Lower Yakima River Eutrophication Study: Year Two Update

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Outline

- Study partners, objectives
- 2004 recap
- 2005 highlights
  - Biomass
  - Light
  - Turbidity
  - Water chemistry
  - Productivity
- 2006 questions

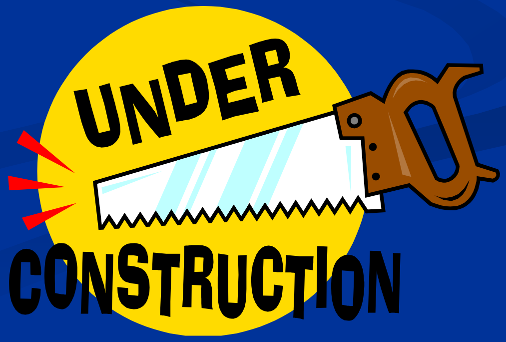
Study Partners, Objectives

- 3-way partnership: U.S. Geological Survey, South Yakima Conservation District, and Benton Conservation District.
- Multi-agency support
  - U.S. Bureau of Reclamation, EPA, USDA Agricultural Research Service, Yakama Nation, Dept. of Ecology, Washington State University, Yakima Joint Board, Roza Irrigation District, Sunnyside Valley Irrigation District, etc.
- 5-year study, objectives include:
  - Characterize pH and dissolved oxygen (DO) conditions, nutrient concentrations, type of substrate, and aquatic plant and algal communities.
  - Assess relationships between nutrient concentrations, plant growth, substrate, stream flow, pH, and DO for the conditions observed.

Work in Progress

Caveat:

My understanding of nutrient-related processes occurring in the Yakima River has completely changed after each year of this study. I fully expect it to change again after this year.



2004 Results from 10 Reaches: Three Very Different River Segments

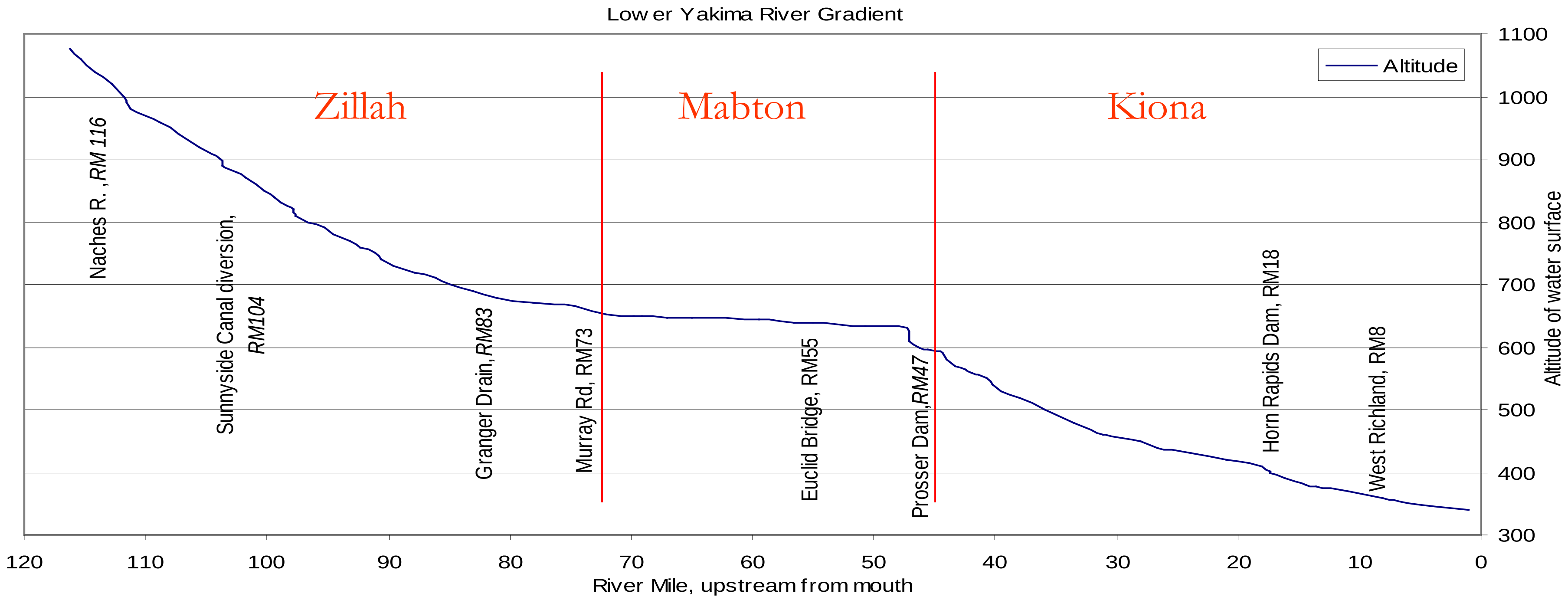
Segment	Zillah	Mabton	Kiona
Aquatic plants	Moderate (dense patches)	Sparse to moderate	High
Algae	Abundant	Phytoplankton?	Abundant
DO & pH	Moderate DO, severe pH	Moderate	Severe
Nutrient concentrations	Low	Highest	High
Substrate	Cobble	Mud	Cobble
Velocity	Fast	Slow	Moderate to fast

2005 Focused Studies

Focused on three reaches near Zillah, Mabton, and Kiona. Needed to begin to quantify relationships.

What did we learn? Highlights (next slide)

2005 Highlights



Reach	Zillah	Mabton	Kiona
Productivity	50-100x lower than Kiona reach	Not measured	50-100x higher than Zillah reach
Biomass (median)	0 gm/m2	0 gm/m2	1020 gm/m2
DO violations	31% of time	12% of time	34% of time + 1% less than 4 mg/L
pH violations	91% of days	78% of days	91% of days
Turbidity (median)	2 FNU	8 FNU	1 FNU


Water star grass downstream of
Benton City, July 2005

Biomass

Samples on deck from Kiona reach – each and every plant was water star grass.

Samples on table from Mabton reach.

30 quadrats sampled each reach.

With assistance from EPA's dive team and Jennifer Parsons, Ecology's aquatic plant specialist

Light

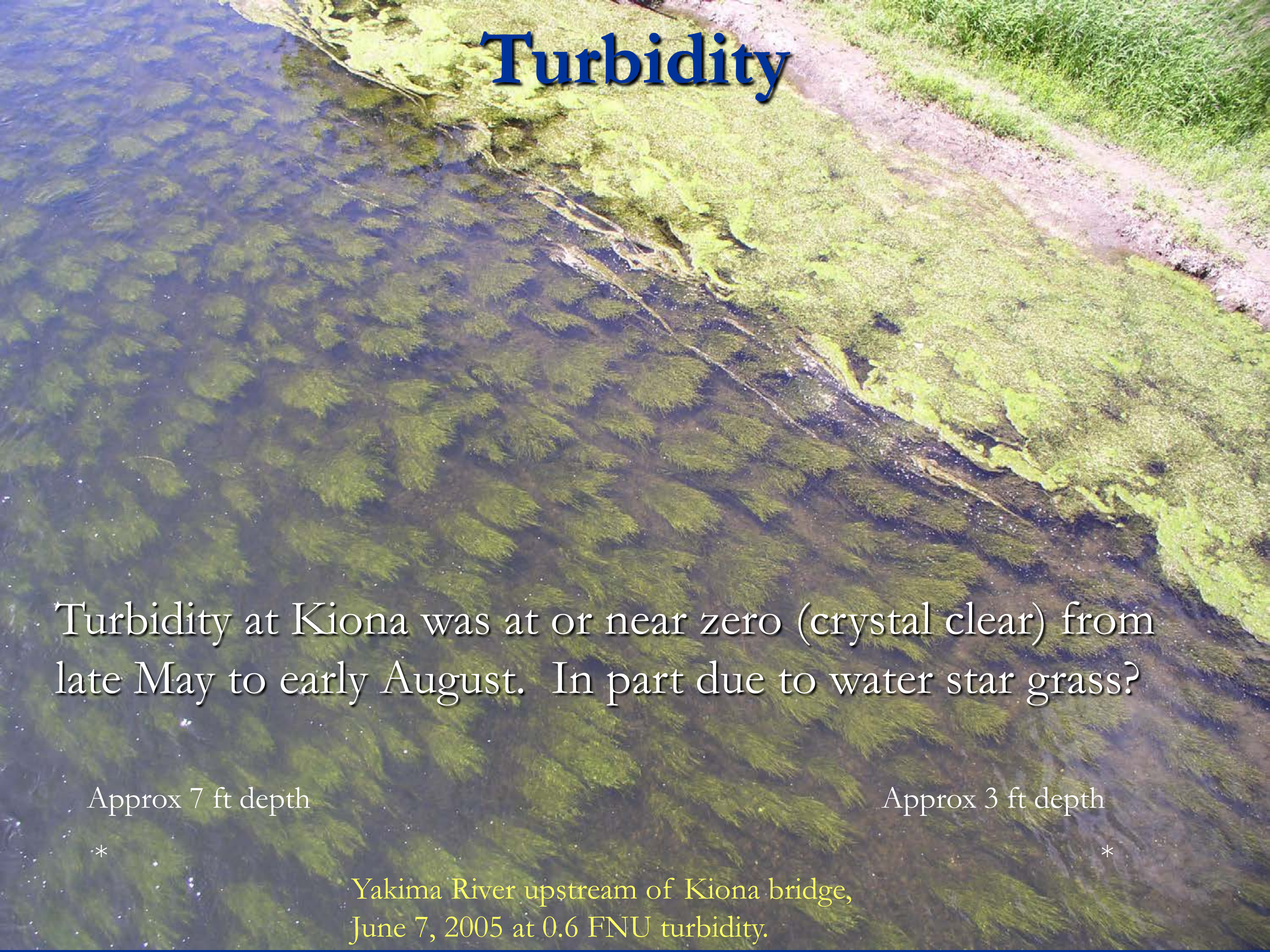
- Estimated maximum depth of plant colonization based on in-stream PAR (photosynthetically active radiation) measurements and using Vant's equation:
  - Zillah reach: 18 feet
  - Mabton reach: 9 feet
  - Kiona reach: 12 feet

- Most of the river is shallower than these depths, suggesting that light no longer limits plant growth, as it may have in past years when turbidity was higher. Caveats:
  - uncertainties in Vant's equation
  - leaves coated with algae not receiving as much light

Sept 2004 near mouth, water star grass

Turbidity

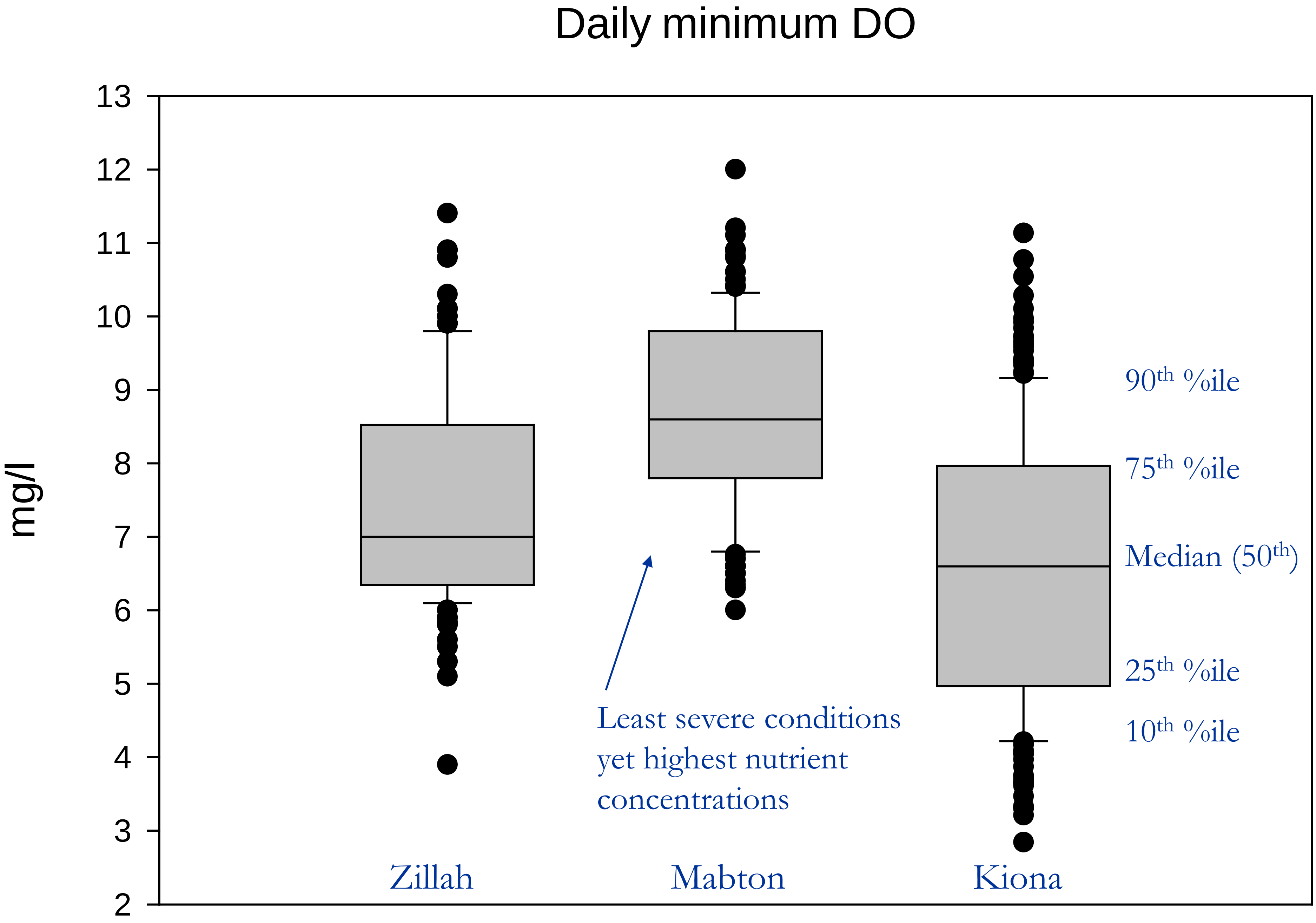
Turbidity at Kiona was at or near zero (crystal clear) from late May to early August. In part due to water star grass?

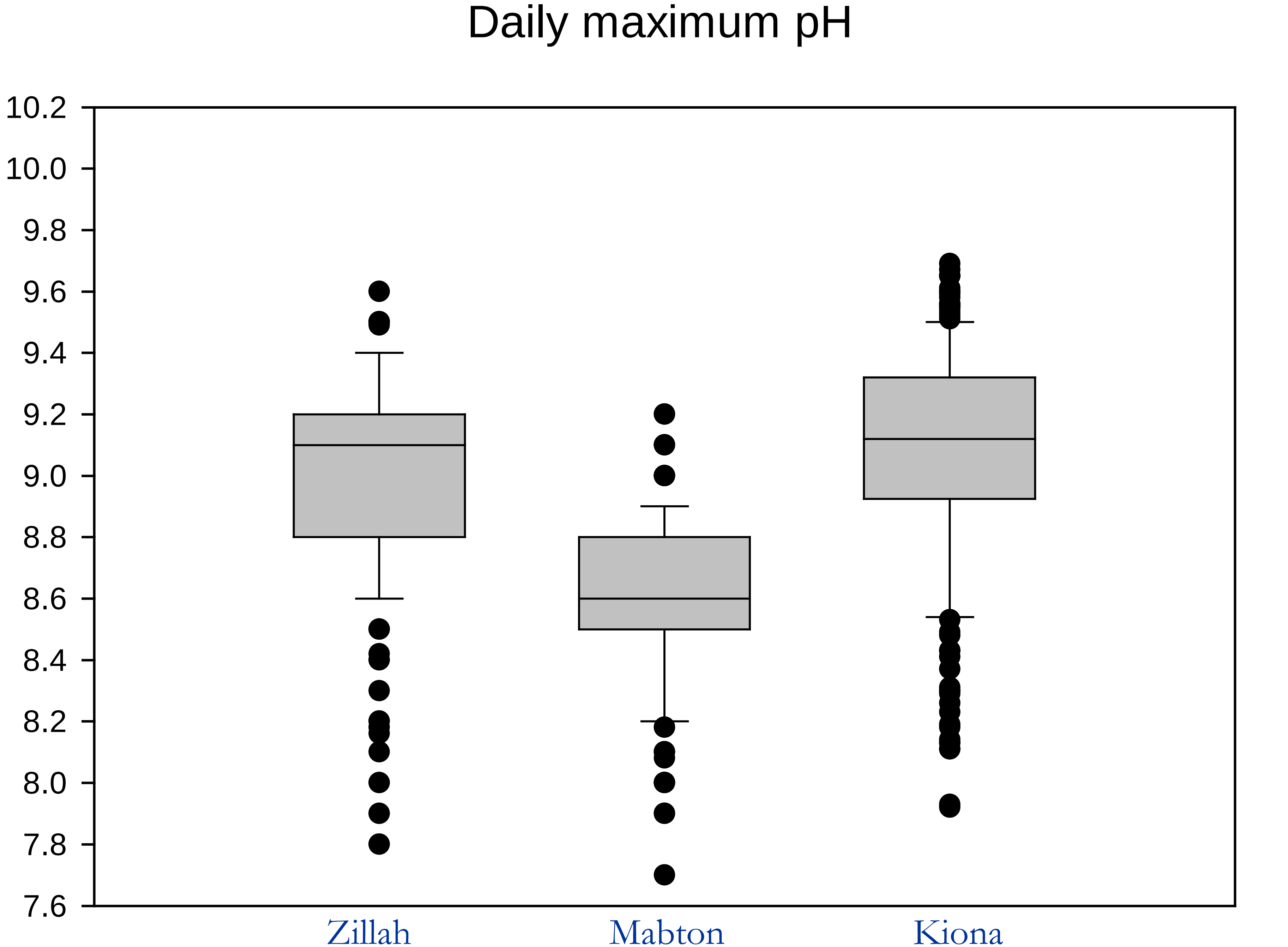


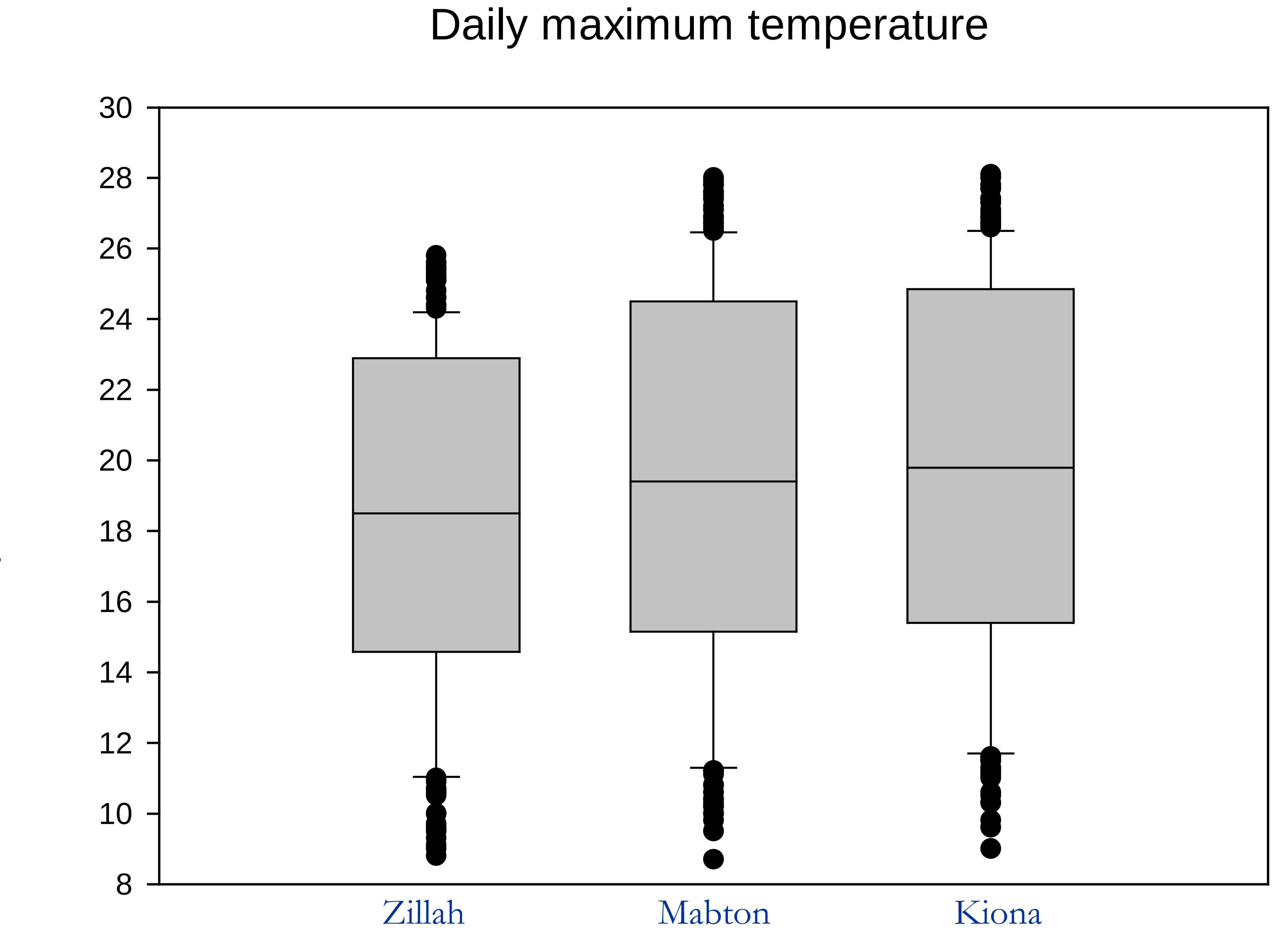
Yakima River upstream of Kiona bridge,
June 7, 2005 at 0.6 FNU turbidity.

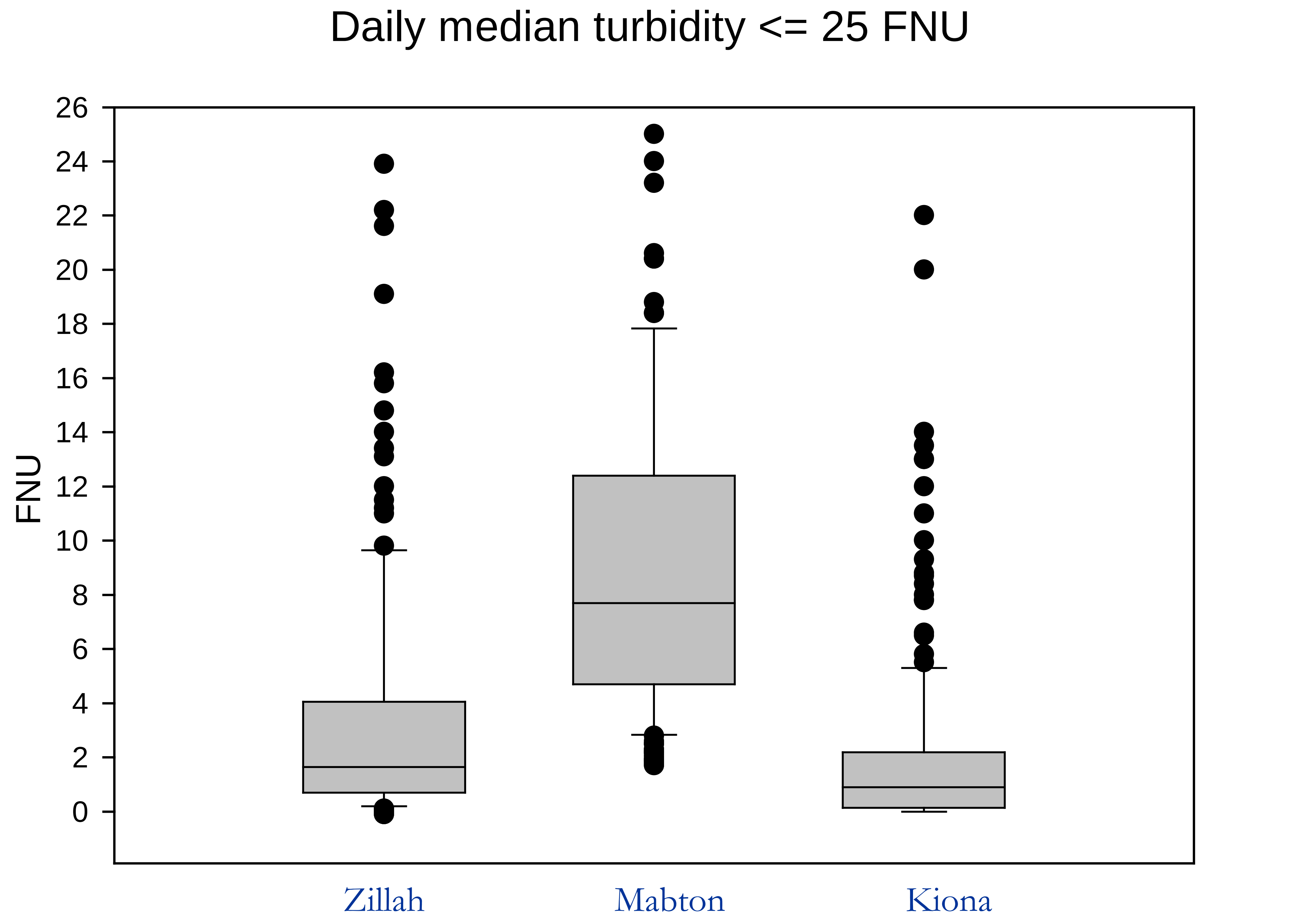
Water Chemistry

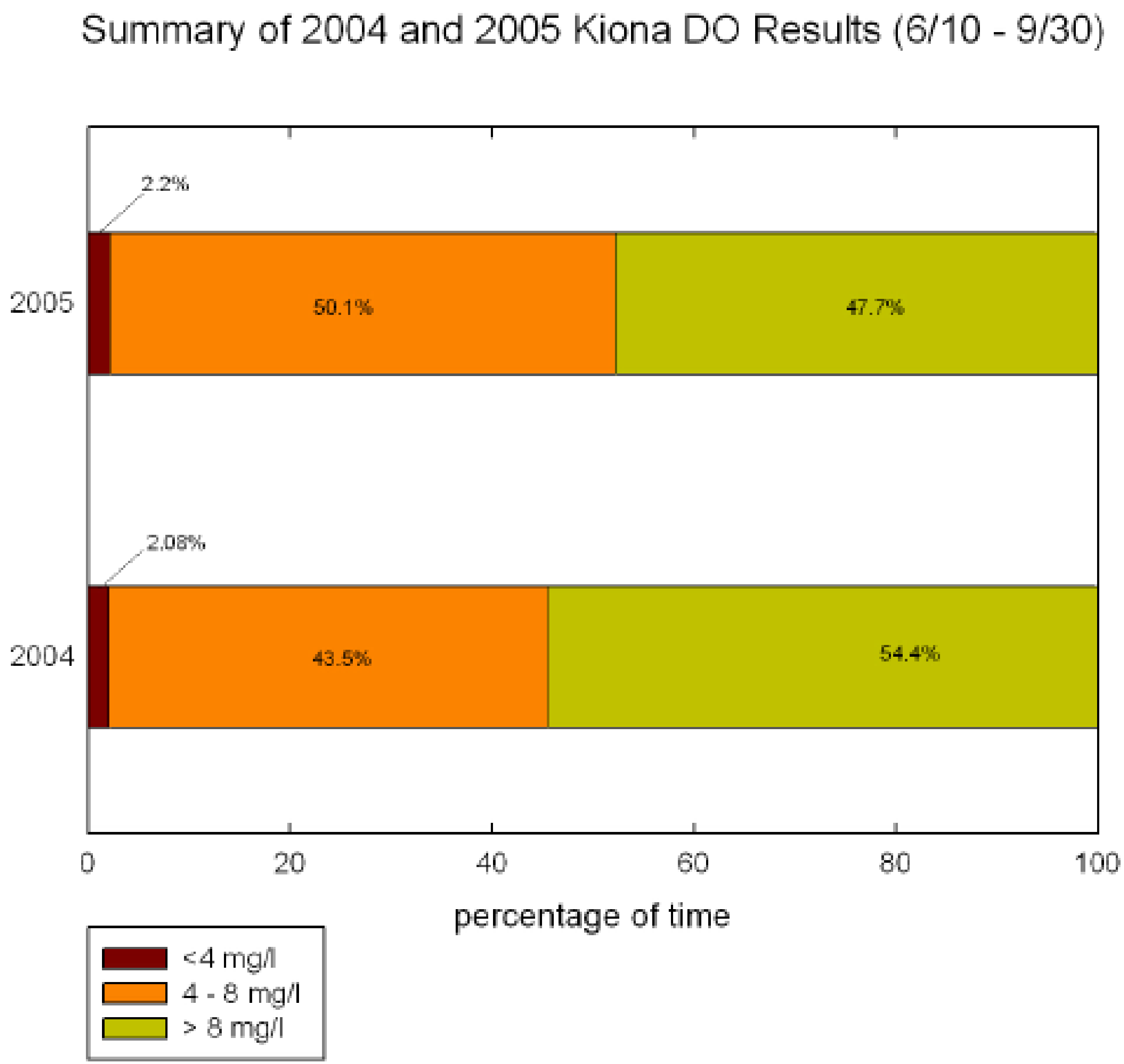
- Differences between 3 sites in 2005
  - Dissolved oxygen, pH, temperature, and turbidity
- Differences in dissolved oxygen between drought and non-drought year at Kiona


Daily minimum DO
mg/l
13
12
11
10
9
8
7
6
5
4
3
2
90th %ile
75th %ile
Median (50th)
25th %ile
10th %ile
Least severe conditions yet highest nutrient concentrations
Zillah
Mabton
Kiona


Daily maximum pH
10.2
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
Zillah
Mabton
Kiona


Daily maximum temperature
30
28
26
24
22
20
18
16
14
12
10
8
Zillah
Mabton
Kiona


Daily median turbidity <= 25 FNU
FNU
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Zillah
Mabton
Kiona



Drought (2005) vs. Non-drought (2004)

Productivity

- Productivity = metabolism
- Productivity (grams O_2 per m^2 per day) 50-100 times higher in Kiona reach than Zillah reach
    - In both reaches, the lowest DO concentrations were in part due to non-photosynthetic organisms (invertebrates, bacteria, etc.).

Conclusions

- Taken singly, none of the measured variables can explain the differences in dissolved oxygen and pH conditions. Examples:
  - Reach with highest nutrients has least severe dissolved oxygen and pH conditions.
  - Kiona and Zillah reaches similar pH conditions yet 1000x difference in plant biomass. Perhaps reflecting differences in algal biomass and buffering capacity?
- Light and nutrients are likely not limiting aquatic plant growth in most of the river.

2006 Study Questions Relating to Resource Management Considerations

1. Are nutrient concentrations low enough in Zillah reach such that small improvements could limit algal growth?
2. Is the algae in the Zillah and Kiona reaches limited by nitrogen, phosphorus, or neither?
   - Which would improve the river the most -- reducing N or P?
3. Is variability in distribution of the algae in the Zillah reach related to nutrient-rich porewater in the river bed?
   - Should nutrient-reduction strategies focus on surface water or groundwater?
4. What are the nutrient concentrations in the river bed?
   - Rooted aquatic plants get nutrients from wherever they are most abundant. If water star grass gets its nutrients from sediments, nutrient reduction strategies won't touch it. Alternatives?

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Questions?