



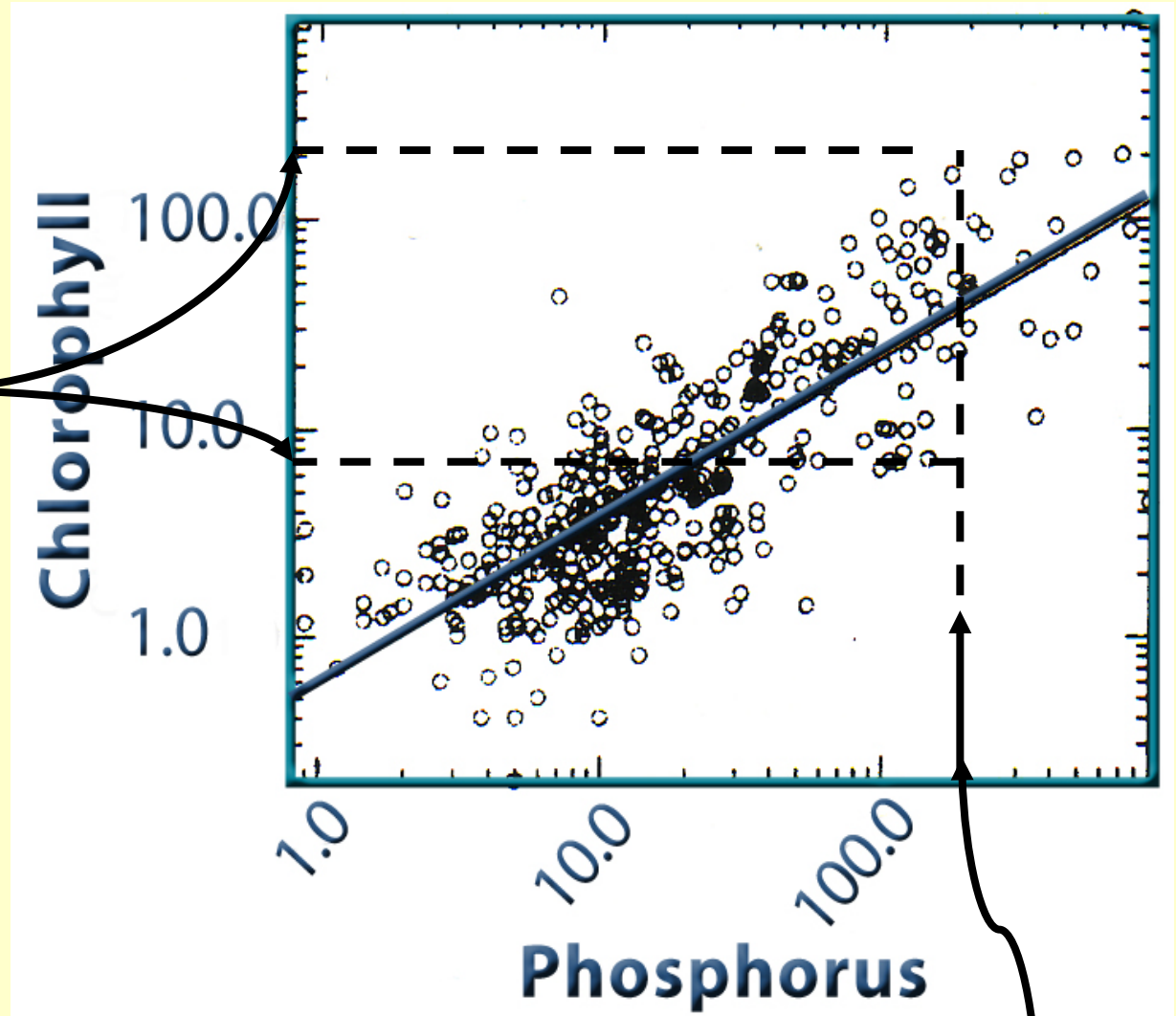
Biotic Interactions and Habitat

Paul Cunningham
Bureau of Fisheries Management



High inter-lake variability between Chlorophyll and TP

Chlorophyll
varies between ~
10 and 220 $\mu\text{g/l}$

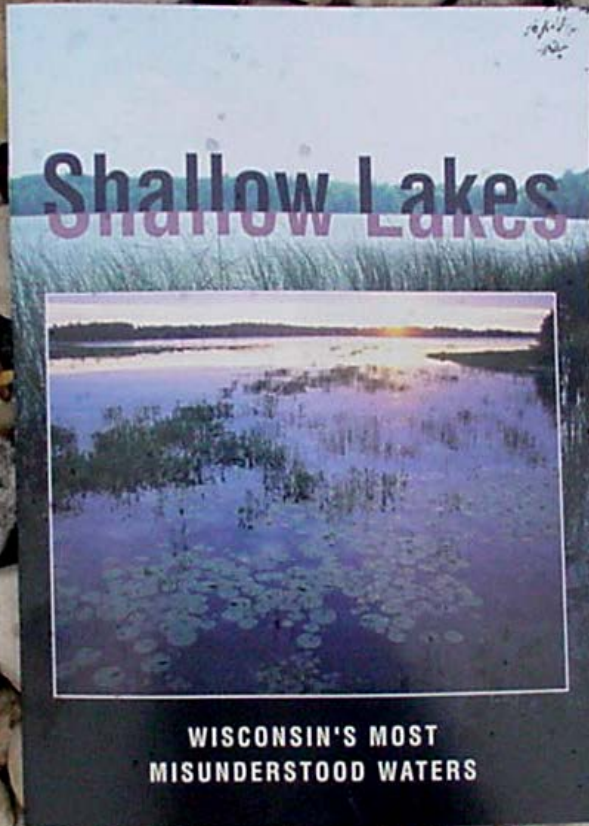


For TP=200 $\mu\text{g/l}$



Photo Courtesy of MNDNR

SHALLOW LAKE : NON-STRATIFIED, < 7 m DEEP, > 4 ha



✓ > One third of WI lake acres, > 300k ac

✓ WI's largest , Winnebago @ 137,708 ac

✓ Large littoral zone area(>50%criteria)

✓ Aquatic plants = Heart of ecosystem

✓ Exist in turbid or clear water state

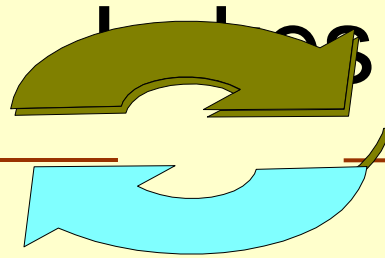
✓ Water column stays mixed

✓ User expectations often unrealistic

Stable States in Shallow

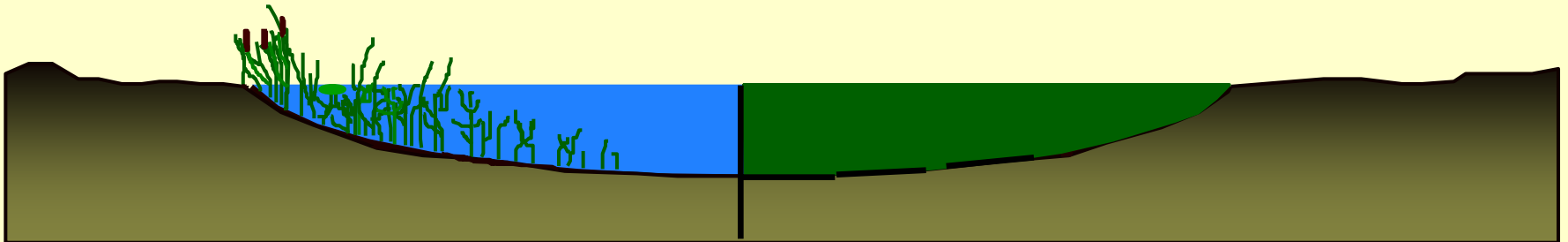
Clear State

- clear water
- low algal biomass
- high macrophyte biomass
- Piscivores dominate

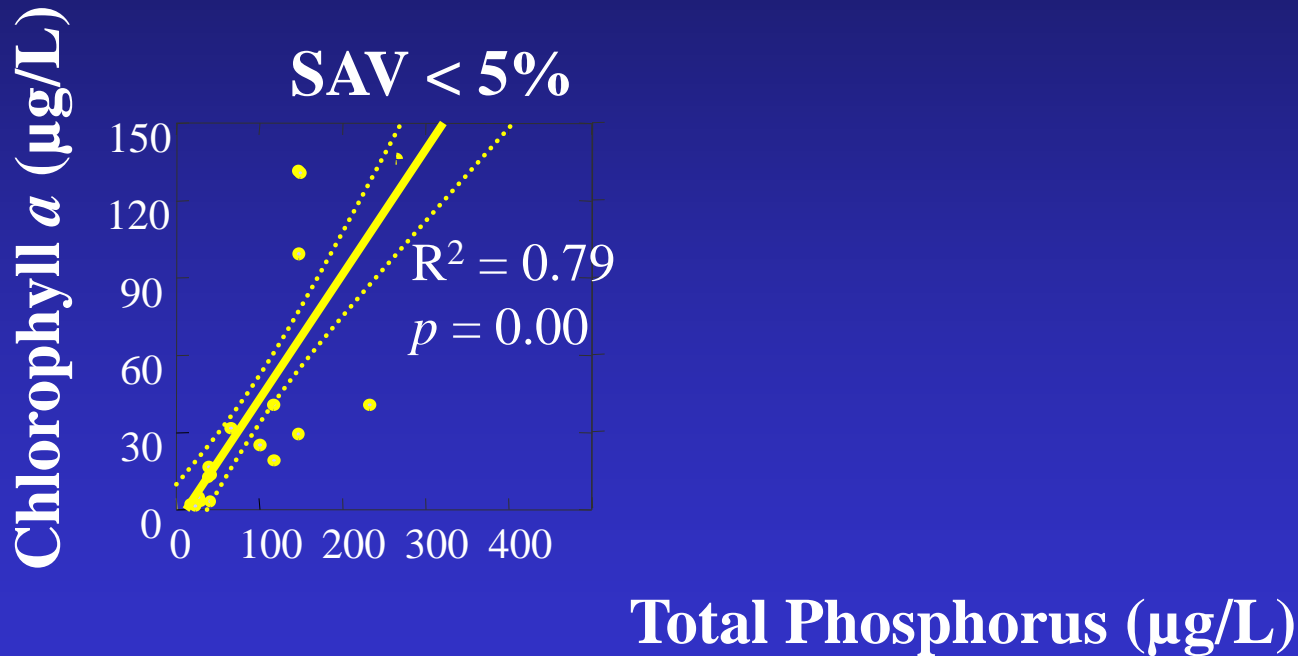


Turbid State

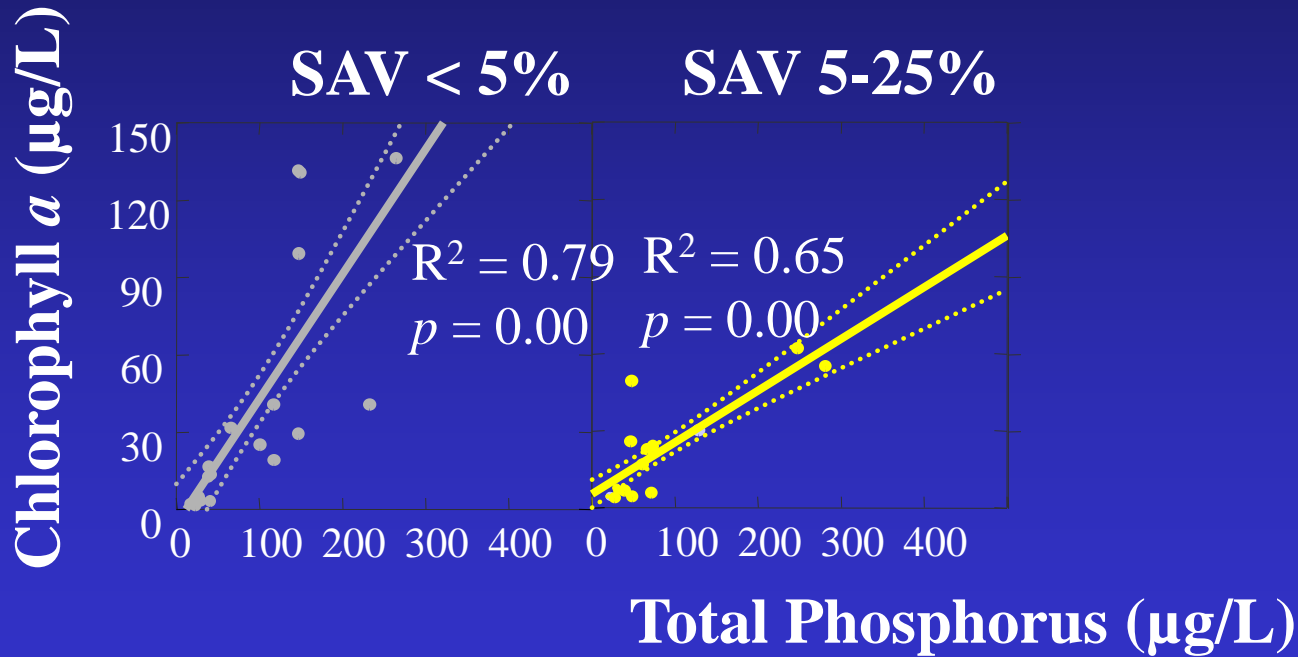
- murky water
- high algal biomass
- sparse macrophytes
- Planktivores/benthivores dominate



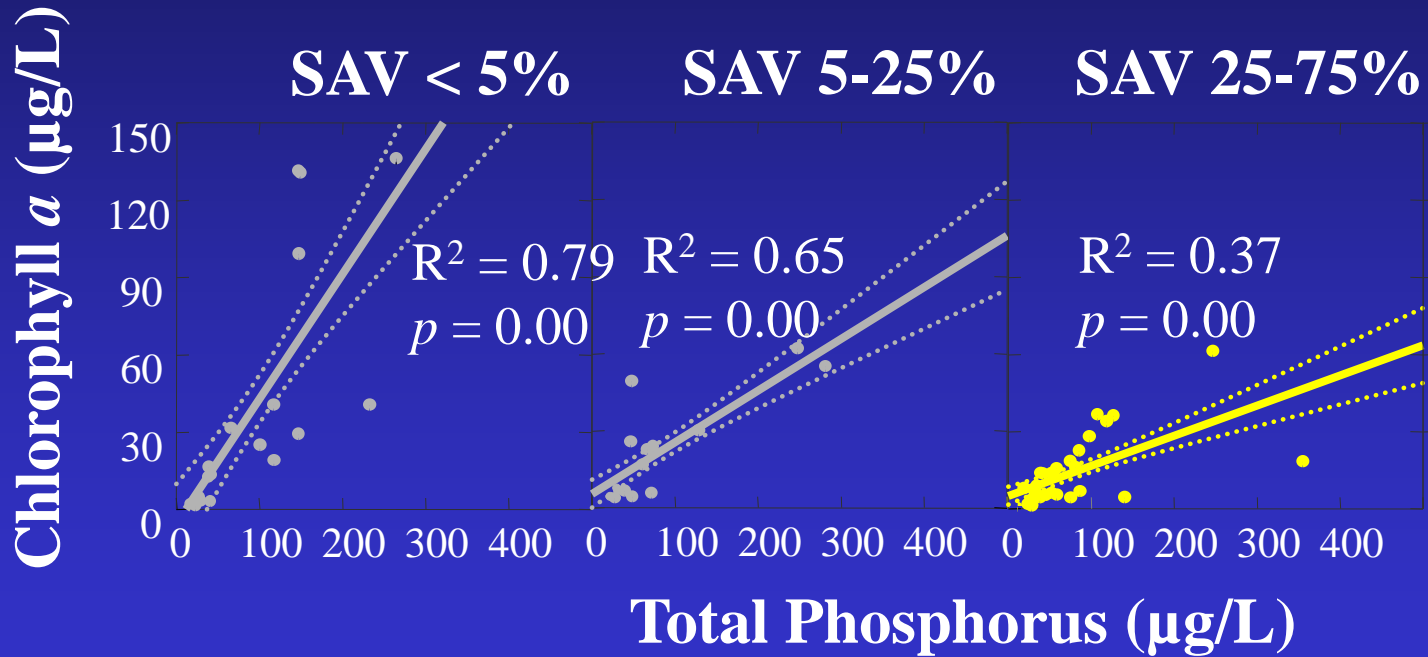
Effect of SAV on the chlorophyll and TP relationship



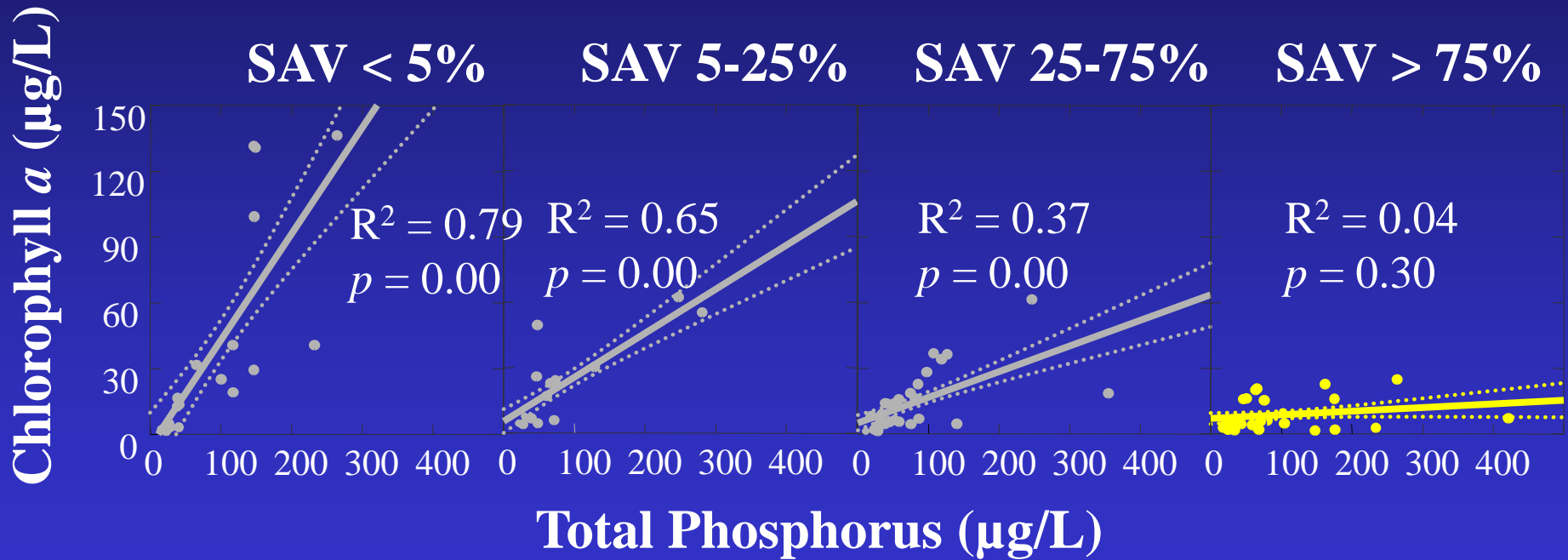
Effect of SAV on the chlorophyll and TP relationship



Effect of SAV on the chlorophyll and TP relationship



Effect of SAV on the chlorophyll and TP relationship



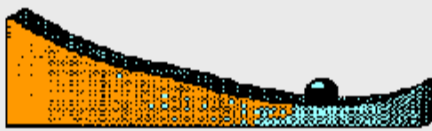
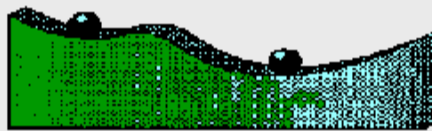
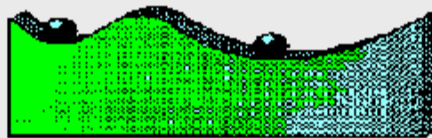
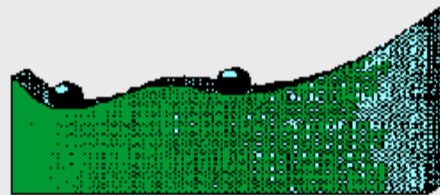
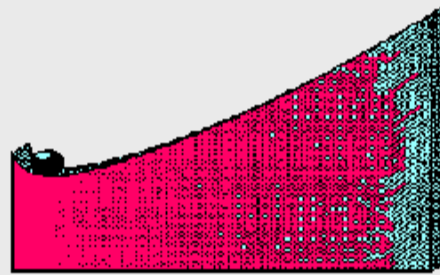
Shallow Lake Ecology

(From Scheffer et al. 1993)

**NUTRIENT
POOR**



**NUTRIENT
RICH**



CLEAR



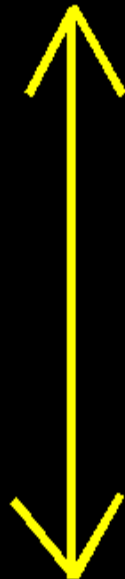
TURBID

Shallow Lake Ecology

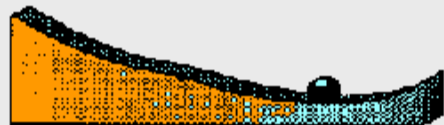
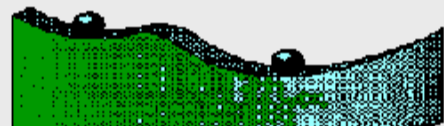
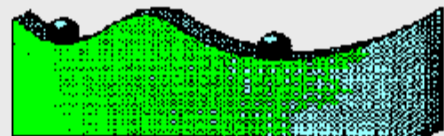
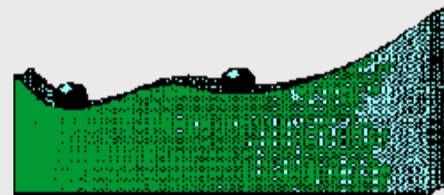
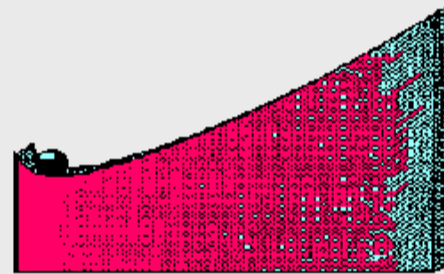
(From Scheffer et al. 1993)

Plants

NUTRIENT
POOR



NUTRIENT
RICH



Small
Rosettes

Submersed
Flexous

Submersed
Shrubs

Emergents

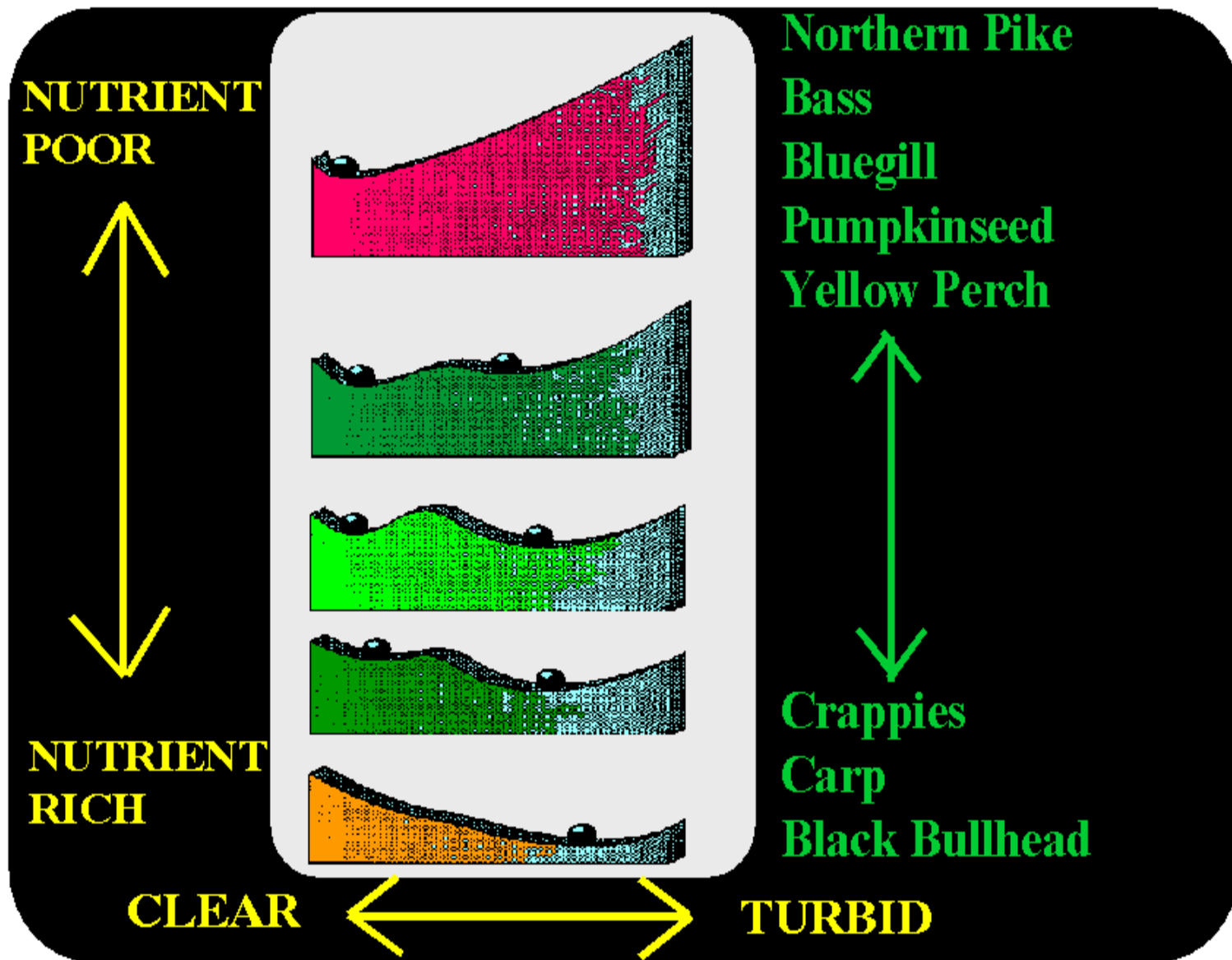
CLEAR



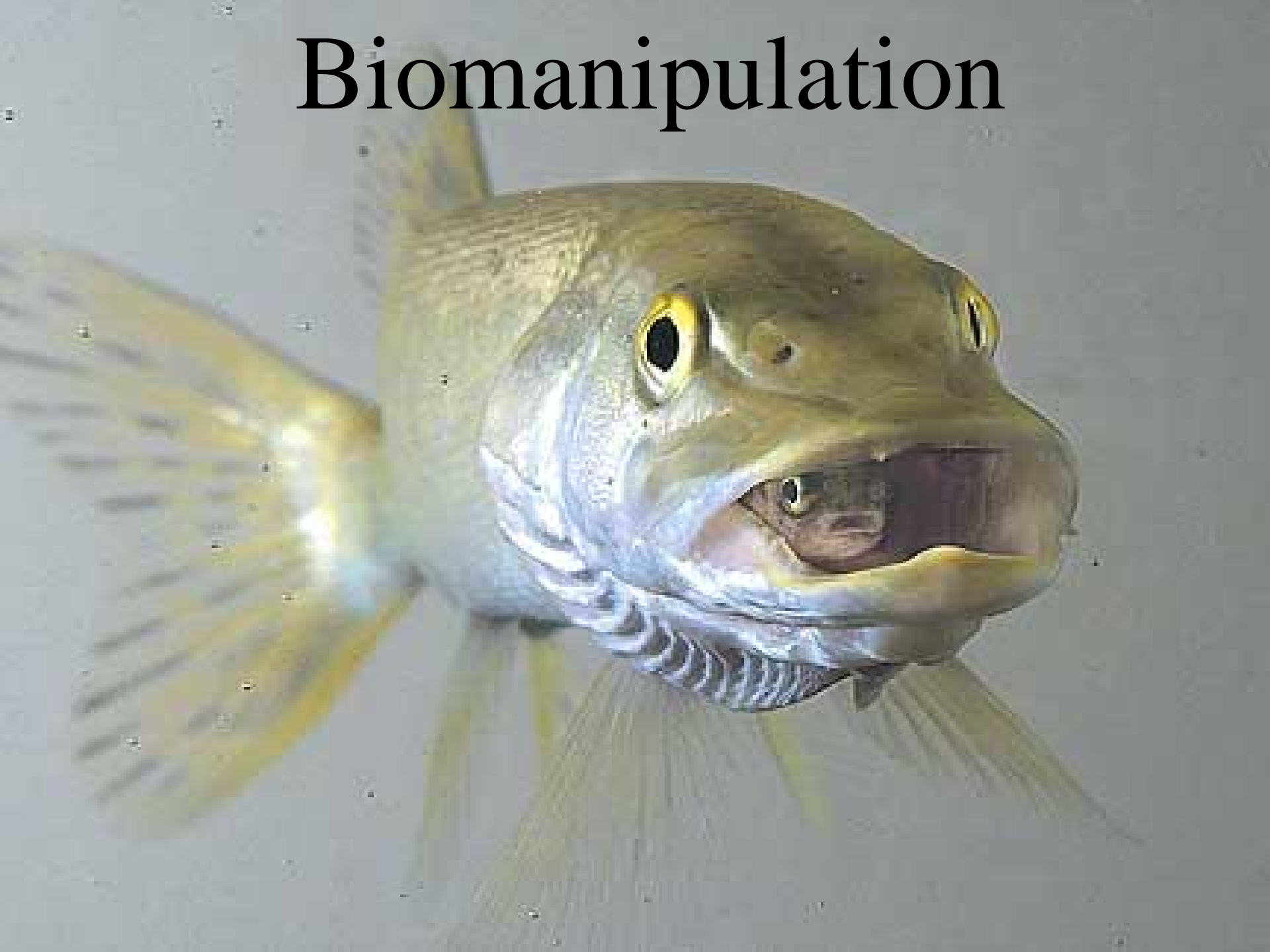
TURBID

Shallow Lake Ecology

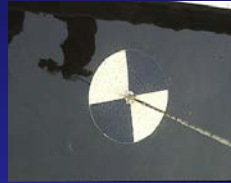
(From Scheffer et al. 1993)



Biomanipulation



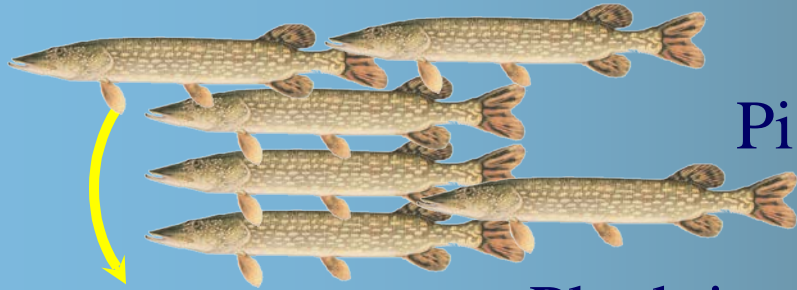
Cladocerans, or water fleas “vacuum” the algae from lake water. When they are abundant, the water is more clear.



If conditions are unfavorable, i.e. zooplanktivorous fish like bluegill are abundant, refuge absent, the lake water remains turbid from algae.



Clear-water State



Piscivores



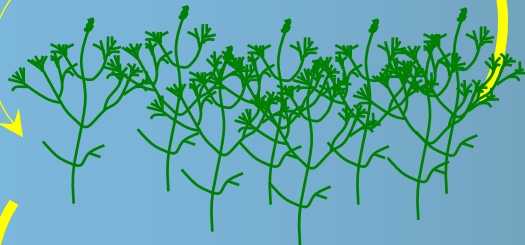
Planktivores/Benthivores



Zooplankton grazing



Algae biomass

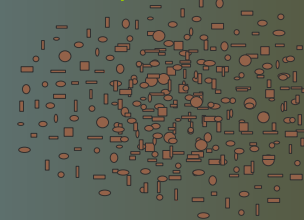
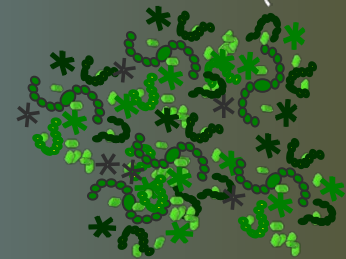


Aquatic plant biomass



Sediment Resuspension

Turbid-water State



Bioturbation





(Commissioner Philo Hoy, 1876)

“When you can go with hook and line and bag ten pound specimens of that most desirable fish, the carp, then you will feel like thanking the men who have so persistently persevered in investigating every condition that can secure benefits so great.”



(General Edwin E. Bryant, President of the Wisconsin Fisheries Commission, 1901)

“ The greatest trouble we have in some of our lakes in Wisconsin is that the carp have got in there. I do not know of a fisherman in Wisconsin that would catch one if he could, and I never heard of one being eaten either by anybody in the circle of my acquaintance... Within a radius of five miles of Madison there are billions of carp. Every fisherman sees them, curses them, and refuses to catch them.”

“Advances” in Fisheries Management





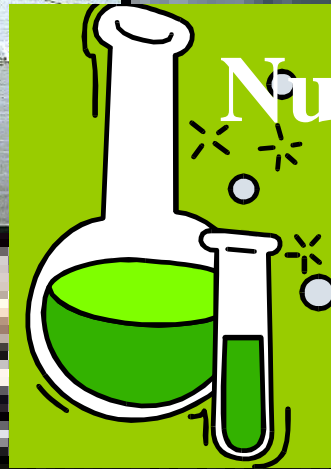
Hammering Carp



Trap em



Net em



Nuke em



Suffocate
the bastards

Contract Removal

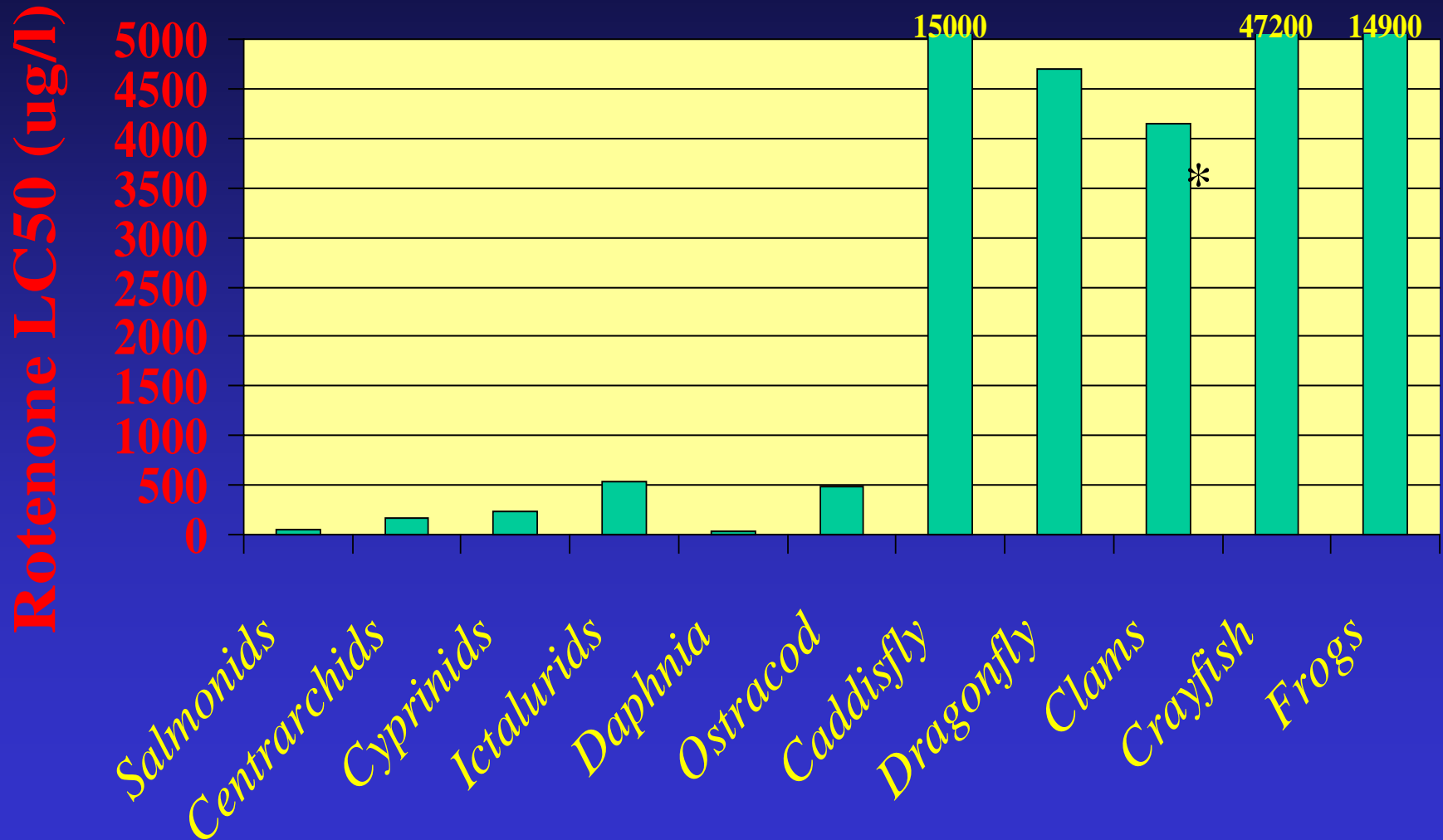


Rotenone



Toxicity of Rotenone

Laboratory Tests; 24 hr LC₅₀



* 96 hour

Fry Stocking



Fry Stocking

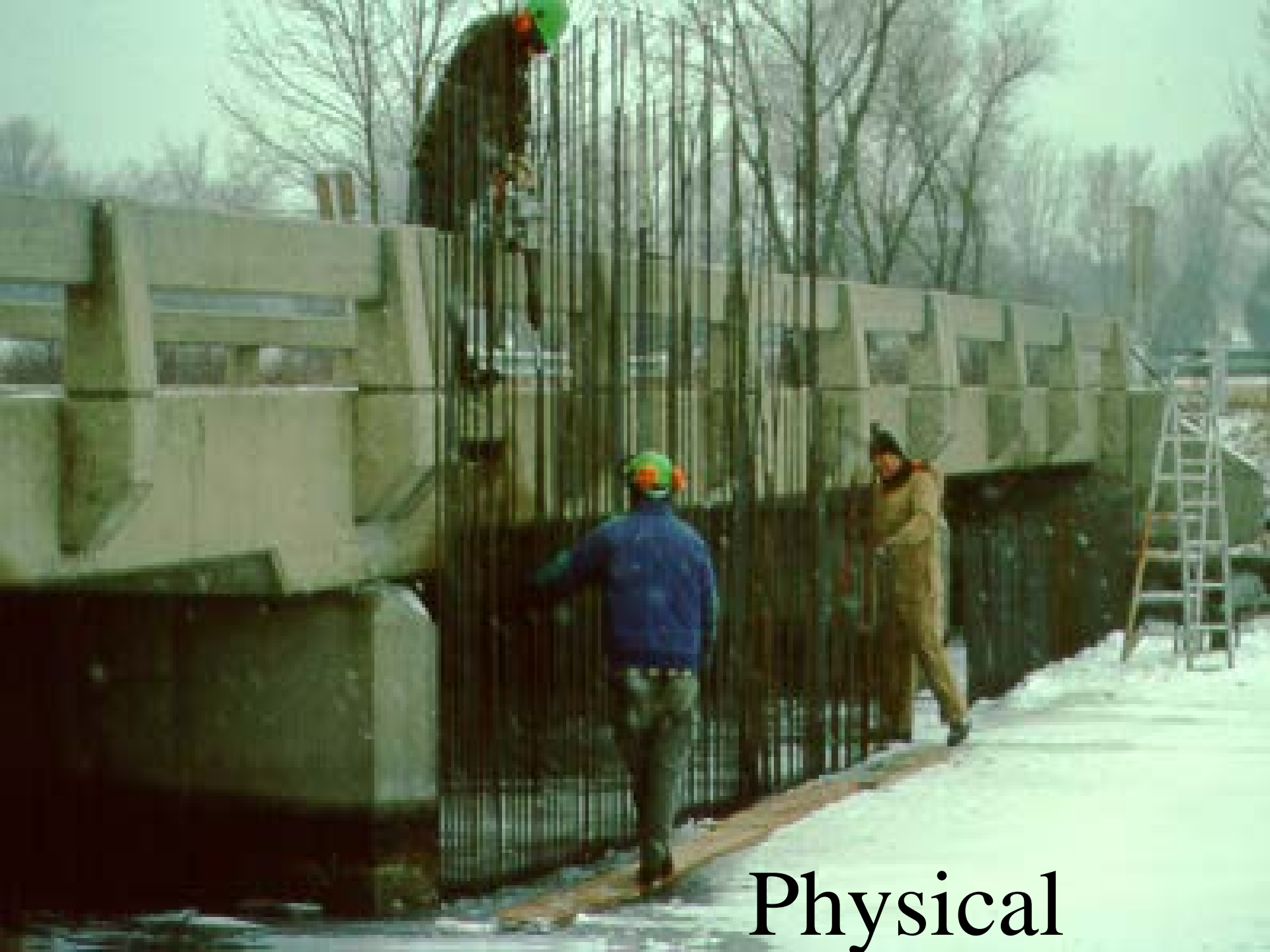


Aeration to Prevent Winterkill



Aeration - Refuge Area





Physical

Electrical Barrier



HIGH WATER LEVELS DESTROY HABITAT

NOW



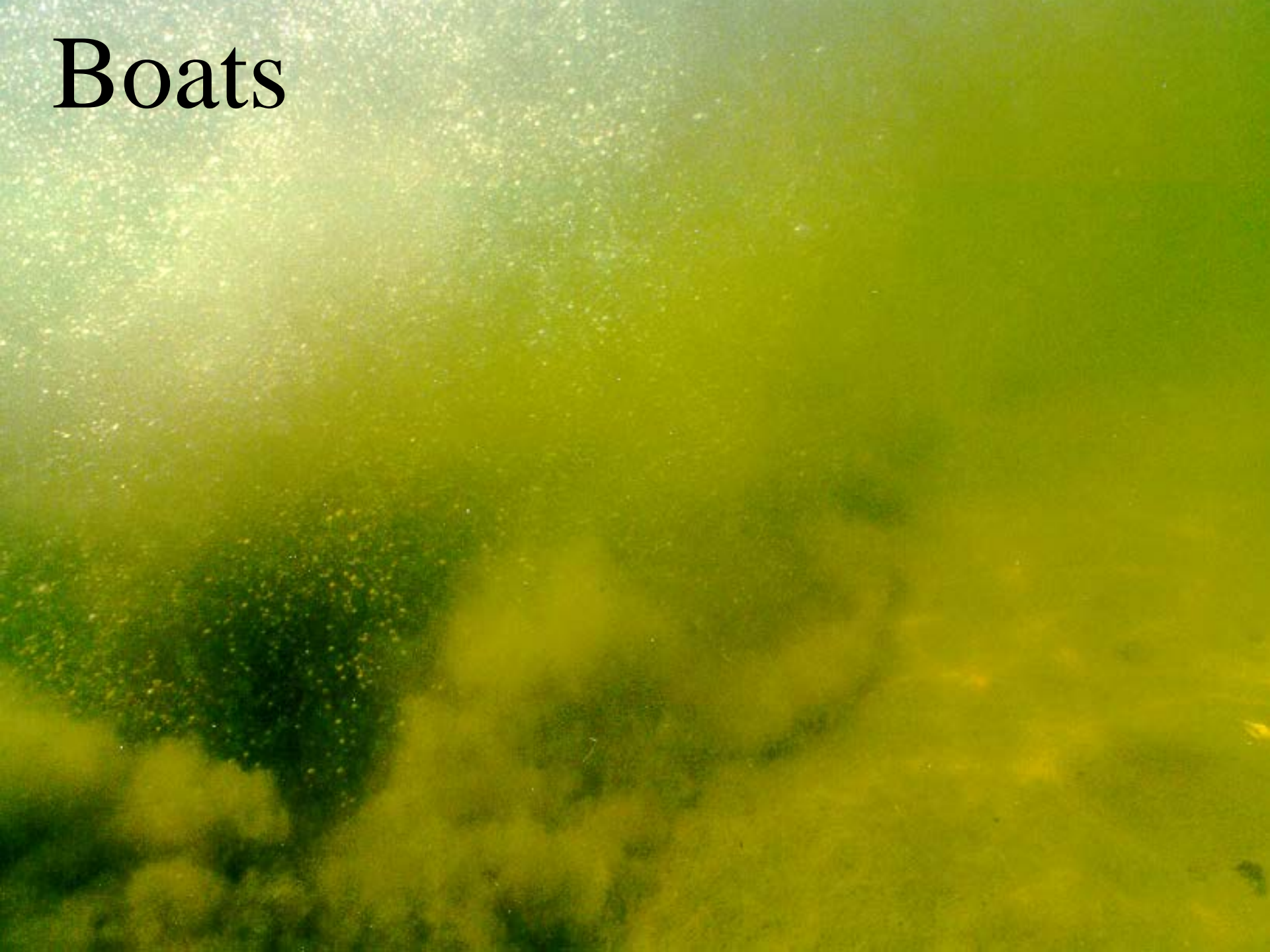
Boats





IF MOM ONLY KNEW

Boats



Management Tools

**BENTHIVORES
PLANKTIVORES**

**PROTECT PISCIVORES
STOCK PISCIVORES
COMMERCIAL HARVEST
CHEMICAL RECLAMATION
SPOT TREATMENTS**

**WATER
DEPTH**

**DRAWDOWN
LONG-TERM LEVELS**

WAVES

**TEMPORARY BREAKWATERS
BARRIER ISLANDS
BOATING RESTRICTIONS**

NUTRIENTS

Essential Habitat

A photograph of a wetland or marsh area. In the foreground, there are several tall, green grasses or reeds. The middle ground shows a body of water with lily pads and other aquatic plants. In the background, there is a dense forest of trees with green and some autumn-colored leaves. The sky is overcast and grey.

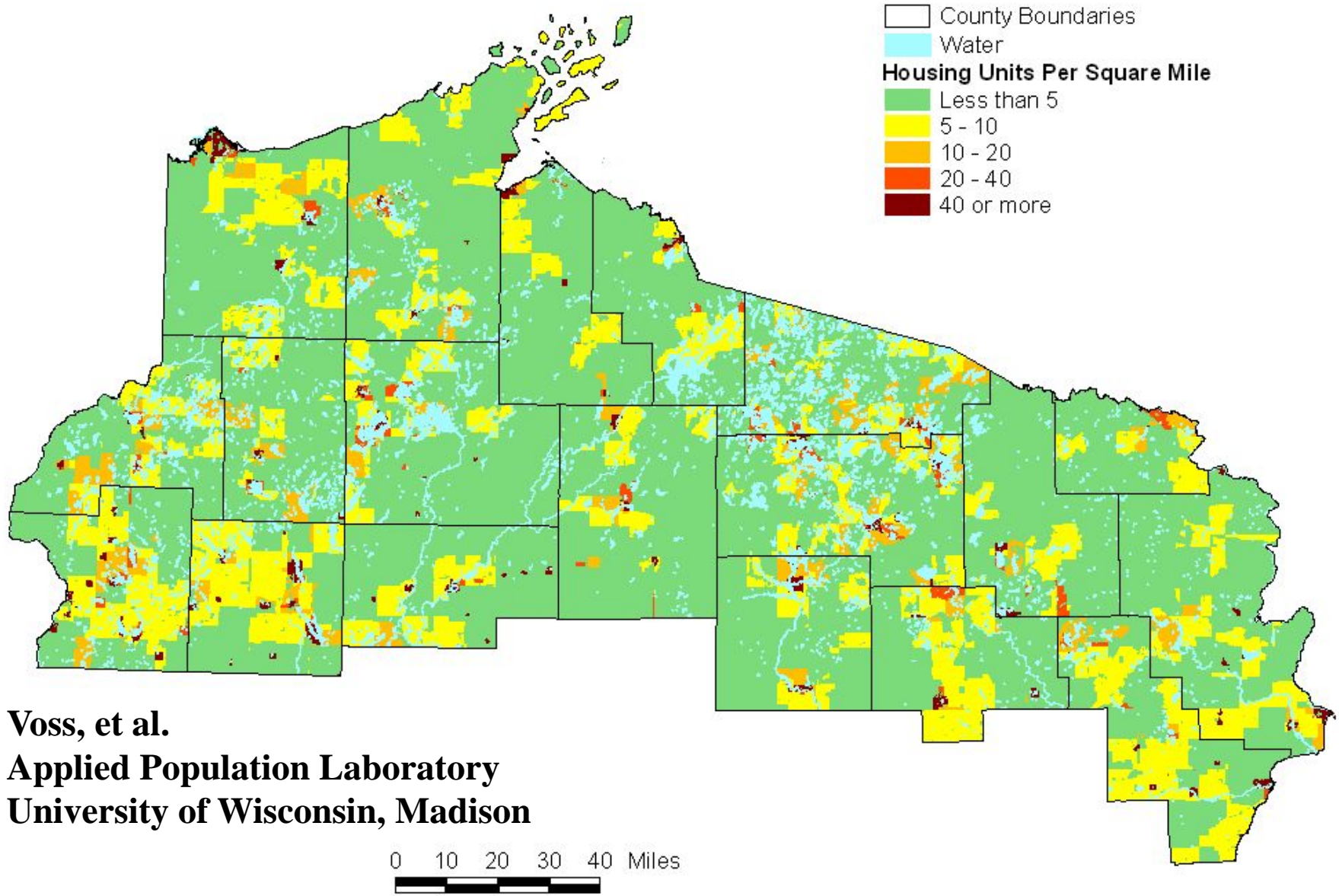
- Littoral zone
- Tributary areas
- Adjacent shoreland

Features of Littoral Zone Habitat

- Vegetation
- Substrate
- Woody Cover
- Overhanging Bank Cover
- Depth and Depth Gradients

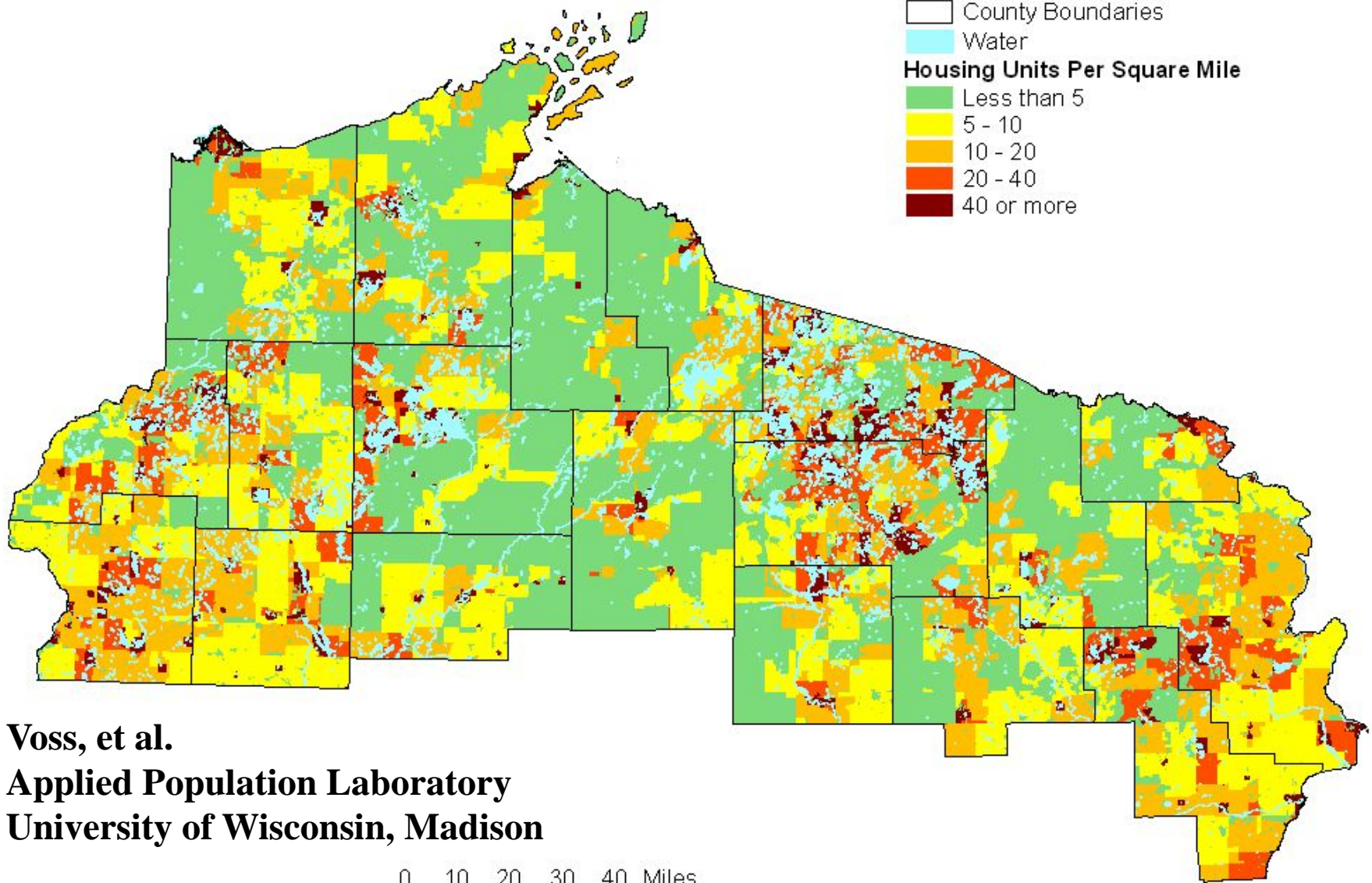


1940 Housing Density by Partial Block Group



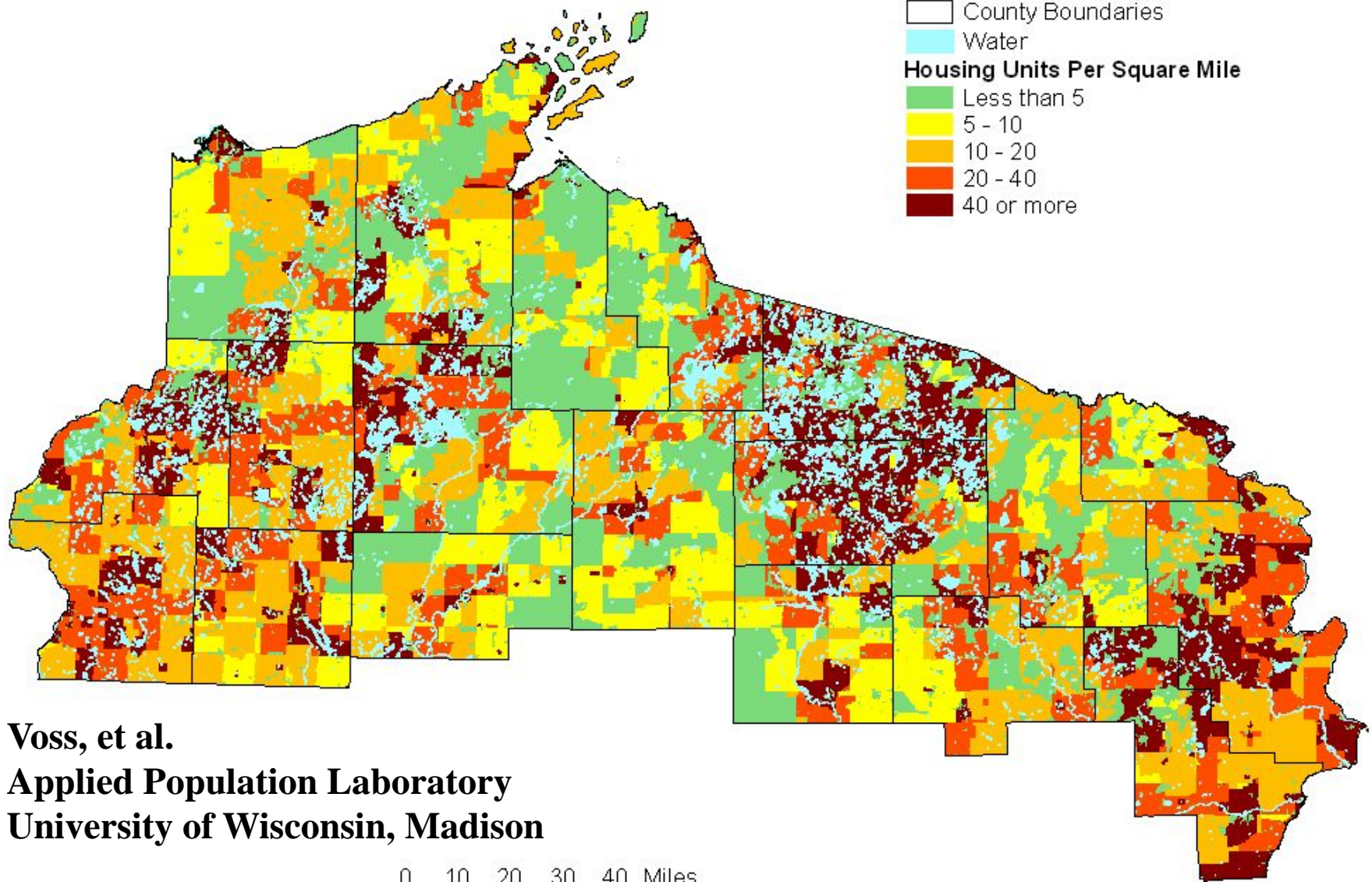
Voss, et al.
Applied Population Laboratory
University of Wisconsin, Madison

1990 Housing Density by Partial Block Group



Voss, et al.
Applied Population Laboratory
University of Wisconsin, Madison

2010 Housing Density by Partial Block Group Rural Renaissance Forecast



Voss, et al.
Applied Population Laboratory
University of Wisconsin, Madison

Consequences of Lakeshore Development on Emergent and Floating-Leaf Vegetation Abundance



Radomski and Goeman, 2001



Minnesota Department of Natural Resources

Consequences of Lakeshore Development on Emergent and Floating-Leaf Vegetation Abundance



- Developed shores had less aquatic vegetation
- For each lake lot, 2/3rds of the emergent and floating-leaf vegetation was lost
- Minnesota has lost 20-28% of

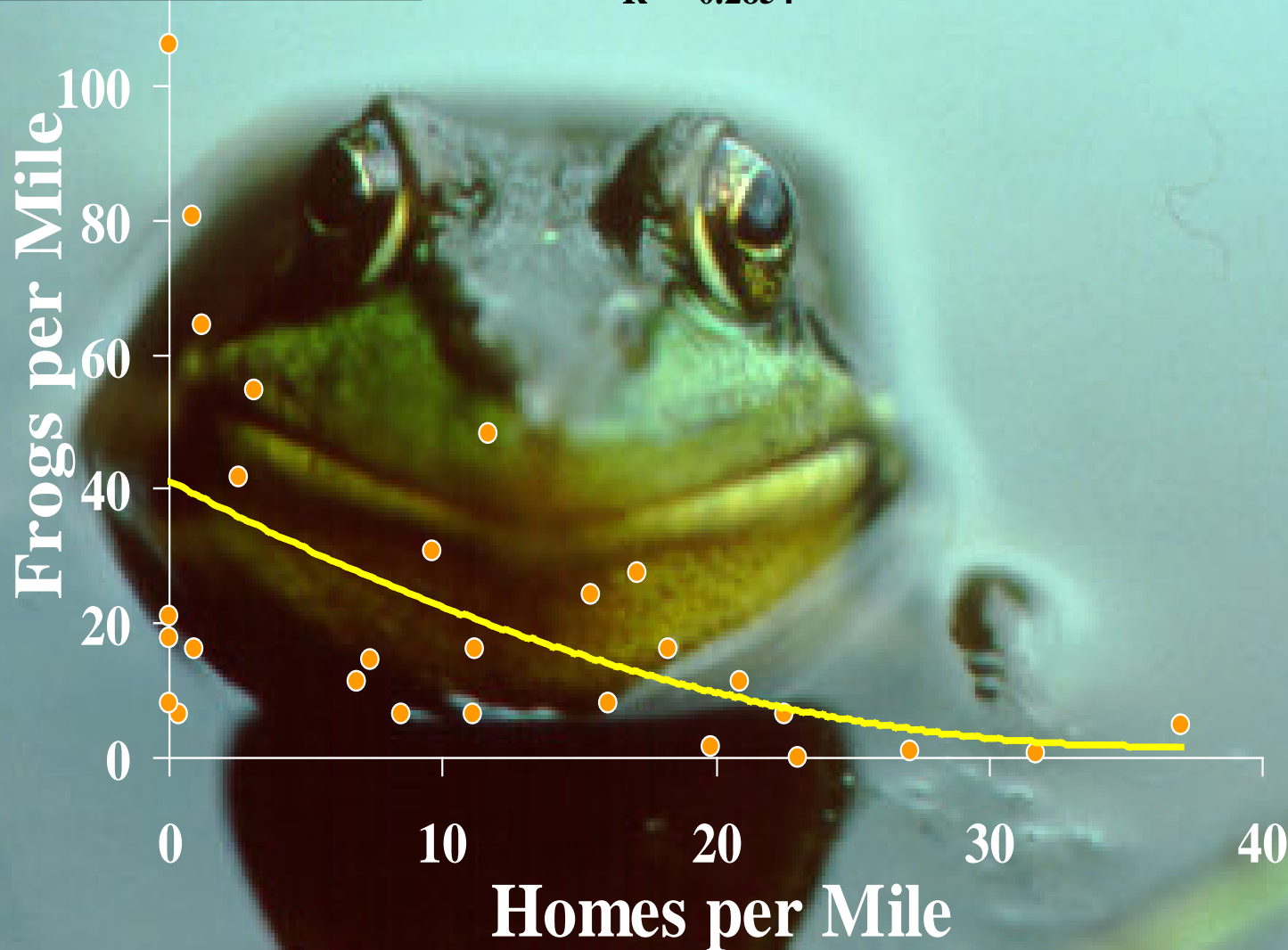
Radomski and Goeman, 2001

What's Happened to Green Frogs

● Frogs/mile
— Poly. (Frogs/mile)

$$y = 0.0298x^2 - 2.1712x + 41.227$$
$$R^2 = 0.2854$$

(Woodford and Meyer)



Impacts of Lakeshore Development on Tree-falls in North Temperate Lakes

Christensen et al. 1999

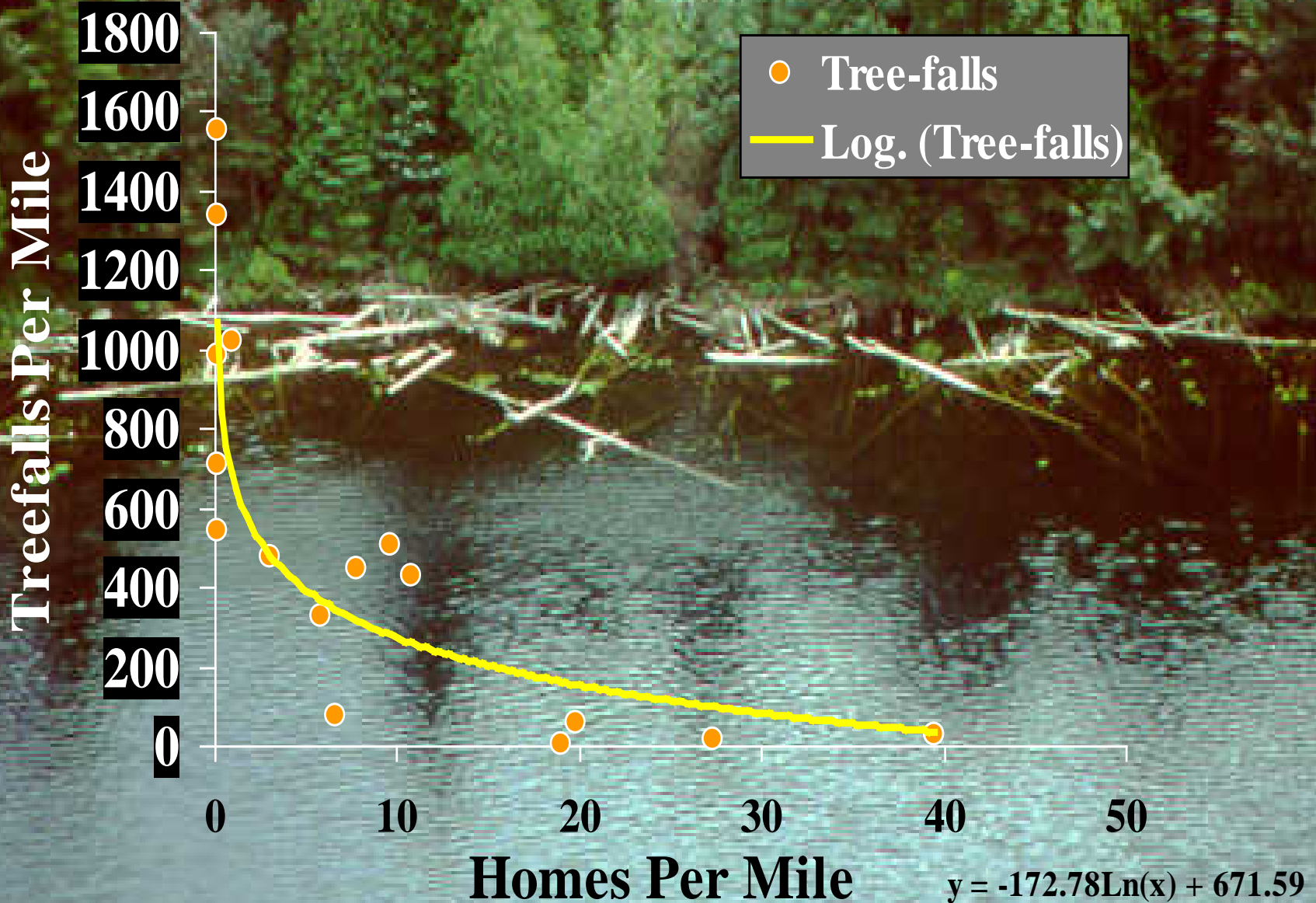


University of Wisconsin

Center for Limnology



Impacts of Development on Tree-falls

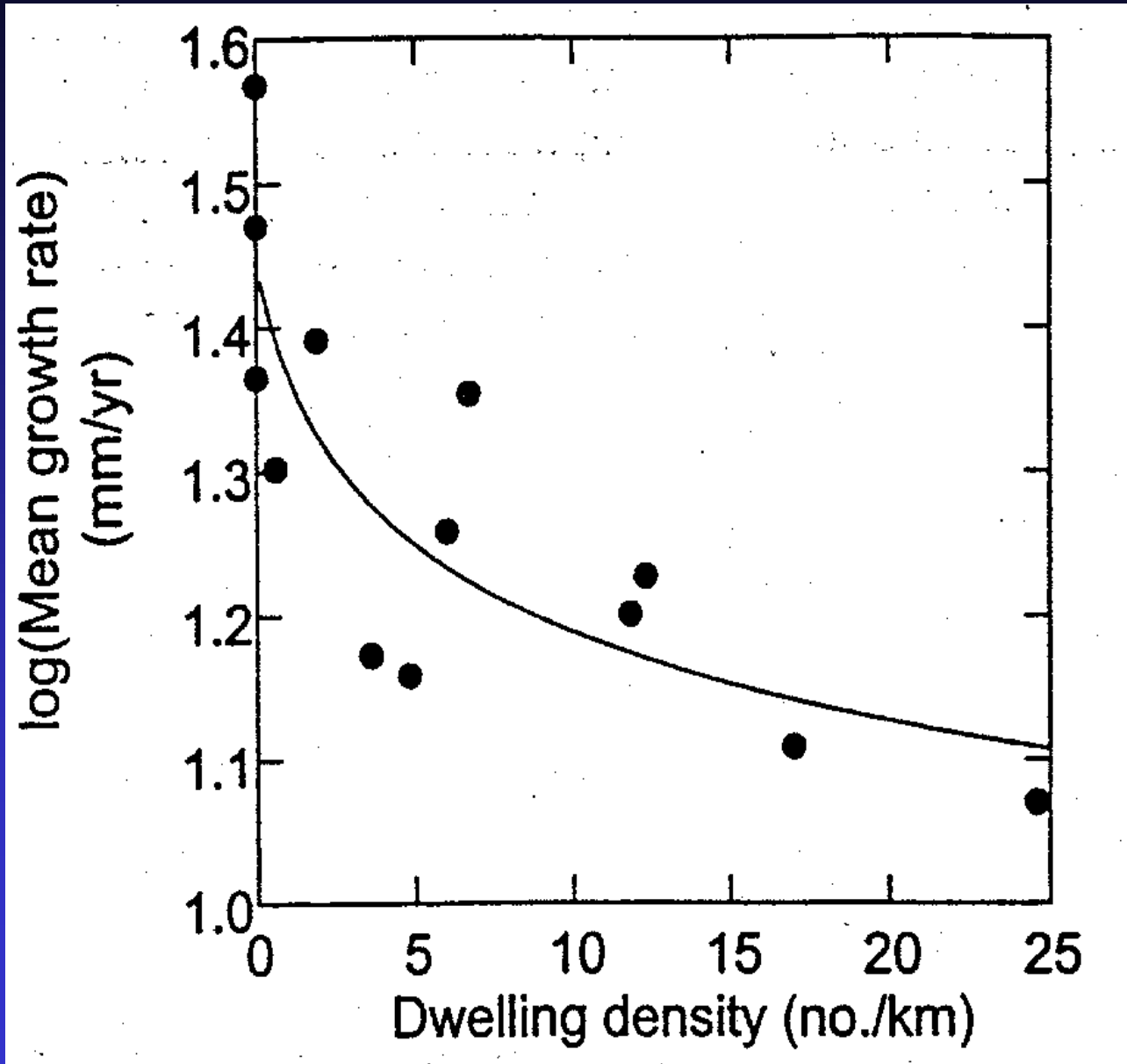


Christensen et al. 1996

$R^2 = 0.7164$

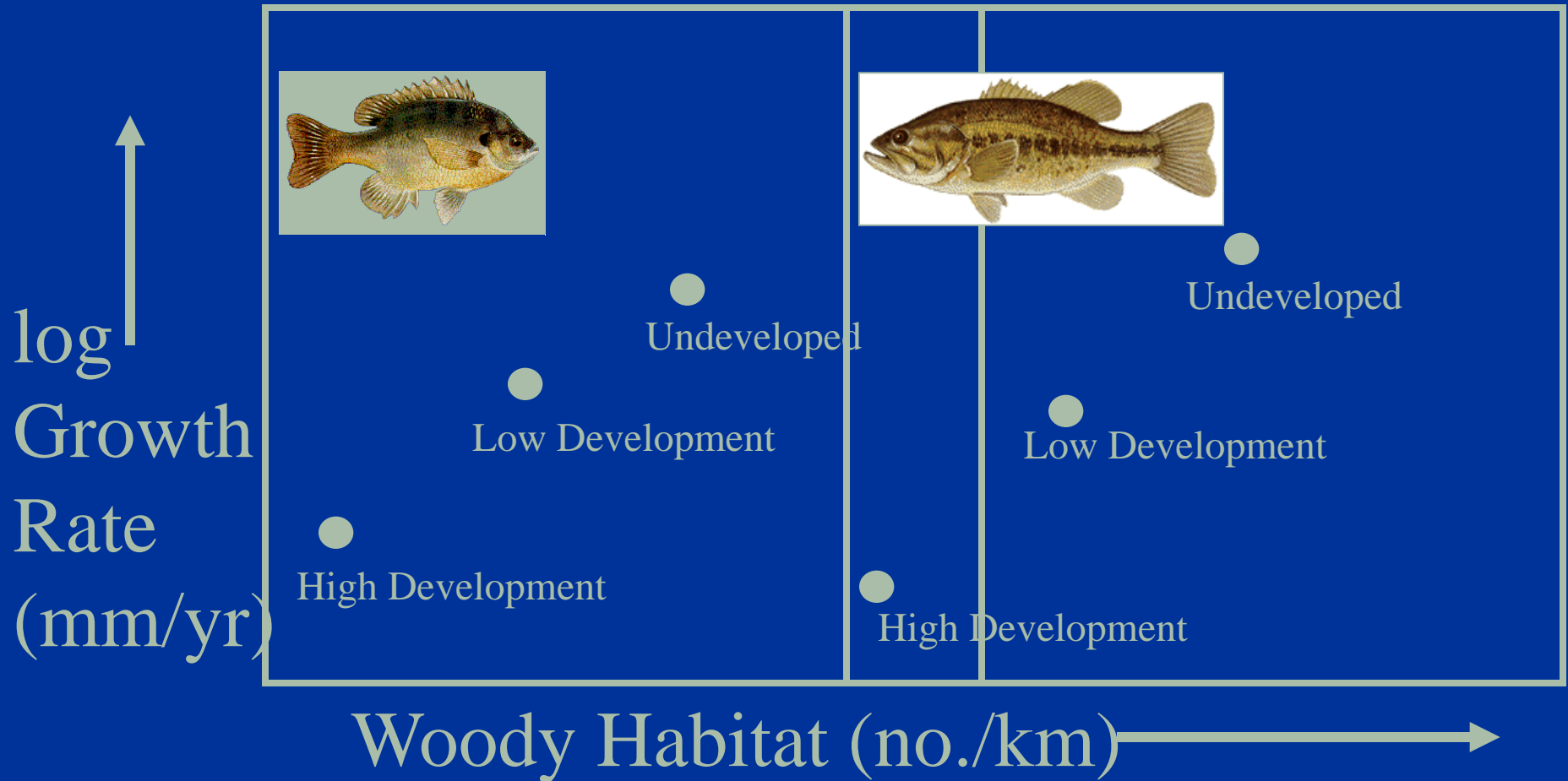


Development Impacts on Bluegill Growth



Schindler
et al. 2000

Fish grow ~3X faster in lakes with lots of woody habitat



From Schindler et al. 2000

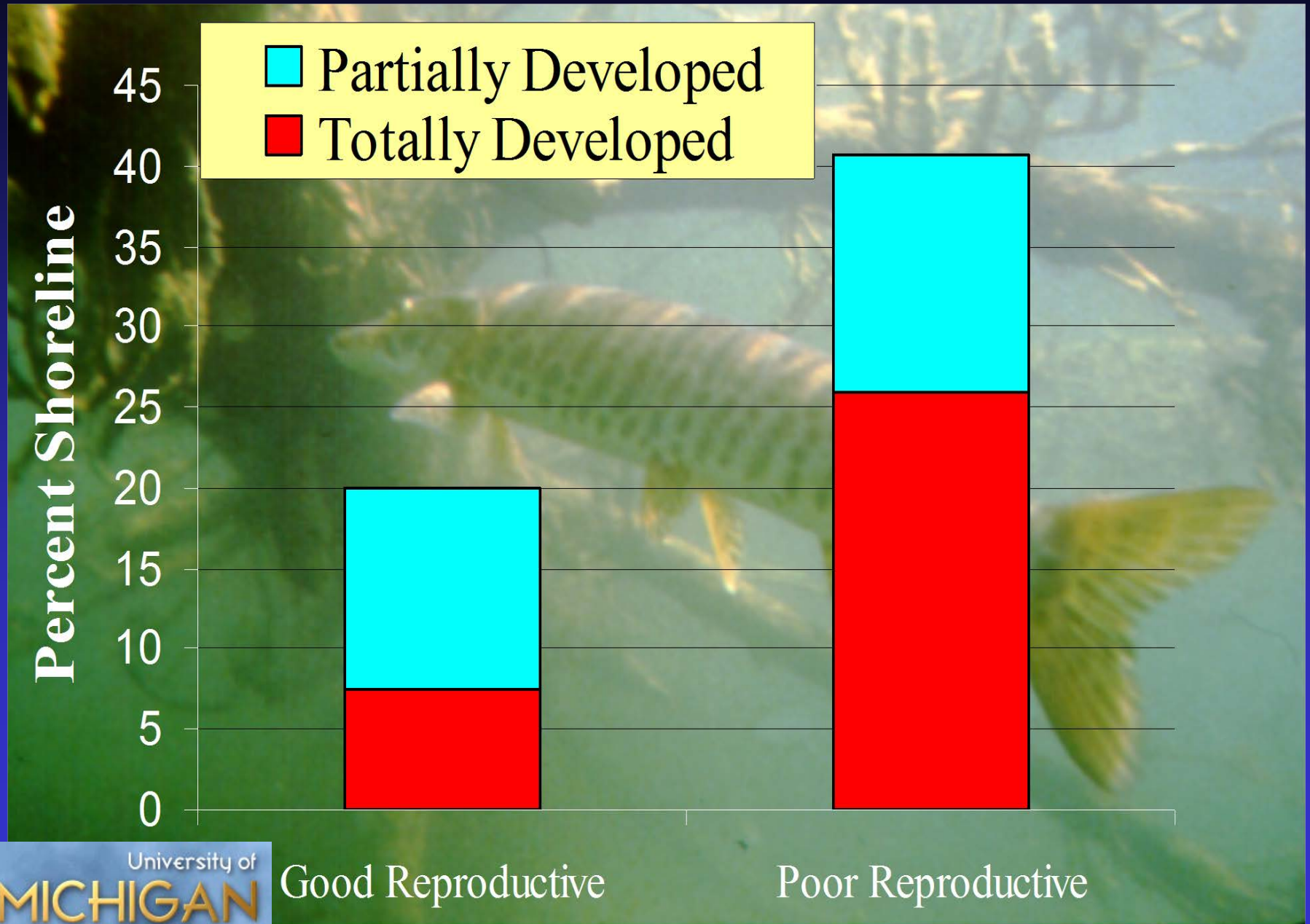
Lake Characteristics Influencing Spawning Success of Muskellunge



Rust et al.,

University of
MICHIGAN

Lake Characteristics Influencing Muskellunge Reproduction



Habitat Changes With Lakeshore Development

Shrub layer at lake-forest edge

Bank cover

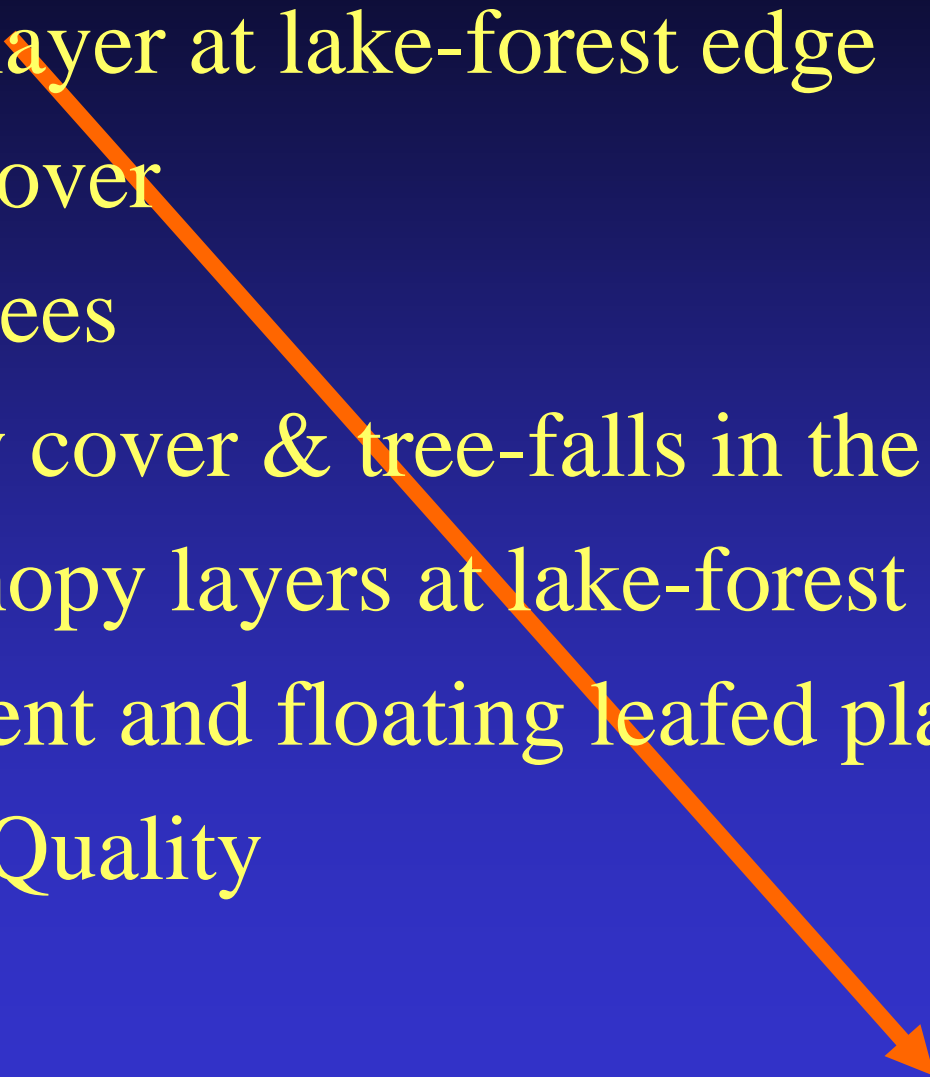
Snag trees

Woody cover & tree-falls in the nearshore

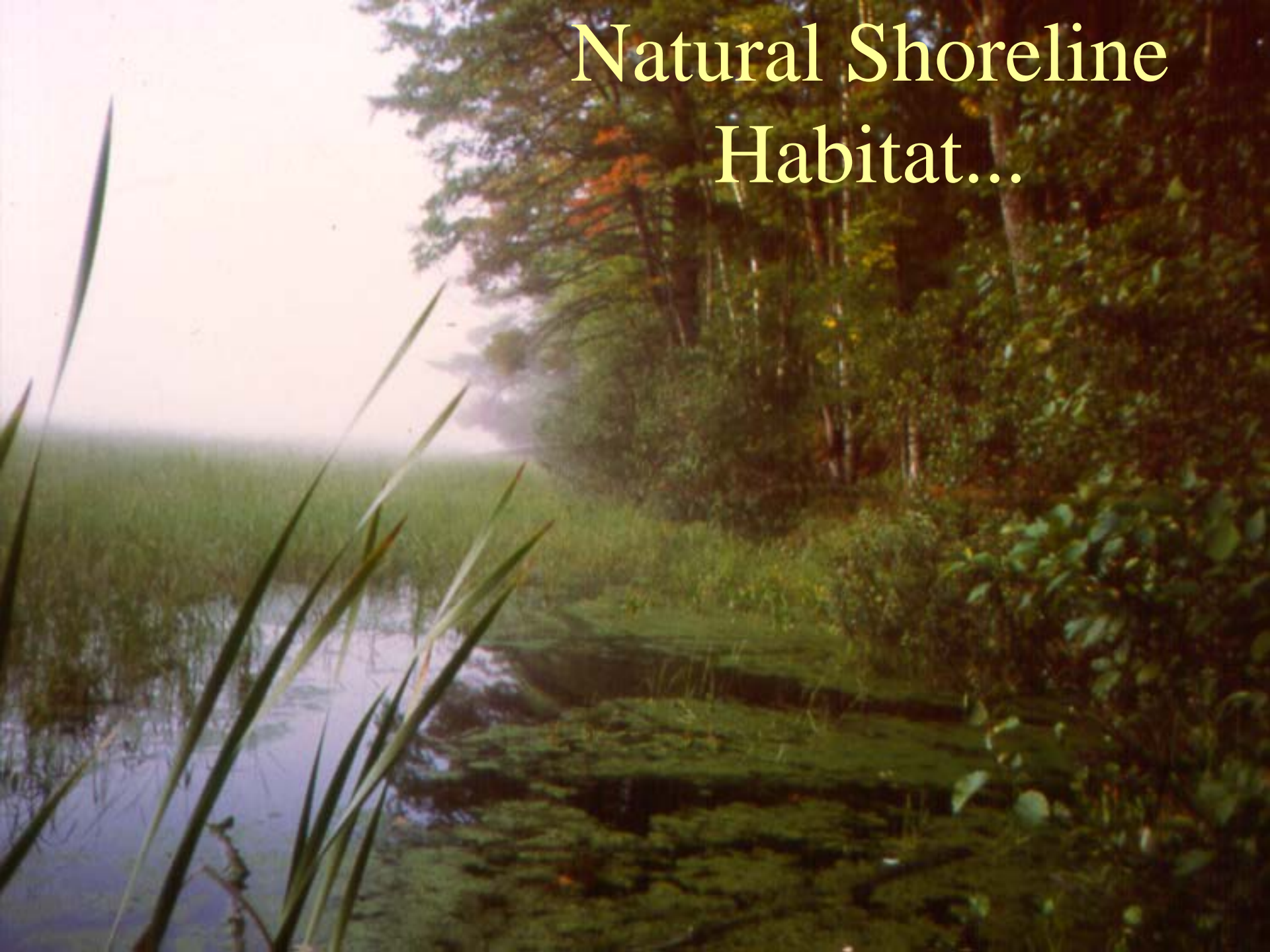
Subcanopy layers at lake-forest edge

Emergent and floating leafed plants

Water Quality



Natural Shoreline Habitat...





Going, ...



Going, ...



Going, ...

Gone.....



Well it Doesn't Have
to Be That Way!

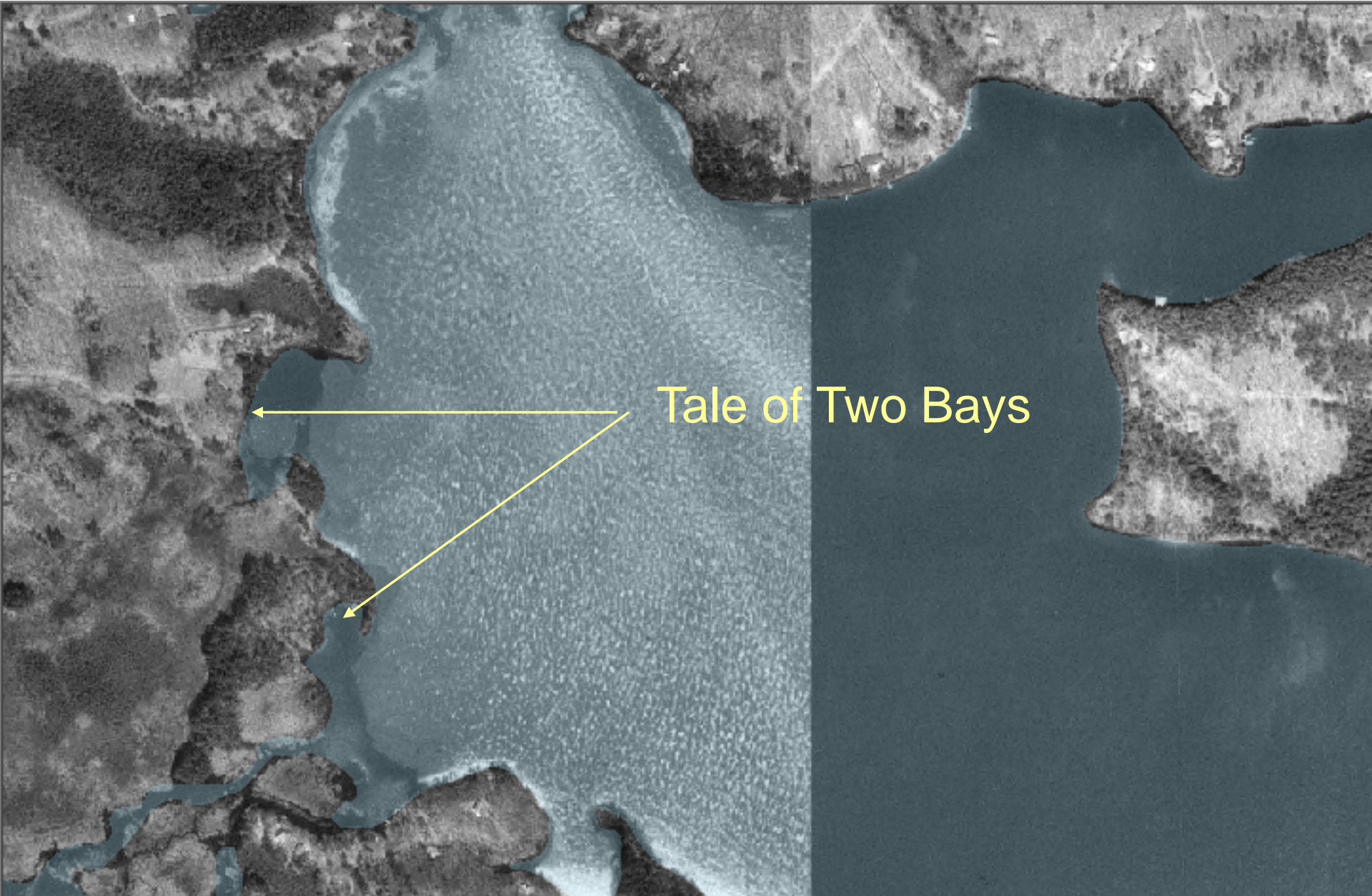






The Remedies seem obvious and the stakes are great

Lake Tomahawk, Oneida County



Tale of Two Bays

Break
Time!

