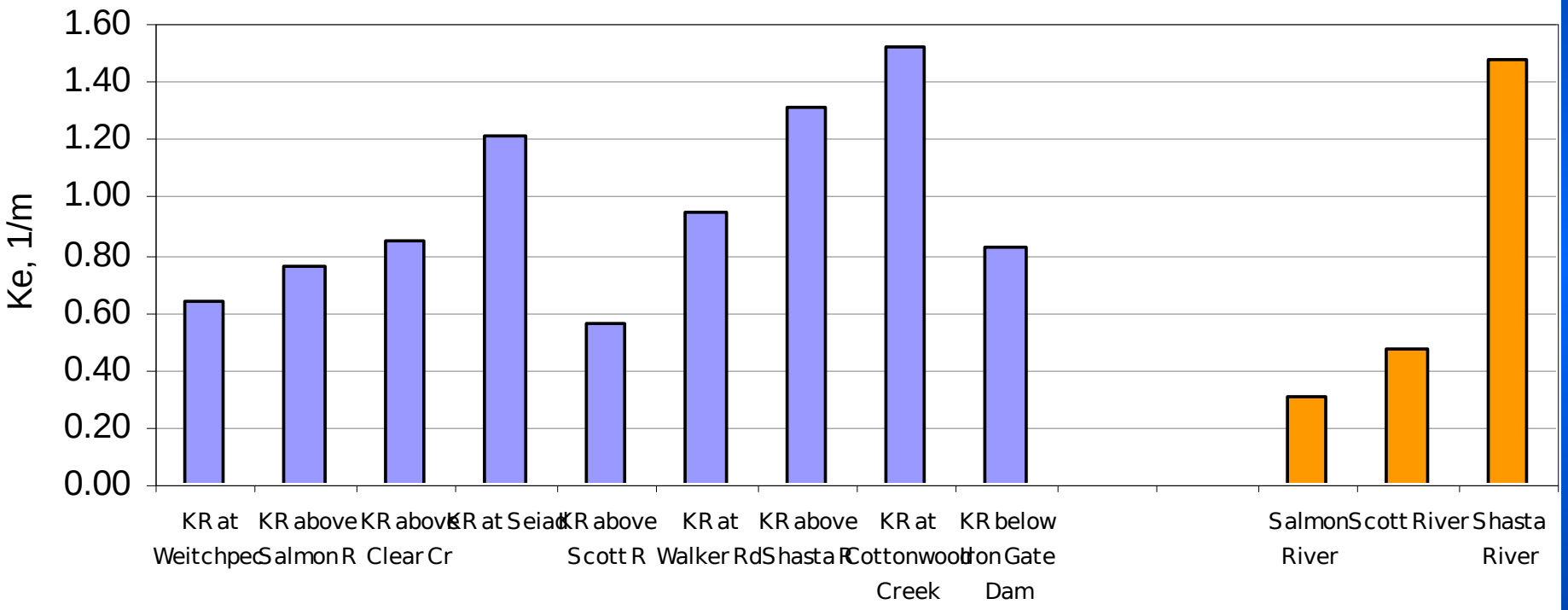
Epithemia sorex	**Favors nitrogen limited waters**
Nitzschia frustulum	**Common. Most often in higher nutrient, higher conductivity flowing waters. Rarely occurs in "cleaner" headwaters**
Cymbella affinis	**Most common in headwaters: cleaner, lower nutrient, lower conductivity**
Diatoma vulgare	**Attached and planktonic diatom)**
Navicula cryptocephala veneta	**Very common. Occurs under a wide range of ecological conditions. More common in "mid-range" stretches of rivers... not cleaner headwaters, and not sluggish nutrient-richer lower sections.**
Cocconeis placentula	**Very common (often attached to vegetation, but also to rocks). Found under a very wide range of ecological conditions, but tending more towards the higher nutrient waters**
Achnanthes minutissima	**Found commonly in both flowing (attached) and lake (plankton) habitats. More frequent (distinctly so) in clean headwaters than in lower, slower, nutrient-rich river sections.**

Species Distribution

Diatom	Upper River	Lower River	Shasta R	Scott R	Salmon R
Epithemia sorex	O	X	O	O	O
Nitzschia frustulum	X	X	X	O	O
Cymbella affinis	O	X	O	X	X
Diatoma vulgare	X	O	O	O	O
Navicula cryptocephala veneta	X	O	O	O	O
Cocconeis placentula	X	O	X	O	O
Achnanthes minutissima	O	O	O	X	X

Watercourse

Benthic Algae - Chapter 7: Light Extinction



Light Extinction Coefficients for locations in the Klamath River

Benthic Algae - Chapter 8: Conclusions to Date

- Dissolved Oxygen, Nutrients, pH and algae are all inter-related
- Field Studies…
  - Growth (floating periphyton samplers)
  - Sampling biomass and Species (from natural substrate)
  - Field observations (nutrient grab samples, as well as diurnal dissolved oxygen monitoring)
- And Analysis…
  - Model Simulations
  - P&R Analysis
- Suggests a common theme of complex and dynamic longitudinal distribution of benthic algae in the Klamath River below Iron Gate Dam

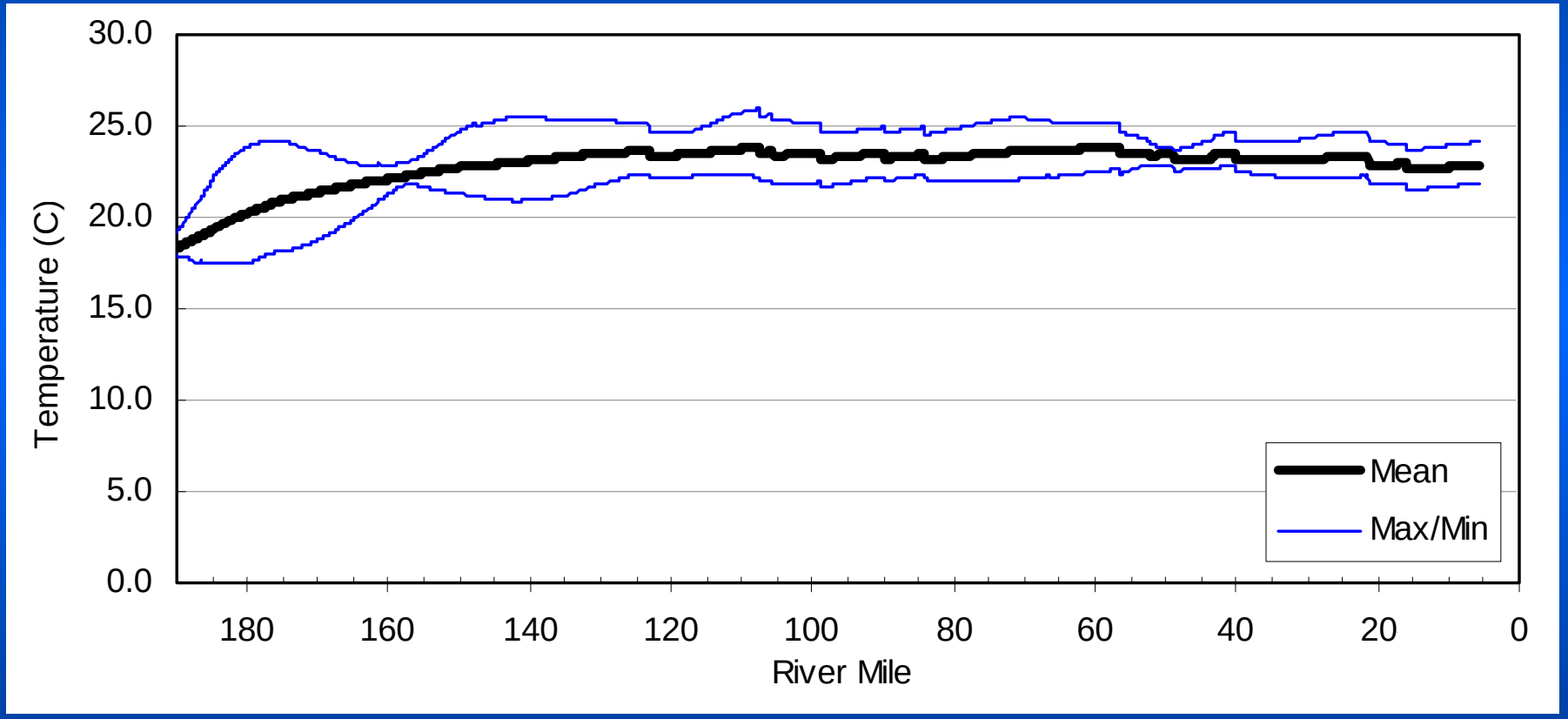
Benthic Algae - Chapter 8: (cont)

- Benthic algae distribution plays a potentially dominant role in the Klamath River, particularly above ≈ RM 100
  - DO deviations from saturation
  - pH
  - Nutrient dynamics
- Nutrients concentrations, through uptake and dilution by tributaries, generally decrease in the downstream direction and may play a direct role in benthic algae populations and species distribution

Benthic Algae - Epilogue

- Future research
  - Additional field data
  - Additional model simulations
  - Identification of resources management through water quality monitoring where benthic algae are a key component
  - What role does the
    - benthic community play (grazing)
    - flow regime play (scour)
    - upstream water quality play (light extinction)
    - Other?

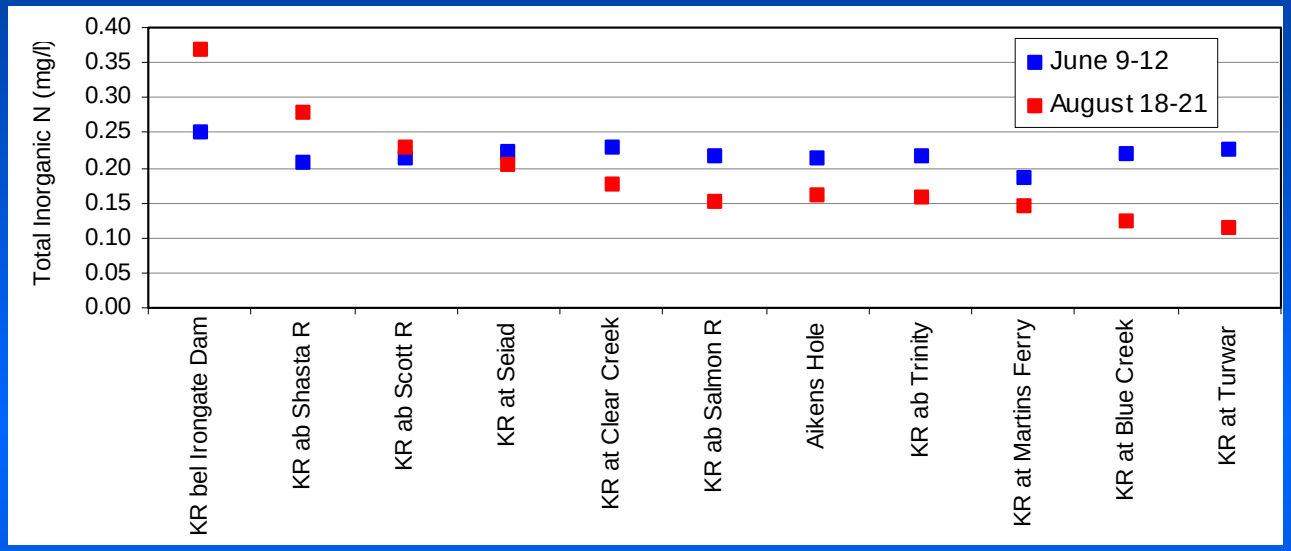
Water Quality: Temperature



Simulated 8/1/00

Water Quality: Nutrients

Inorganic N



Inorganic P

