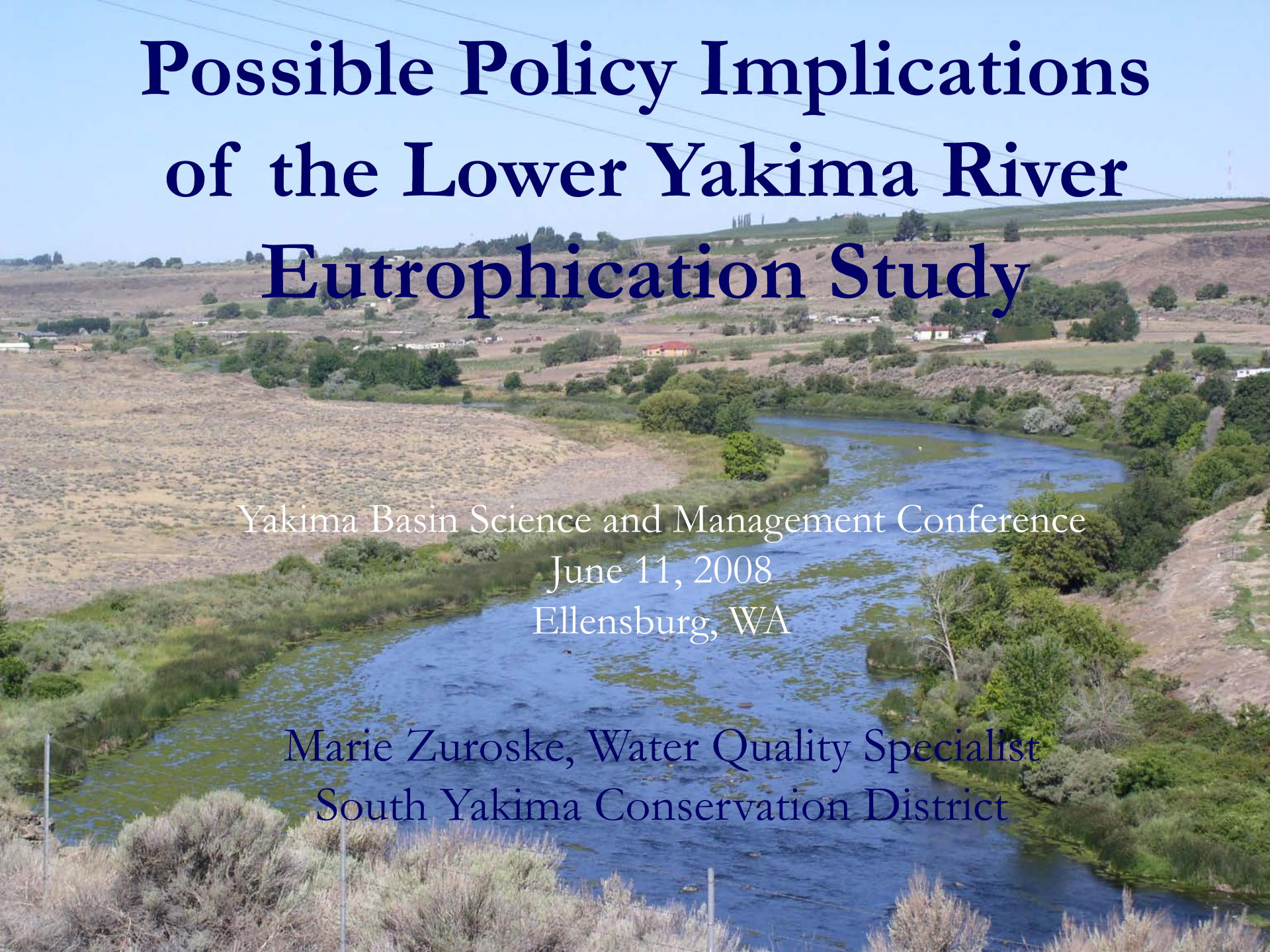
Possible Policy Implications of the Lower Yakima River Eutrophication Study



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Study Background

- USGS, SYCD, and BCD
- 2004-2008
- 116 miles of lower river
- Why were aquatic plants visibly more abundant? Were excess nutrients causing problems in the lower Yakima River?
- If better understand fundamental processes:
  - Help Ecology to develop a better dissolved oxygen and pH clean-up plan (TMDL).
  - Improve effectiveness of time, money, and effort spent in reducing nutrients.
- What do nutrients have to do with DO & pH?

Caveat:

Every single word in this presentation is my perspective, not the U.S. Geological Survey.

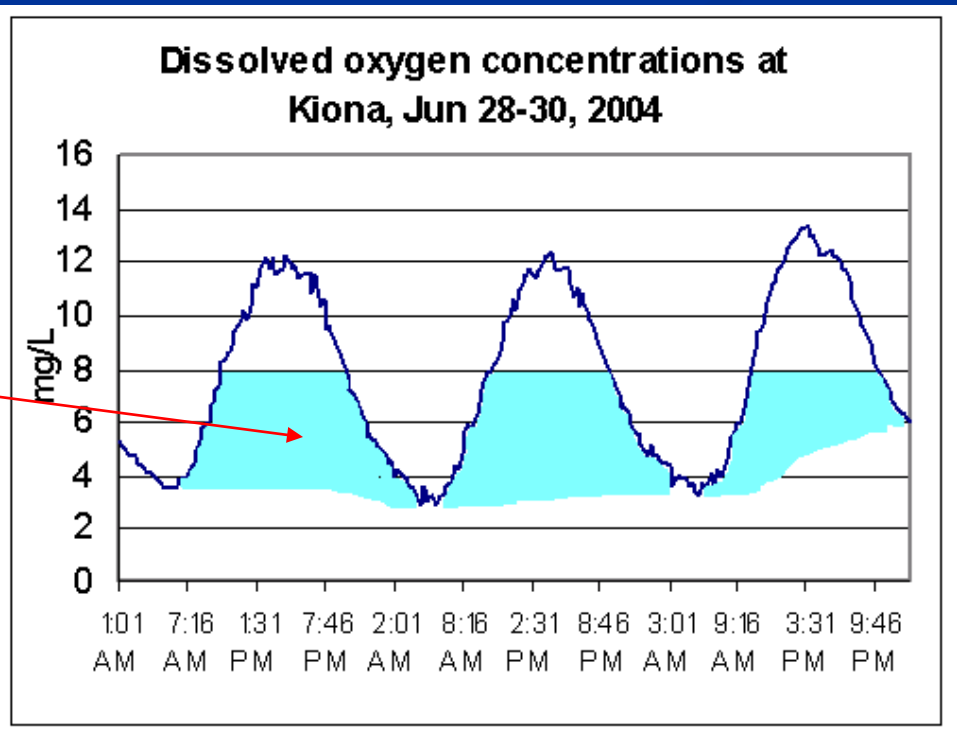
Excess nutrients encourage plant/algae growth, which affects dissolved oxygen and pH thru photosynthesis and respiration.

Fish, bacteria, insects, and plants consume O_2 all the time (respiration).

Plants produce O_2 during the day.

Violations.

State standard: always have at least 8 mg/L oxygen in the water.

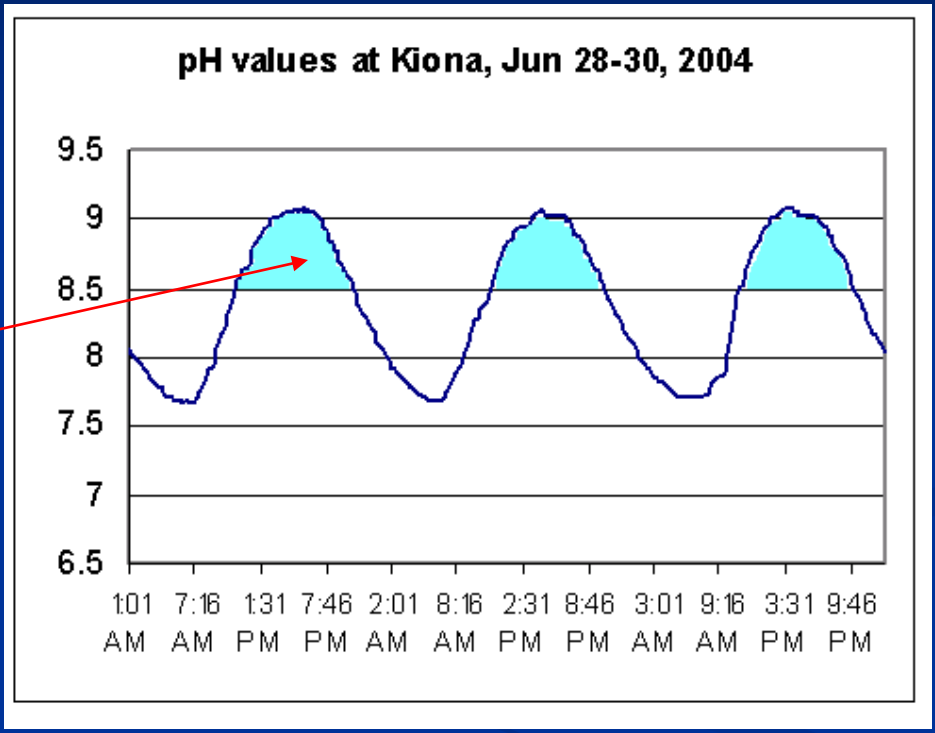


Similar story with pH

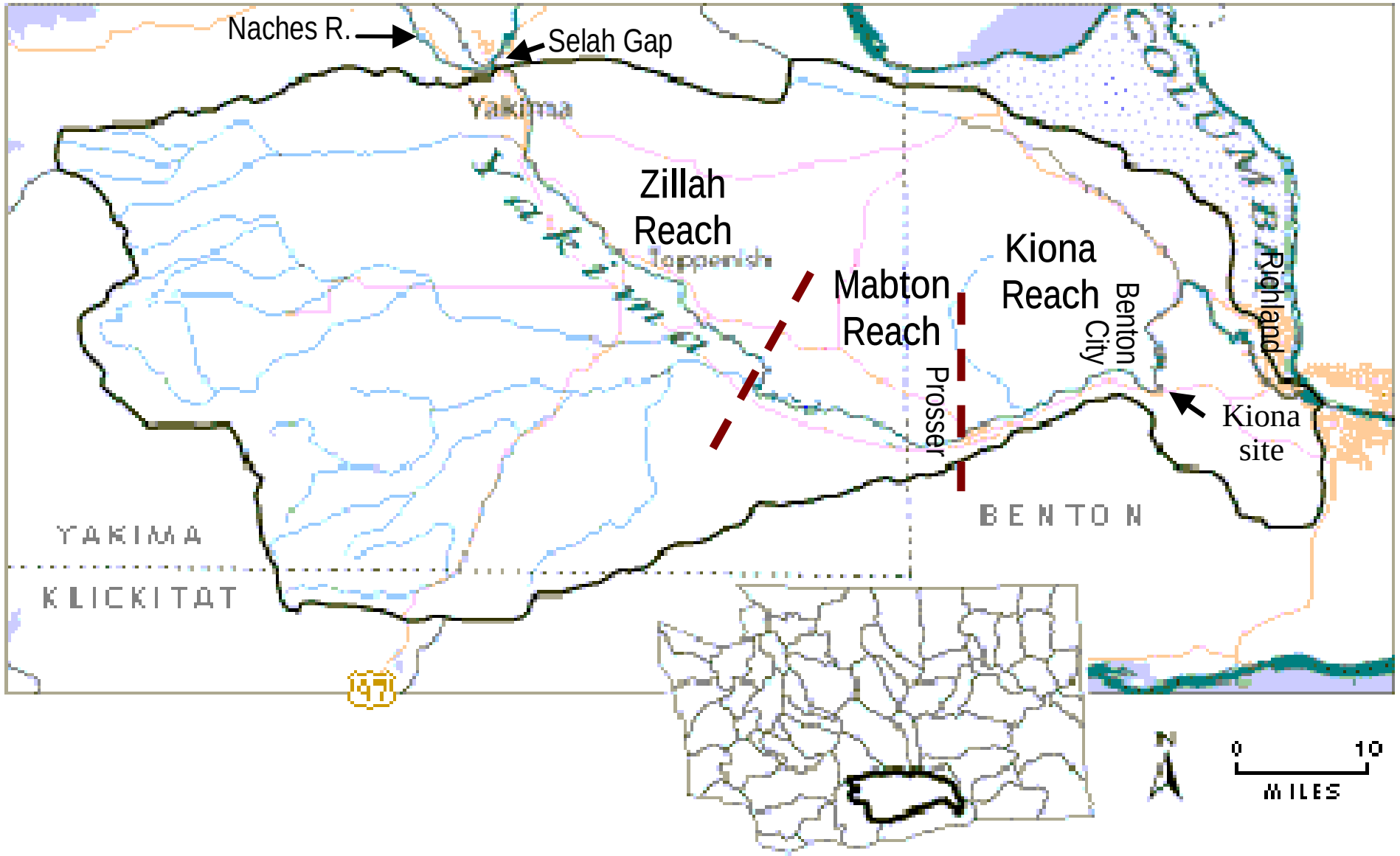
Plants consume CO_2 during the day, which raises the pH.

Violations.

State standard: pH should be no more than 8.5.



Reduce nutrients → fewer plants and algae → less extreme curves → fewer violations. Overly simplistic.



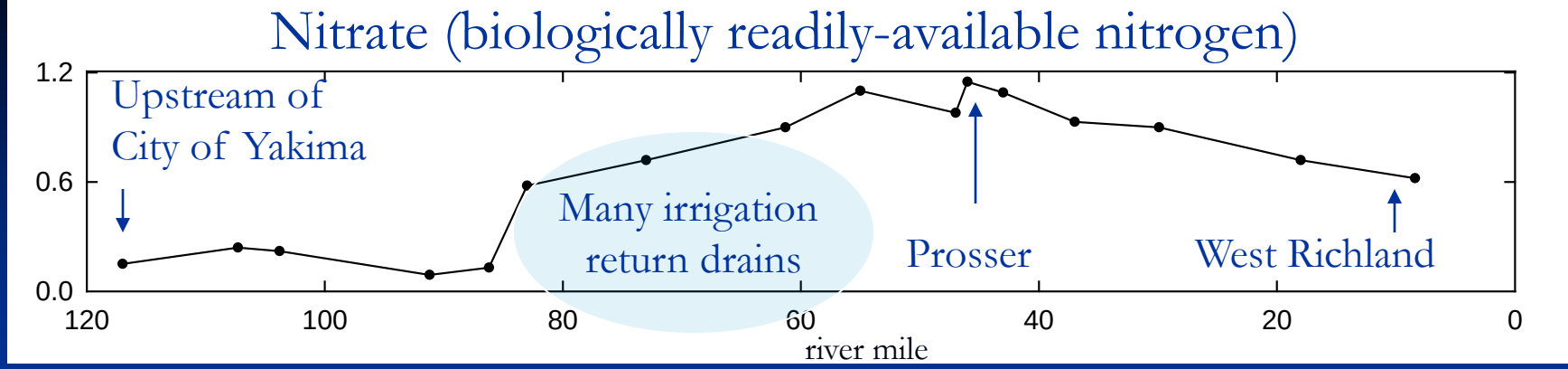
Reaches based on: gradient, substrate, riffle/pool/run, plant/algae abundance, and water quality.

Zillah Reach

Mabton Reach

Kiona Reach

July 2004 Main Stem Nutrient Concentrations (mg/l)

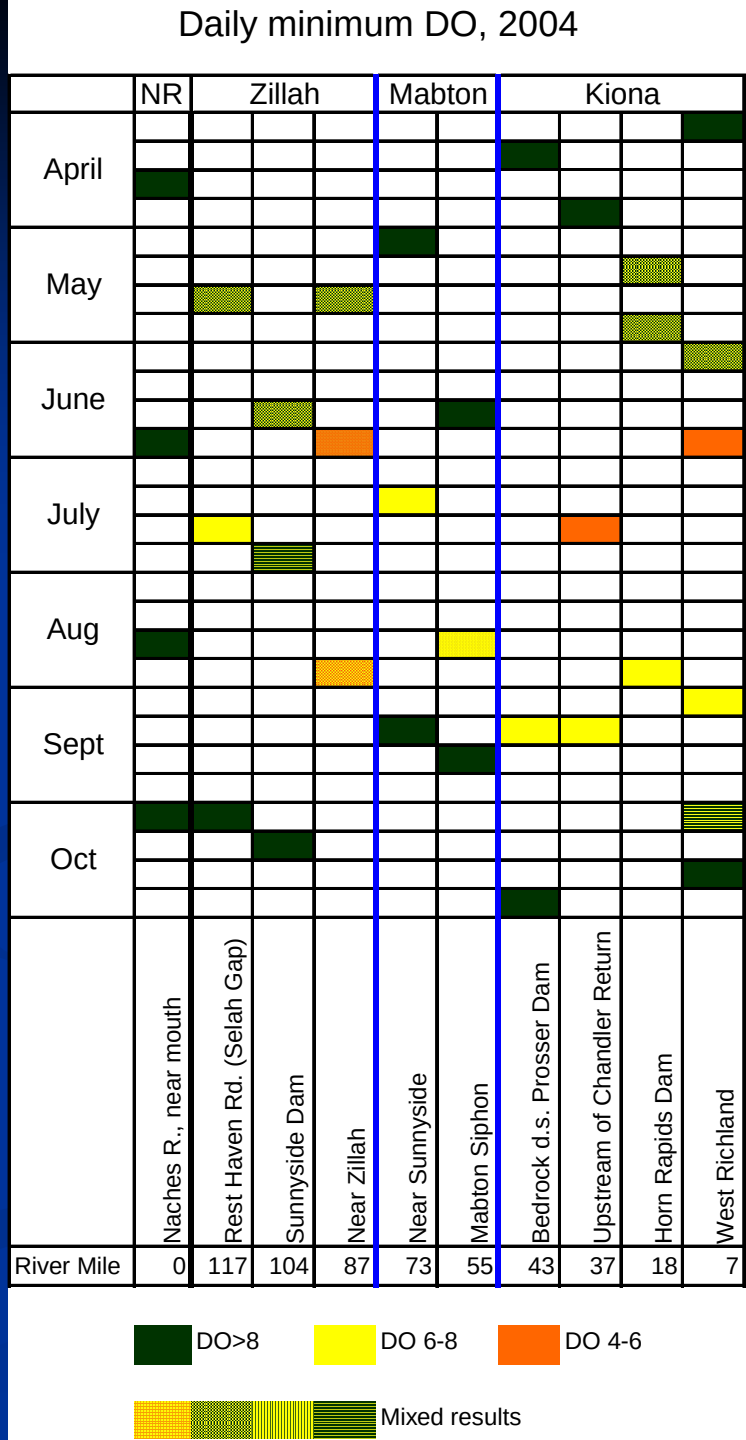


	Zillah	Mabton	Kiona
2005 rooted plant biomass (median)	0 gm/m2	0 gm/m2	1020 gm/m2
Algae abundance	1/3 of samples > 150 mg/m2 (nuisance)	Median chl *a* 12.4 mg/m3 (<10 v. low)	Not sampled

Implication: Cannot focus exclusively on nutrients without accounting for role of habitat.

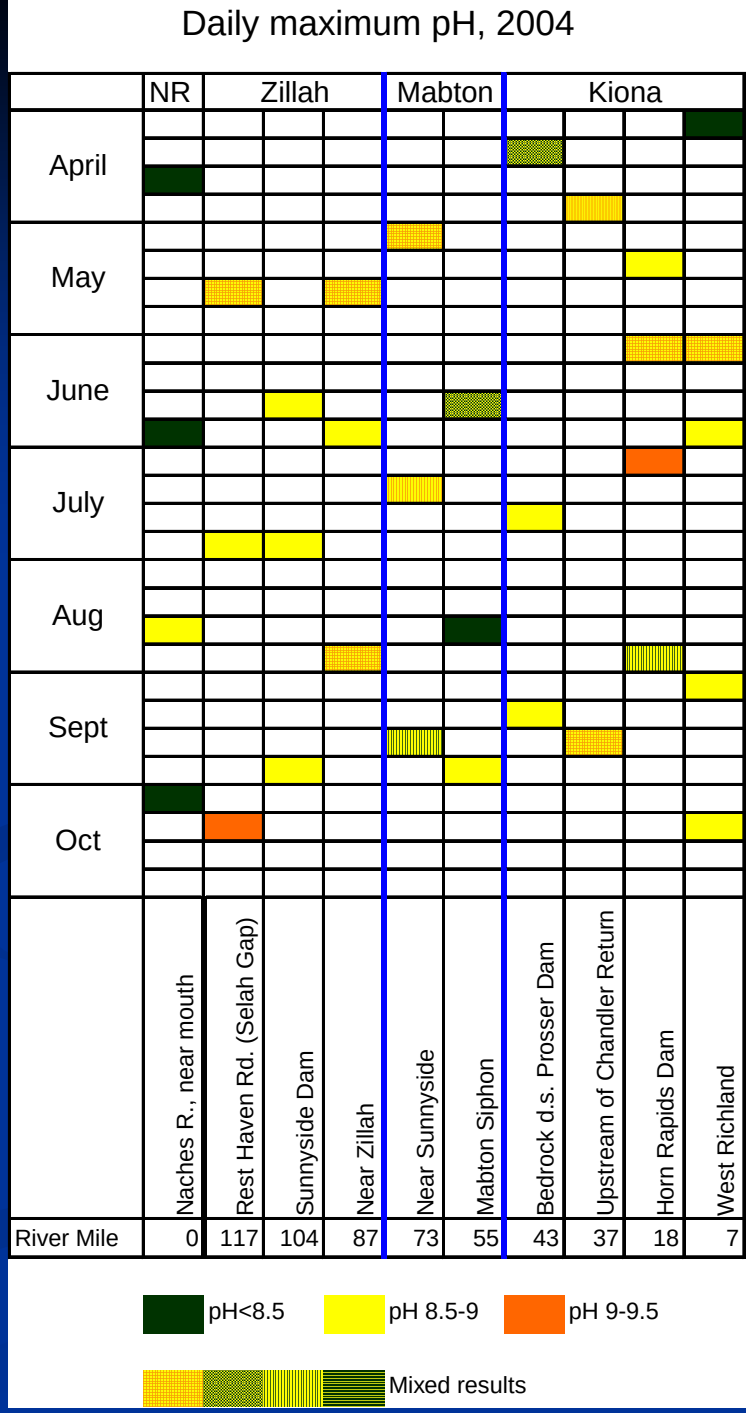
- Spatial & temporal patterns in 2004
  - Dissolved oxygen generally
    - Best in April, worst in late Jun-Aug.
    - Best in reaches with low algal & plant abundance, or with high proportion of riffles (Naches R).

Implication: Since DO patterns seemed to fit pattern of plant & algae abundance, we can expect DO to improve with decreasing abundance.



- Spatial & temporal patterns, continued
  - pH generally
    - Poor at all YR sites, variably, Apr – Oct.
    - Poor even at Rest Haven Road.

Implication: pH patterns didn't seem to fit pattern of plant/algae abundance. Need better understanding of missing factors.



Wintertime pH

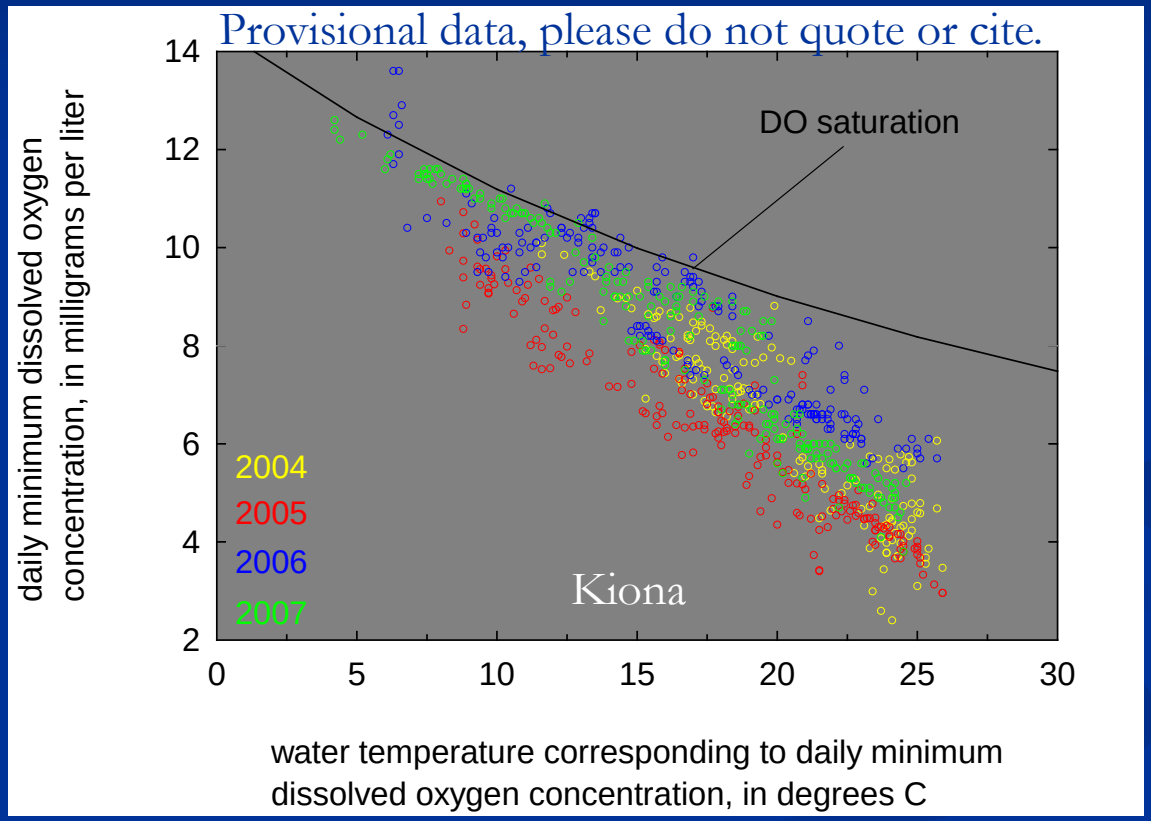
% of days pH > 8.5 at Kiona

WY	Nov	Dec	Jan	Feb
05	16.7	0.0	0.0	25.0
06	53.3	9.7	0.0	21.4
07	18.5	0.0	0.0	57.1

Implication: If naturally-high pH, state criteria becomes no more than 0.5 pH unit change due to human influence. How determine that based on variability seen in previous slide?

Dissolved Oxygen vs. Temperature

- Strong relationship between DO and temperature.



Implication: If we could cool the river, DO should improve, too. How to cool Mabton and Kiona reaches?

- **Plant abundance reduced by 97% in 2006 due to prolonged spring runoff. High turbidity and increased depth resulted in insufficient light for plant growth during much of a 4-month period.**

- **Dissolved oxygen and pH improved but not did not reach compliance. Role of algae?**

- **Heavily-rooted aquatic plants can get nutrients from river bed or water column.** *Implication: reducing nutrients in water column would be ineffective at reducing abundance.*

Nutrients in Bed Sediment

- Could abundant plants be due to higher nutrient concentrations in bed sediment in Kiona reach?
  - Total phosphorus (1987 NAWQA)
    - 0.10% in Quaternary deposits under Zillah reach.
    - 0.09% in Columbia River Basalt under Kiona reach.
  - Abundant plant/algae growth occurred at Kiona in 1937, 1941, 1942, 1944, 1945, 1977, 1994.
    - People in Yakima County:
      - 1940 census: 99,019
      - 2000 census: 222,581
    - Petrochemical fertilizer production boomed *after* WWII.
- Changes in light availability better fits the data. *How develop a TMDL for light availability?*

Mar 1, 2005 Near Zillah

Jul 20, 2004 Chandler pump return

Algae get nutrients from the water. If reduced nutrients enough, will reduce algae.

Apr 12, 2004 Naches R at 16 Ave

Jul 12, 2005 Zillah-Toppenish bridge

Zillah Reach Algae

- Not currently limited by N or P. Future limitation? Out of 83 water samples, 77% had N:P ratio < 7, suggesting N is closer to limiting concentrations.
  - *Implication: Focusing on N-reductions from irrigation return drains (major source of N) upstream of the City of Zillah may yield best return on water quality improvements. Yet improvements in groundwater concentrations come slowly. Focus on P (major source = sewage treatment plants) may yield faster results but at great expense.*
- Algal biomass increased with *decreased* nutrient concentrations. Why? More algae = more nutrient uptake = less nutrients remaining in the water.

Zillah Reach Algae, cont.

- Nutrient-rich water from hyporheic zone (where surface water and groundwater mix below river bed) could fuel algal growth in upwelling areas.

Implication: Complex relationships (Methods in Stream Ecology: Establishing Cause-Effect Relationships in Multi-Stressor Environments.) increase uncertainty, which fosters conflict, especially when $$$ involved.

Conclusions

- Can we use what we learned to improve the cost-effectiveness of nutrient-reduction strategies? Yes, in part.
  - Zillah reach is best hope to reach nutrient-limiting conditions.
    - For N, focus on ag BMPs.
    - For P, focus on STP upgrades.
- The results of this study (in part due to advances in technology, e.g., continuous monitoring for 4 years) suggest a need to update our conceptual understanding of the nutrient/plants/DO&pH relationship and thus our approach to meeting state standards. Will others see the data in the same way? Yet to be determined.

Questions

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