

Setting nutrient standards for
lakes in WV:
Strategy and progress

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Systematic approach

- **Recognize designated uses**
- **Define impairment for designated uses**
- **List possible mechanisms of impairment**
- **Organize and prioritize mechanisms**
- **Set standards to prevent those harms**

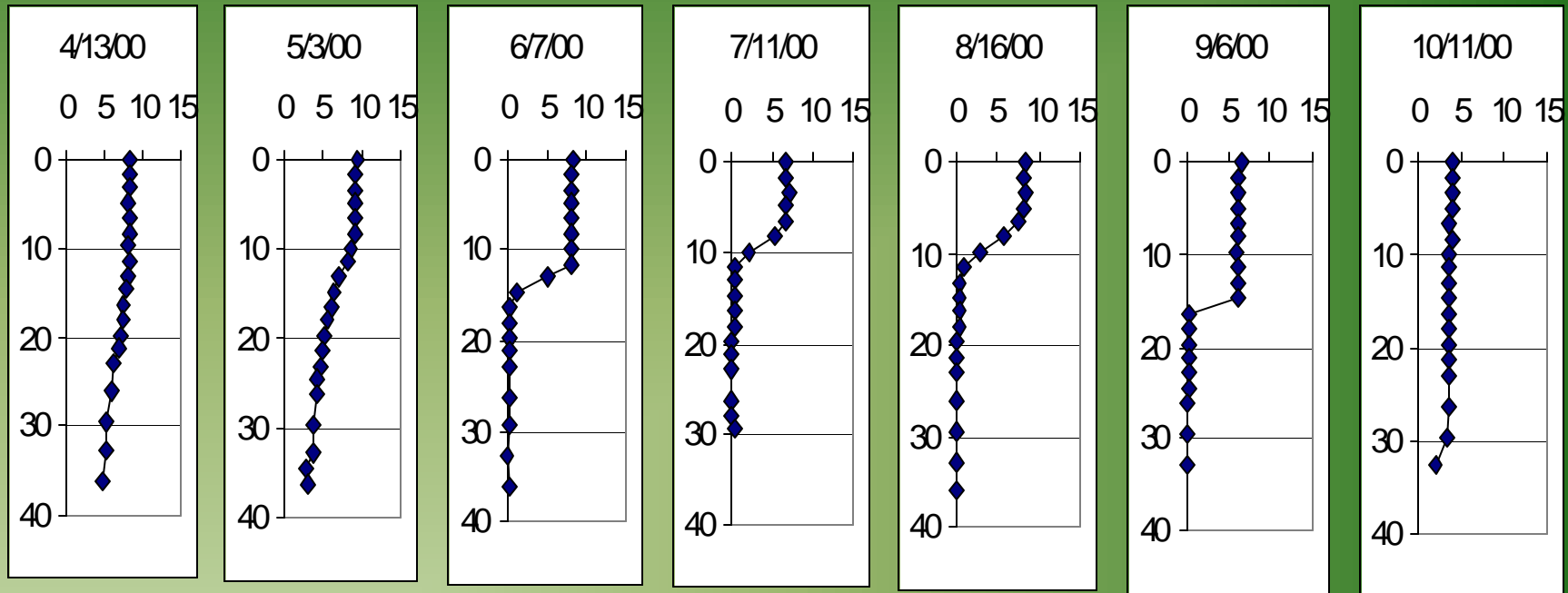
Designated uses

- **Category A: Water supply, public**
 - Impairment includes threats to human health, unacceptable taste or odor, unreasonable treatment requirements
- **Category B: Aquatic life**
 - Impairment includes shifts in communities
- **Category C: Contact recreation**
 - Impairment includes unacceptable lack of clarity, odor, nuisance algae

Potential harms to lakes

Categories	Harms
A,B,C	Nutrients support oxygen consuming biomass
A,B,C	Anoxia causing accumulation of other toxic chemicals (Fe^{2+} , S^{2-})
A	Nutrients supporting toxic or bad-tasting algae
B	Changes mediated through food web
B	Thinning of epilimnetic habitat
C	Nuisance algae (floating or attached mats, smell)

Lake turnover time of greatest sensitivity



Whole lake should not violate standards following mixing of hypolimnion

Organizing harms

Mechanisms for harms related to eutrophication: e.g., low O₂, algae, reduced chemicals, trophic effects

Areas of research for setting standards

Trophic status of WV lakes

- WV lakes generally have high turnover, and are reservoirs. Do they fit the usual trophic descriptions?

Fish communities

- Fish communities artificial like lakes. Do they satisfy users?

Recreation

- Are lake users dissatisfied with clarity or algal biomass in lakes?

Specific research questions

- **What is the relationship between P and oxygen?**
- **What are people's reactions to water quality**
- **What are people's reactions to fish communities**

Phosphorus and oxygen in WV lakes

- **Eutrophication, chiefly due to P, leads to increasingly intense oxygen deficits in the hypolimnion**
- **Oxygen deficits can lead to**
 - **Whole lake hypoxia (WV standard ≥ 5 mg/L)**
 - **Accumulation of iron or sulfide**

Special characteristics of WV lakes

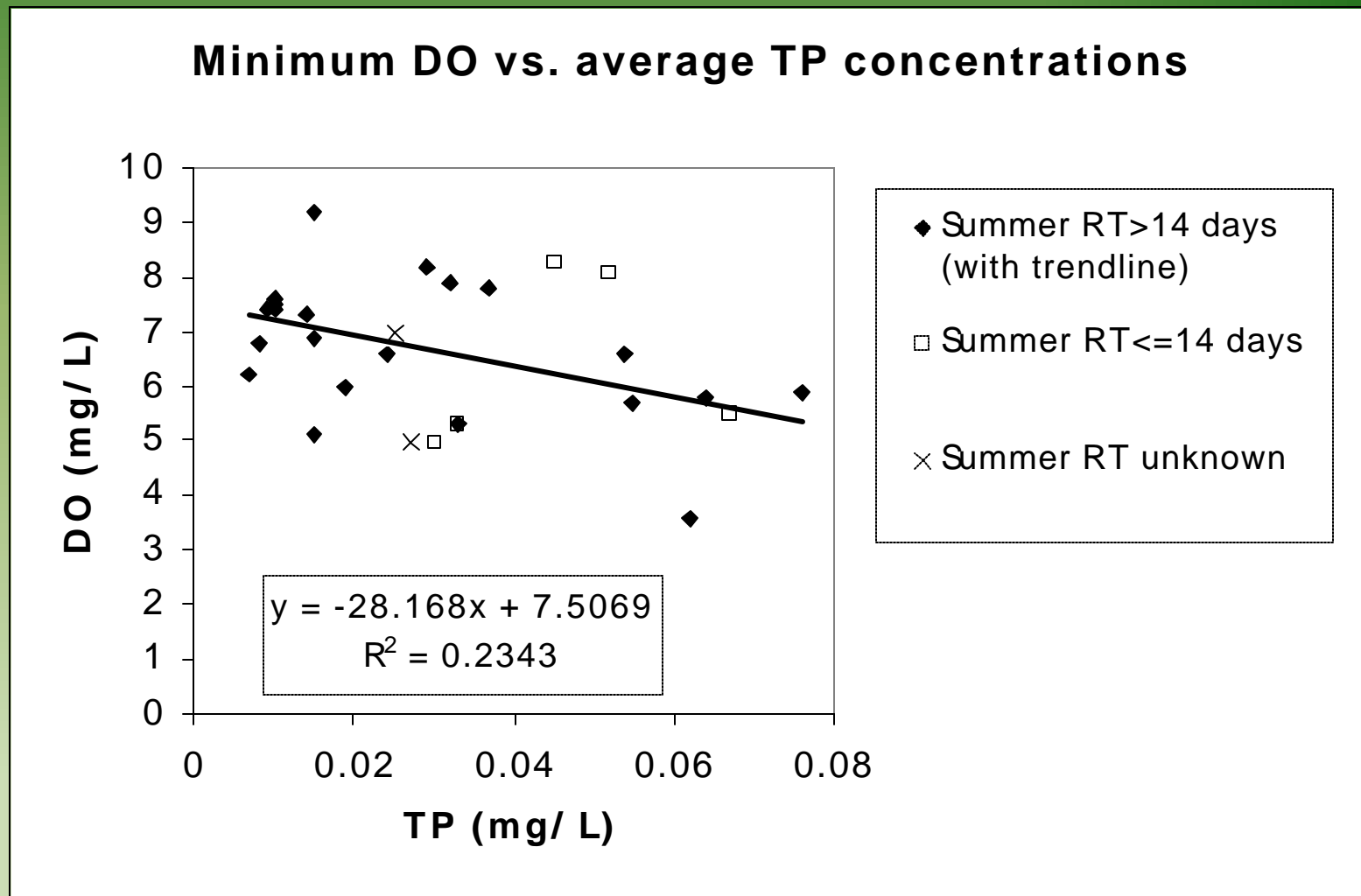
- **High flushing rates—may decrease sensitivity to nutrient enrichment**
- **High sediment load**
 - **May decrease light penetration and decrease algal production.**
 - **May also remove P from water column through adsorption to particles**

Study of existing data on lakes

What levels of P are associated with risk (> 6 mg/L) of surface hypoxia?

- **WVDEP Clean Lakes Program includes data from ~18 lakes between 1989 and 1996**
- **US Army Corps data on large lakes. roughly monthly profiles of one or two lakes per summer season**

Lakes with more P have lower minimum O₂ concentrations



Possible P standards for WV lakes

Method	Standard	
	TP concentration	TSI from TP
EPA reference method	8 $\mu\text{g/L}$ (2.5 to 24 $\mu\text{g/L}$) ^a	34 (17 to 50)
25 th percentile of WV lakes	15 $\mu\text{g/L}$	43
Mesotrophic/eutrophic boundary	24 $\mu\text{g/L}$	50
75 th percentile of lakes in sparsely settled counties	31 $\mu\text{g/L}$	54
Cause and effect analysis	50 $\mu\text{g/L}$	61
Mid-eutrophic threshold (WVDEP practice)	68 $\mu\text{g/L}$	65