

# Ecology of Shallow Lakes

**A Primer**

**Management Tools for Rehabilitation**

**Mason Lake Health Check-up**

# Shallow Lakes



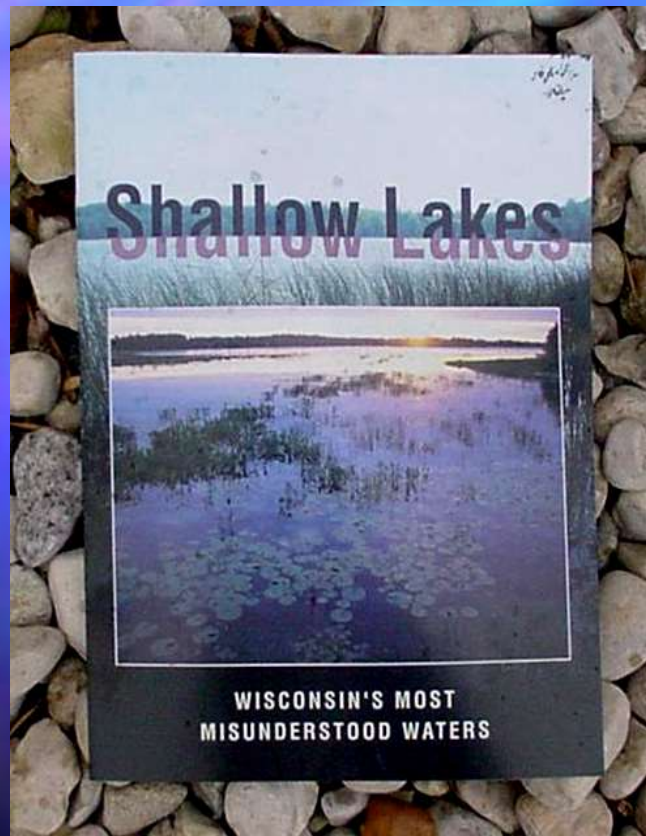
WISCONSIN'S MOST  
MISUNDERSTOOD WATERS

# SHALLOW LAKES



HOPE FOR MINNESOTA'S TROUBLED WATERS

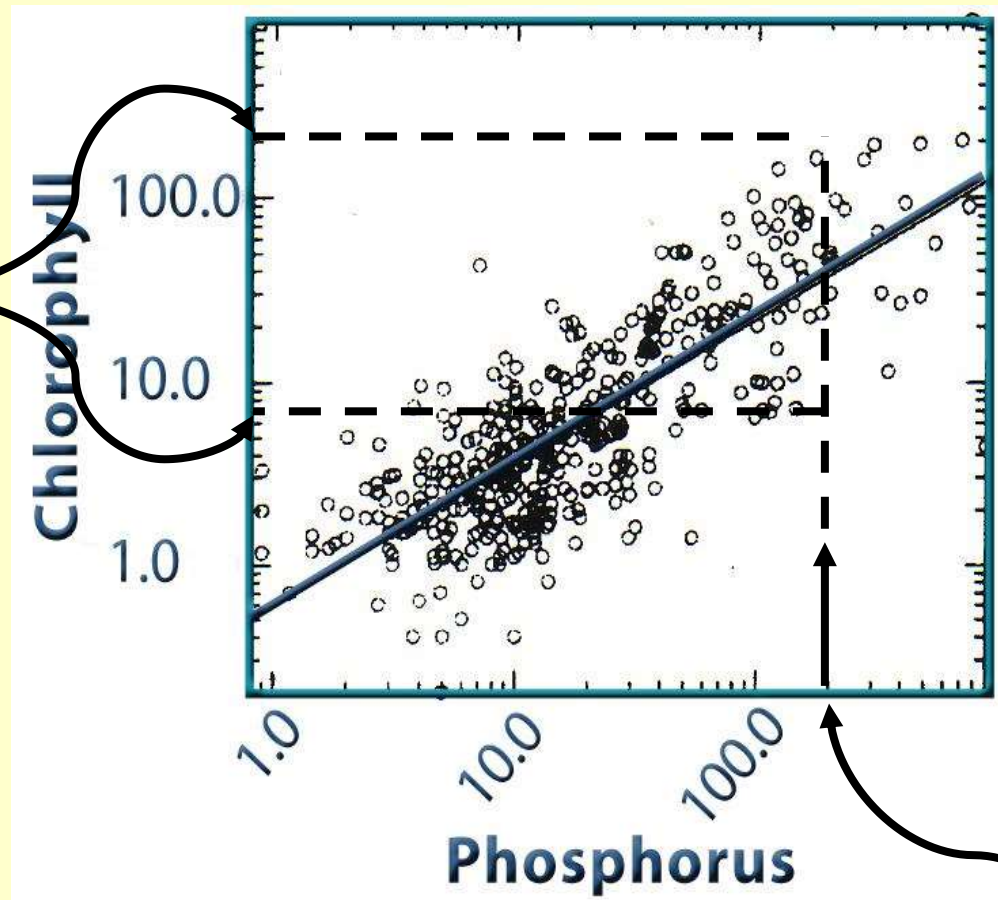
# SHALLOW LAKE



- ✓ **> 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**

# Good Resource Management is Driven by Sound Science and Data.

Chlorophyll varies between ~ 10 and 220 ug/l



High inter-lake variability in Chlorophyll at a given concentration of TP

For TP=200 ug/l



Photo Courtesy of MNDNR

# Catastrophic Regime Shifts

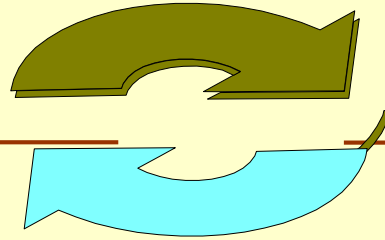
- **Kelp Forests**
- **Drylands**
- **Coral Reefs**
- **Shallow Lakes**



# Stable States in Shallow Lakes

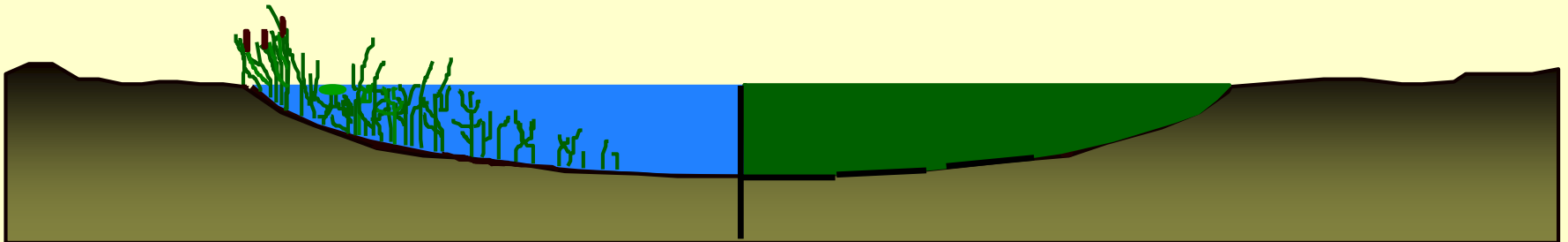
## Clear State

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



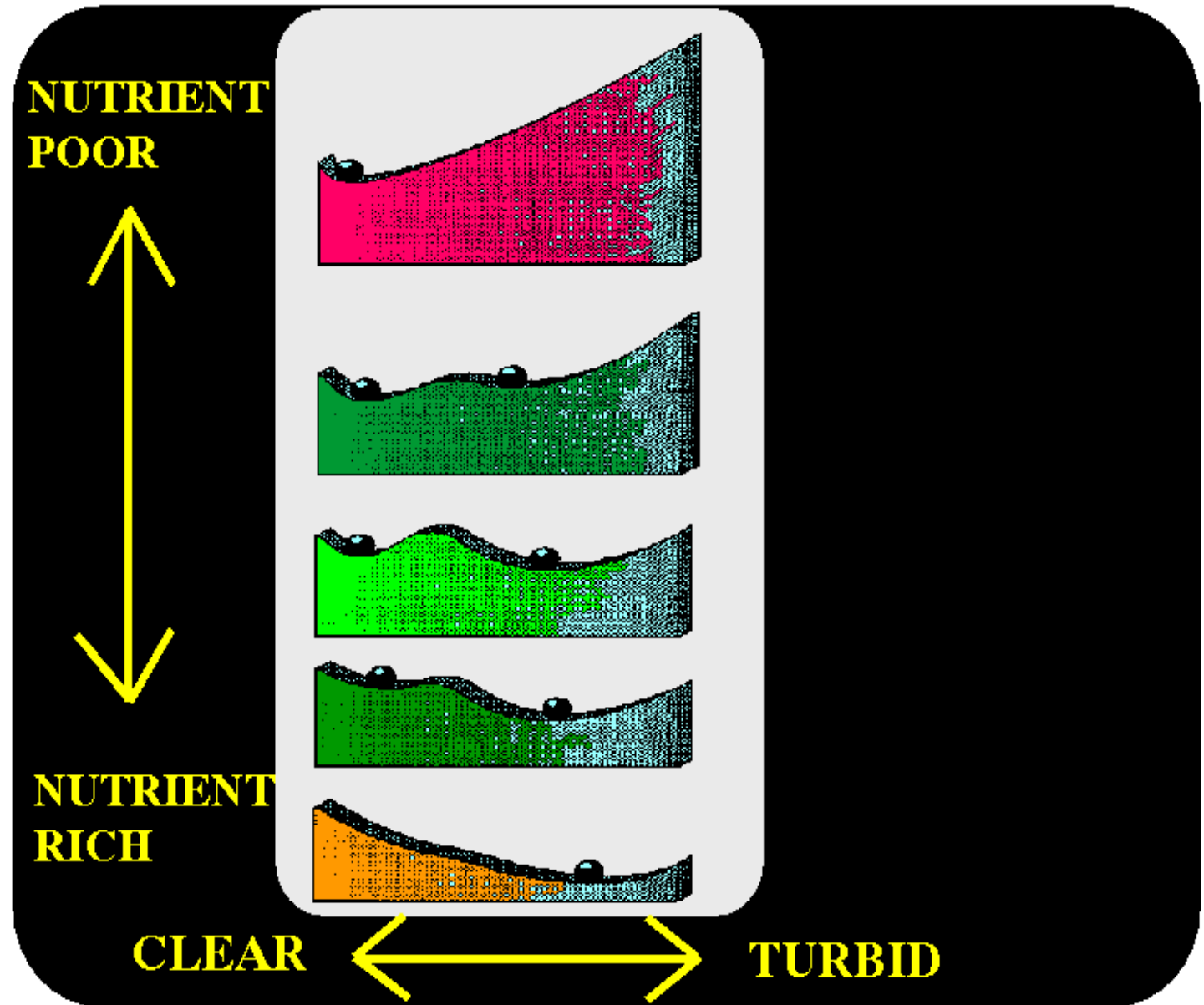
## Turbid State

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



# Shallow Lake Ecology

(From Scheffer et al. 1993)

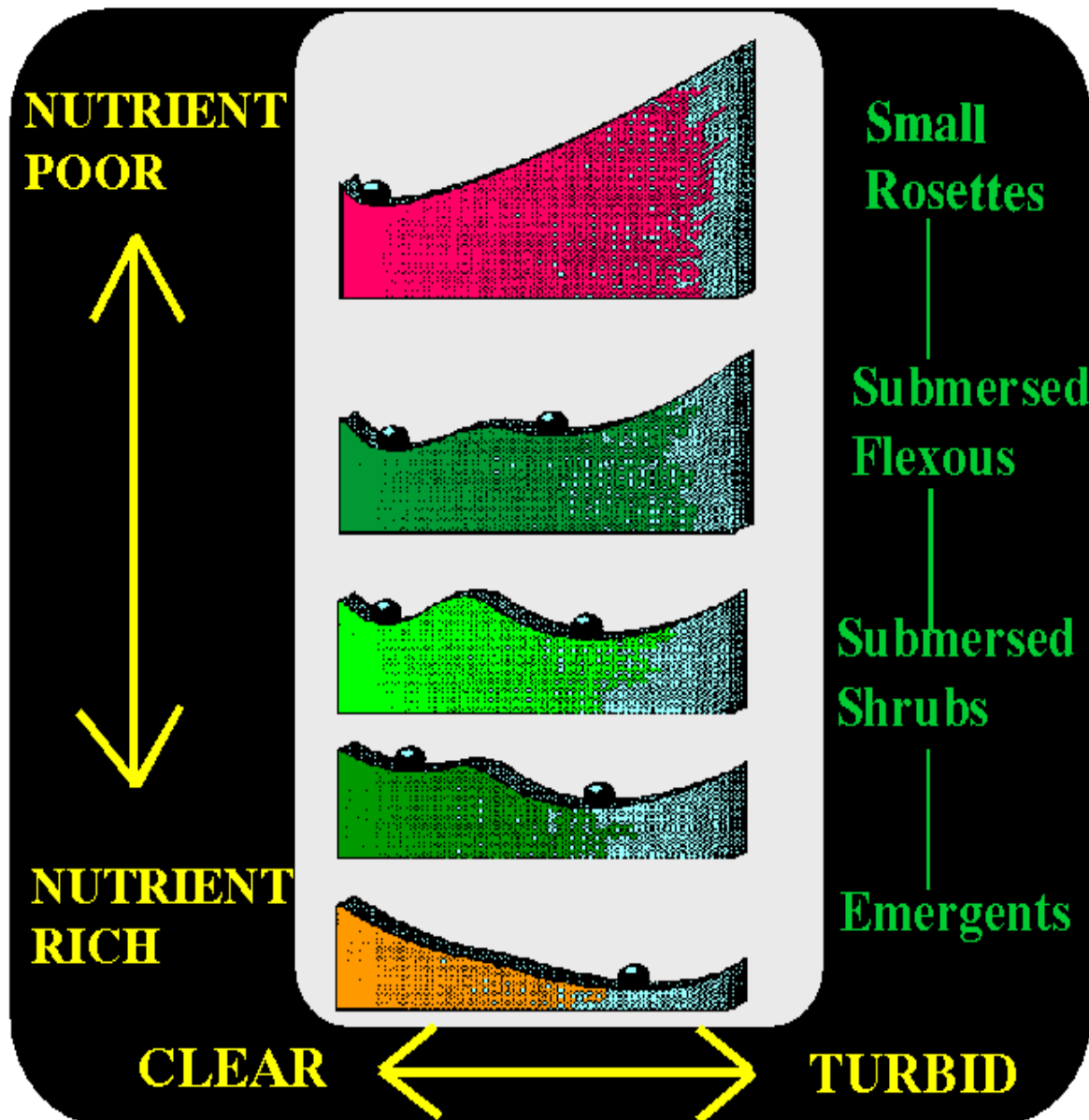




# Shallow Lake Ecology

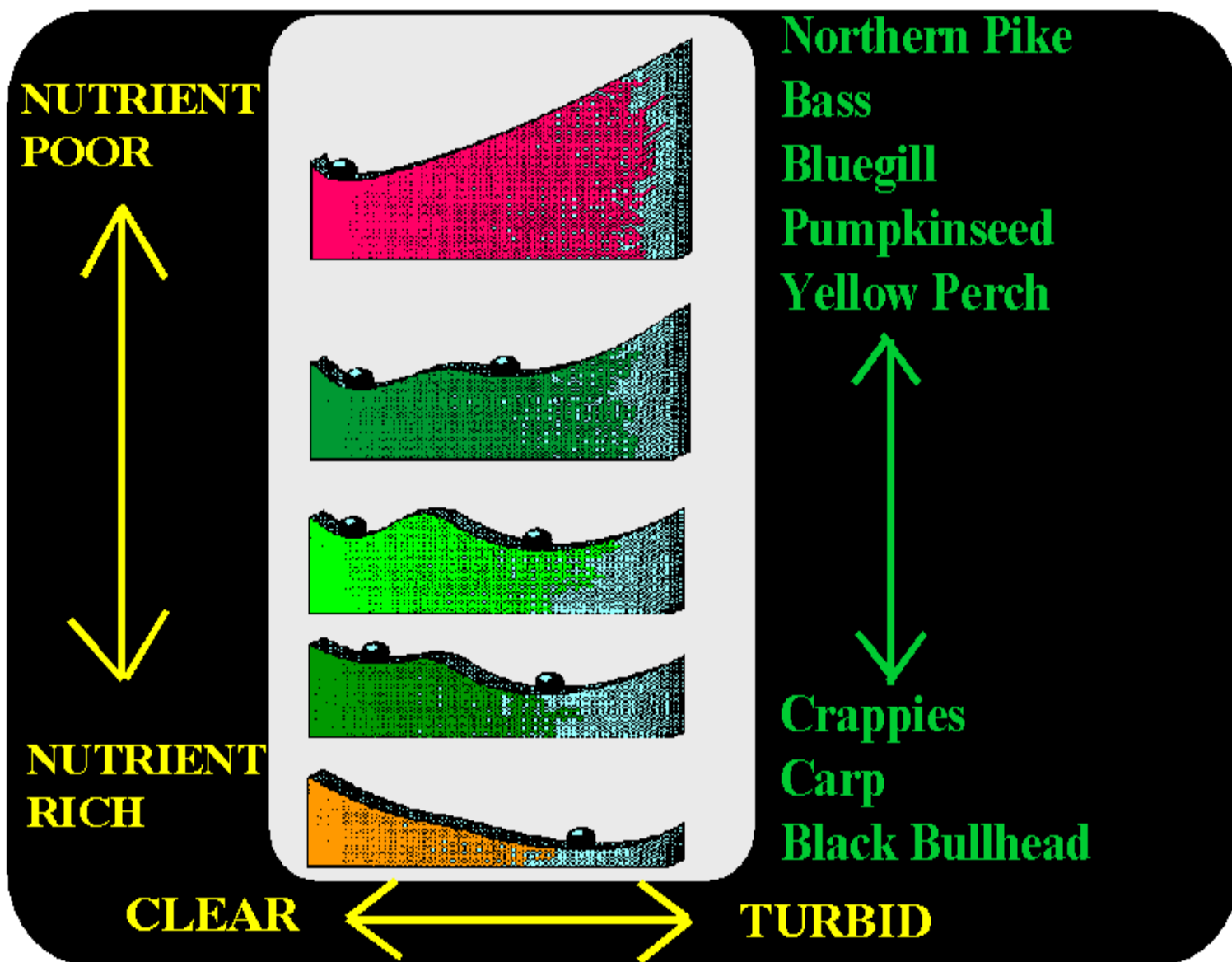
(From Scheffer et al. 1993)

## Plants

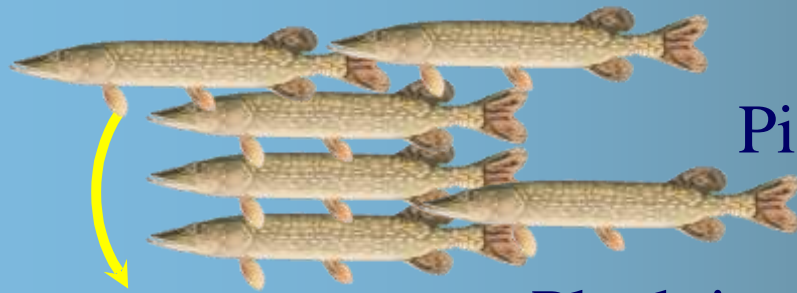


# Shallow Lake Ecology

(From Scheffer et al. 1993)



# Clear-water State



Piscivores



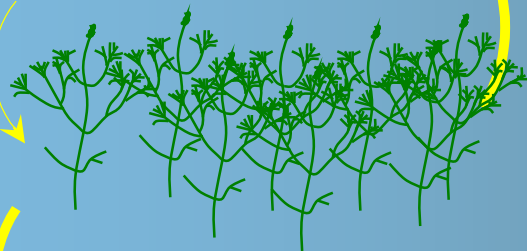
Planktivores/Benthivores



Zooplankton  
grazing



Algae  
biomass

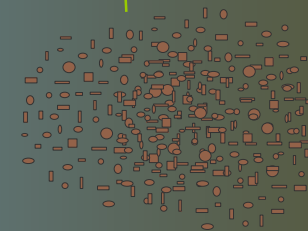
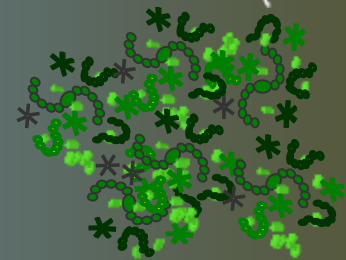


Aquatic plant  
biomass



Sediment  
Resuspension

# Turbid-water State

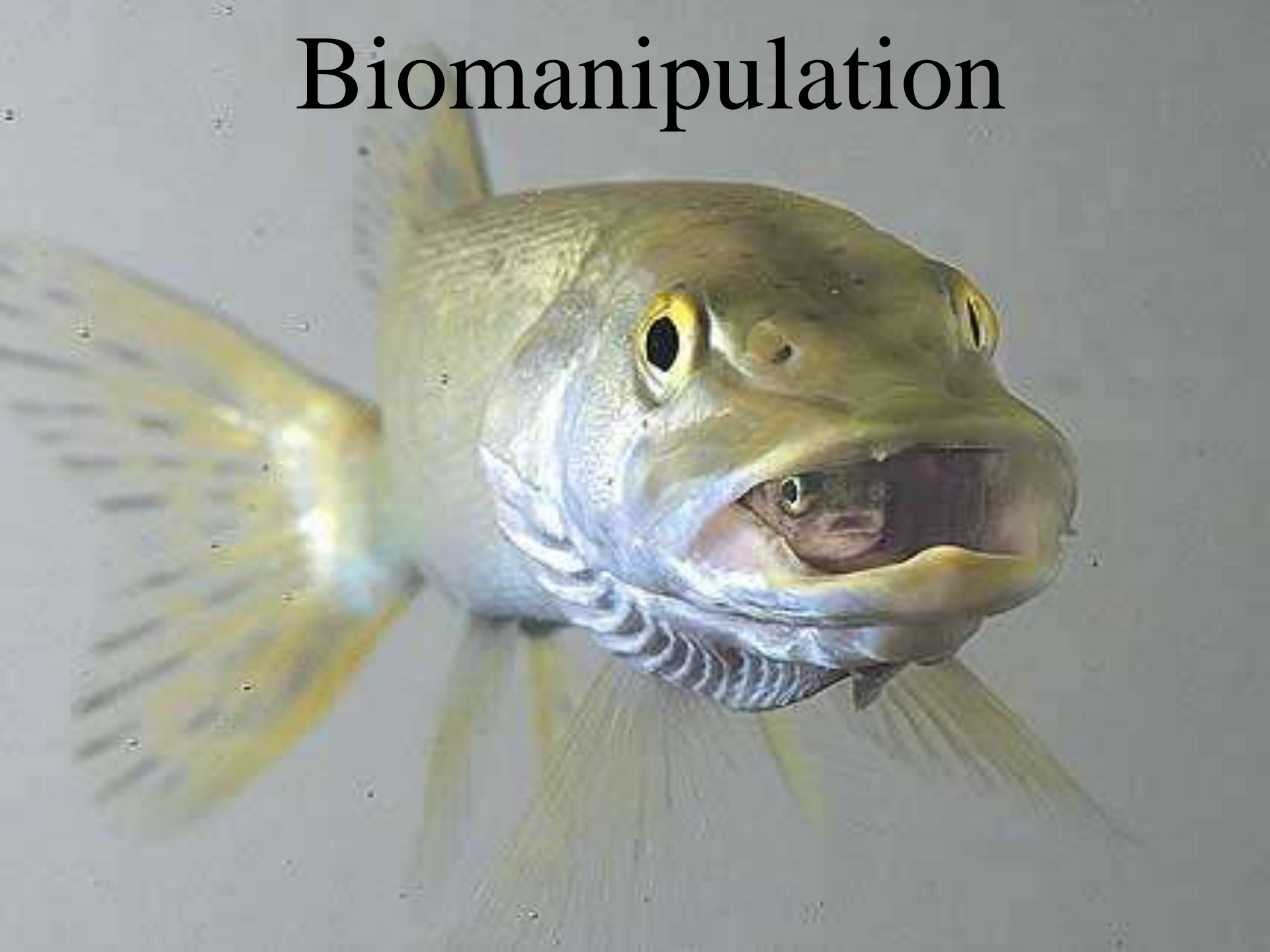




*Cladocerans, or water fleas “vacuum” the algae from lake water. When they are abundant, the water is more clear.*



# Biomanipulation



# Bioturbation

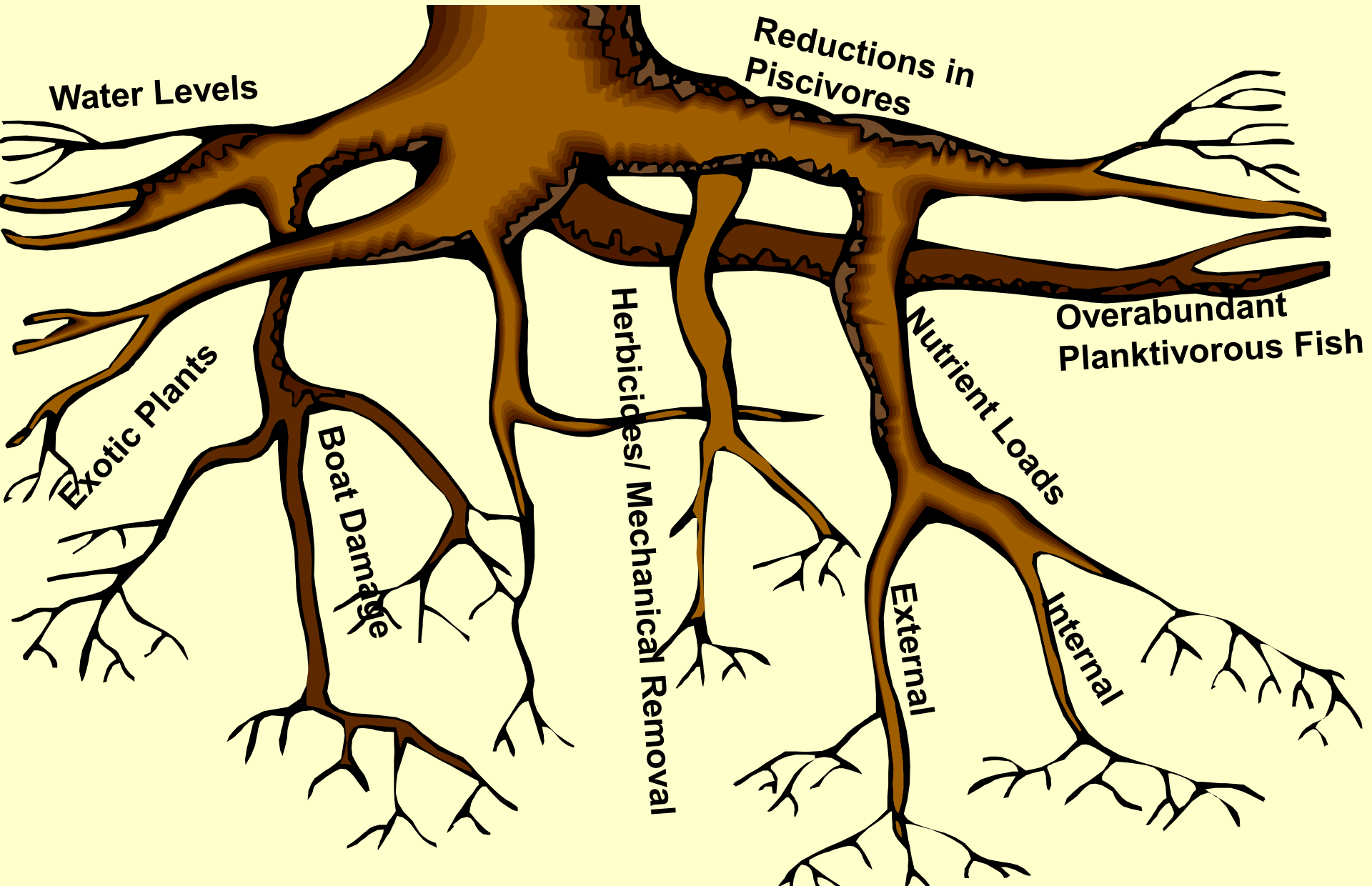




Photo: Mike DeVries, The Capital Times, 5 July 2007

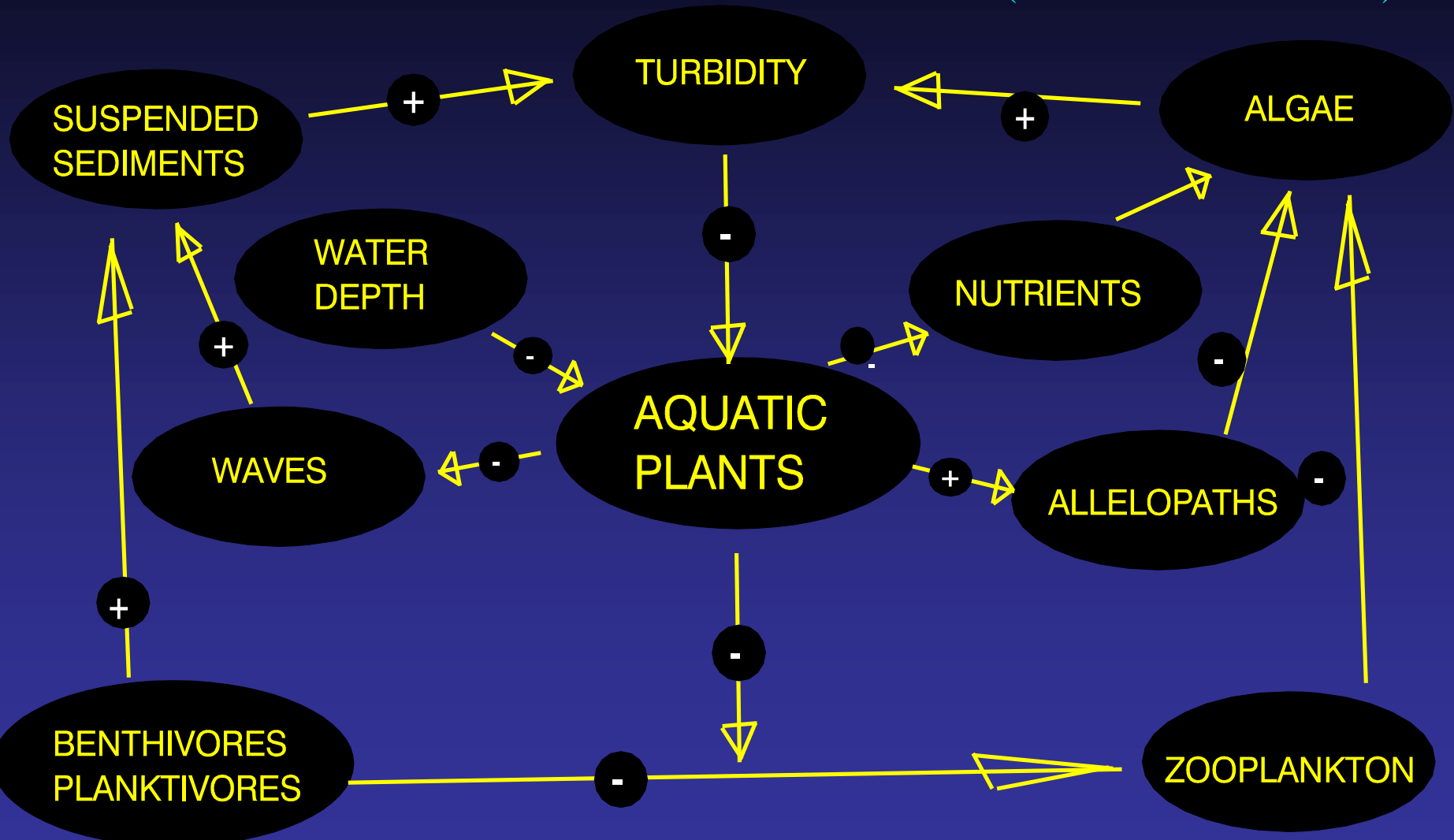


# What is the Root Cause of this Regime Shift?

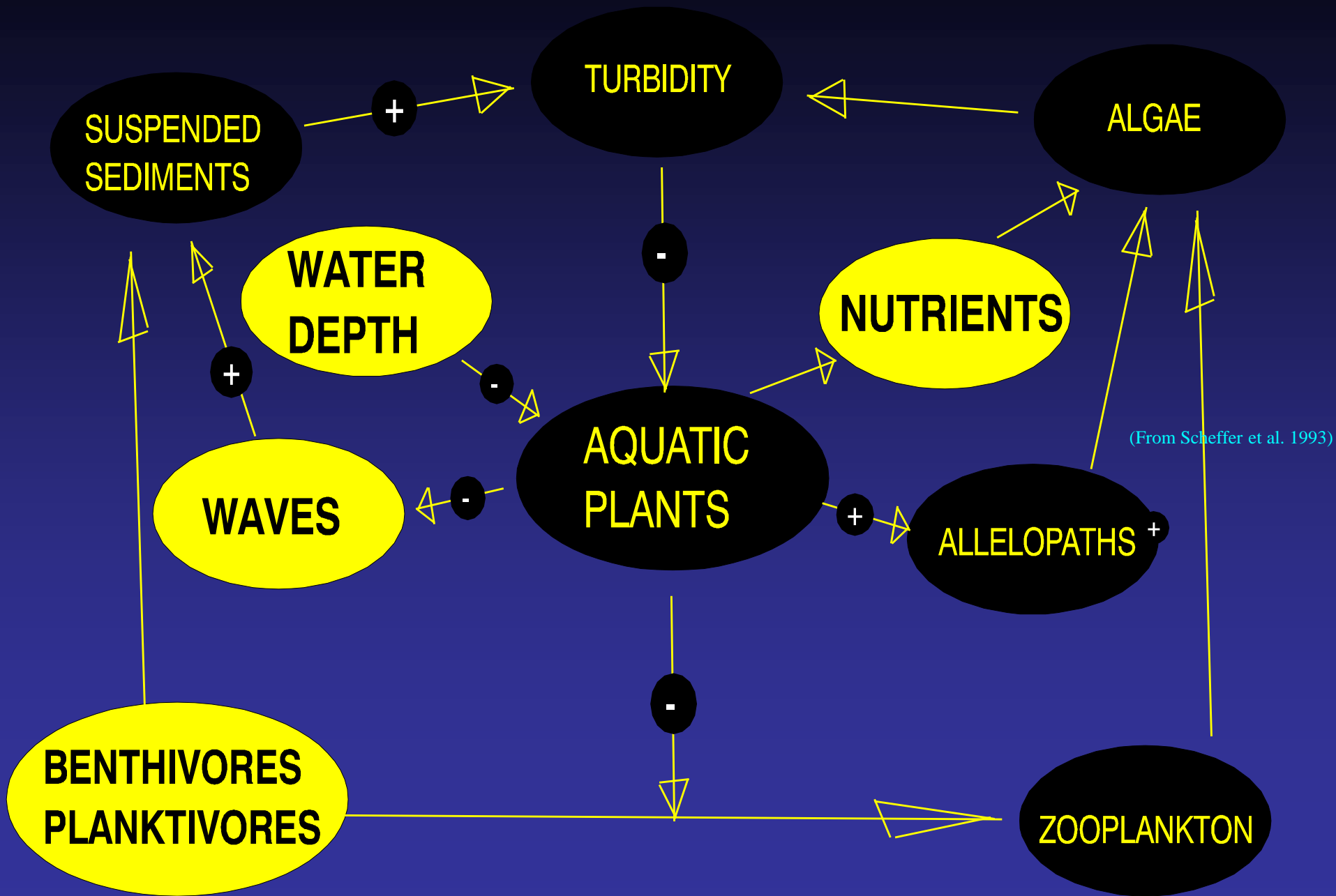


# Shallow Lake Management Tools

(From Scheffer et al. 1993)



# Shallow Lake Management Tools



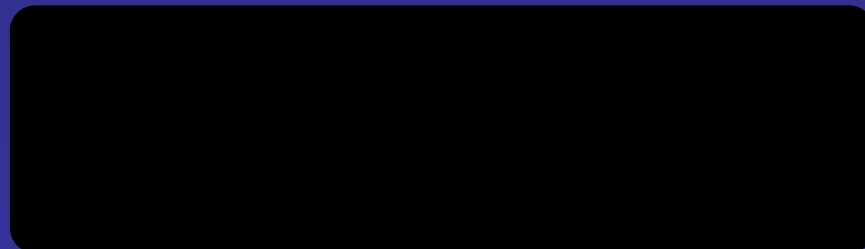
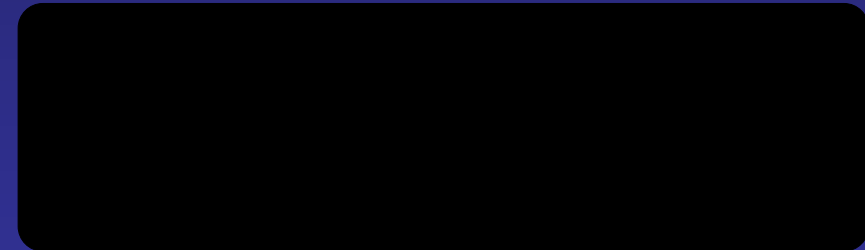
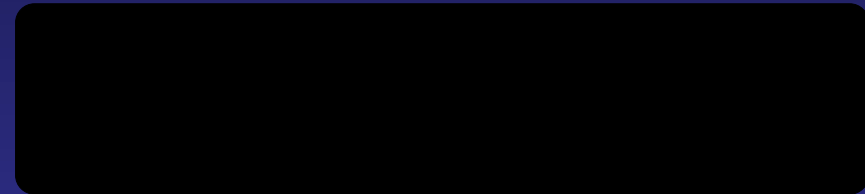
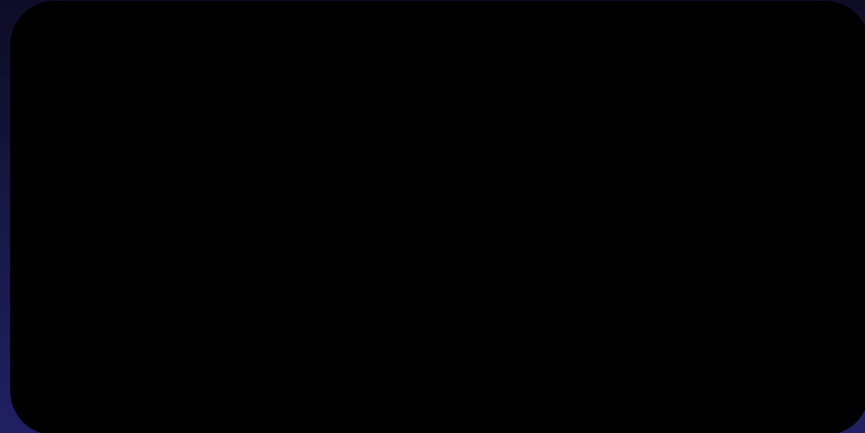
# Management Tools

**BENTHIVORES  
PLANKTIVORES**

**WATER  
DEPTH**

**WAVES**

**NUTRIENTS**

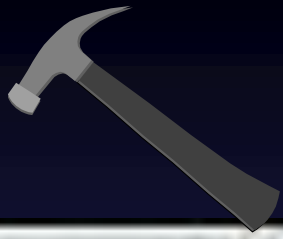


# Management Tools

**BENTHIVORES  
PLANKTIVORES**



**SPOT TREATMENTS  
CHEMICAL RECLAMATION  
COMMERCIAL HARVEST  
STOCK PISCIVORES  
PROTECT PISCIVORES  
FISH BARRIERS  
AERATION**



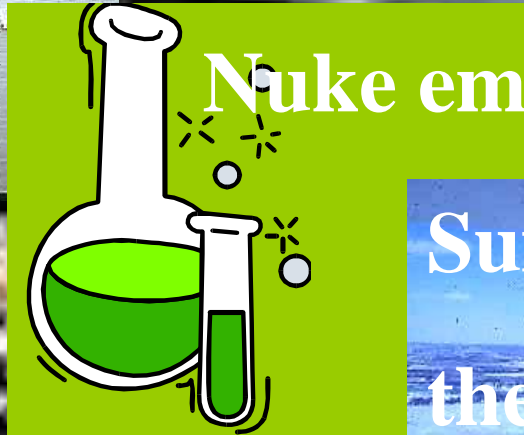
# Hammering Carp



Trap em



Net em



Nuke em



Suffocate  
the  
bastards

# Fry Stocking



# Aeration to Prevent Winterkill

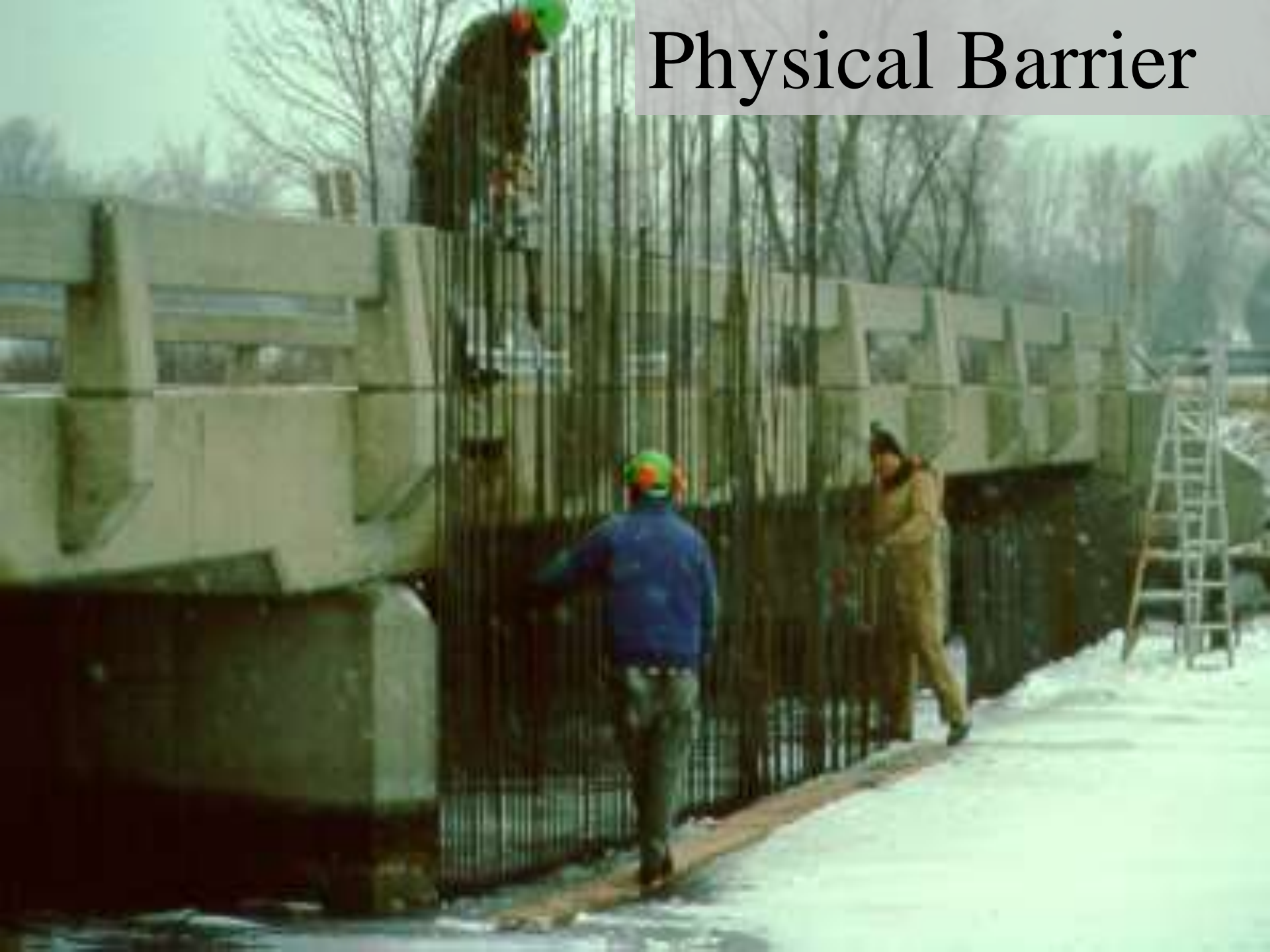




# Electrical Barrier



# Physical Barrier



# Management Tools

**BENTHIVORES  
PLANKTIVORES**

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

**WATER  
DEPTH**

**LONG-TERM LEVELS  
DRAWDOWN**

**WAVES**

**NUTRIENTS**

# HIGH WATER LEVELS DESTROY HABITAT

NOW



# Low Water Levels Rejuvenate Wetlands



# 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**

# Permanent Breakwater



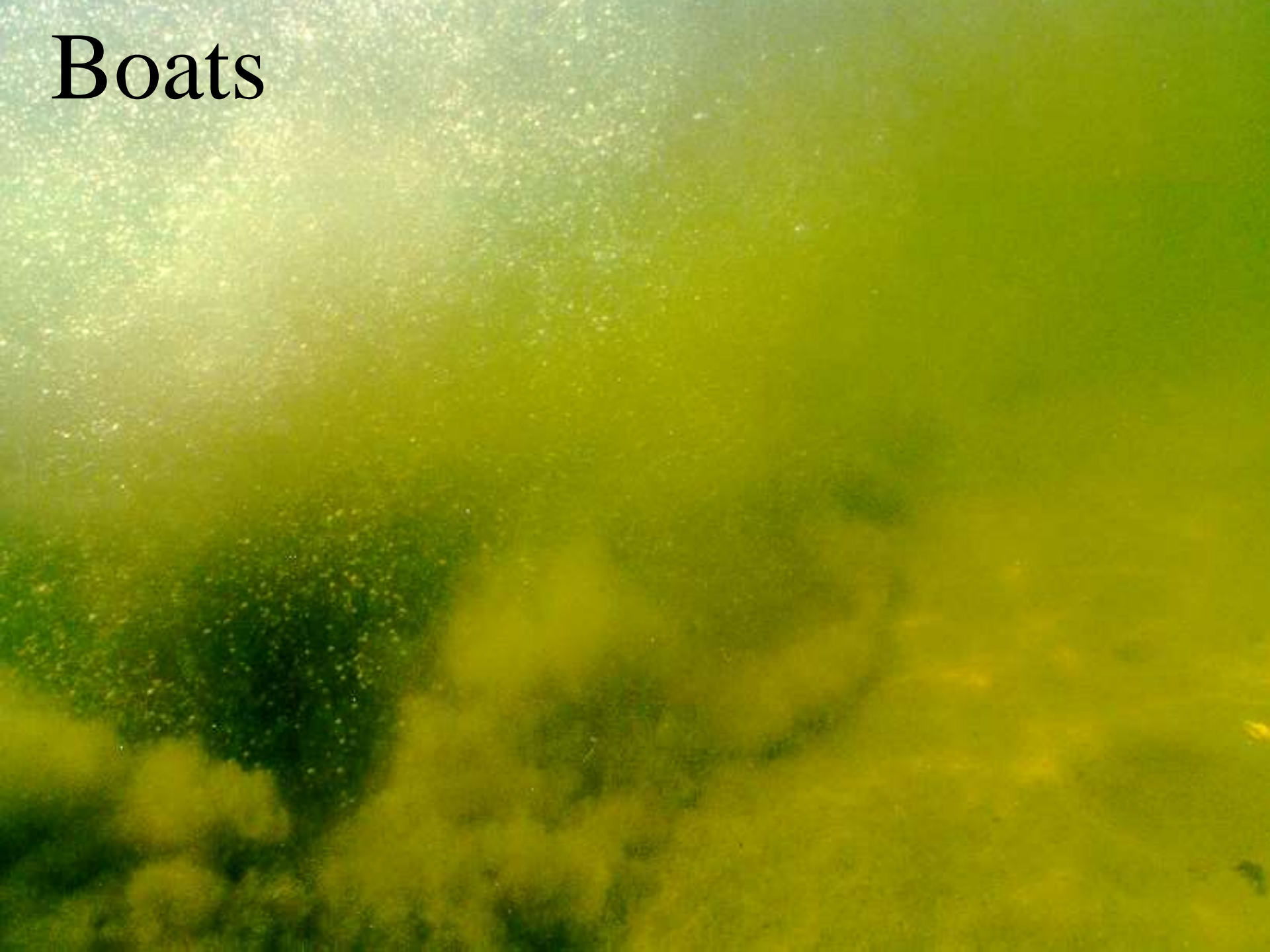




# Boats



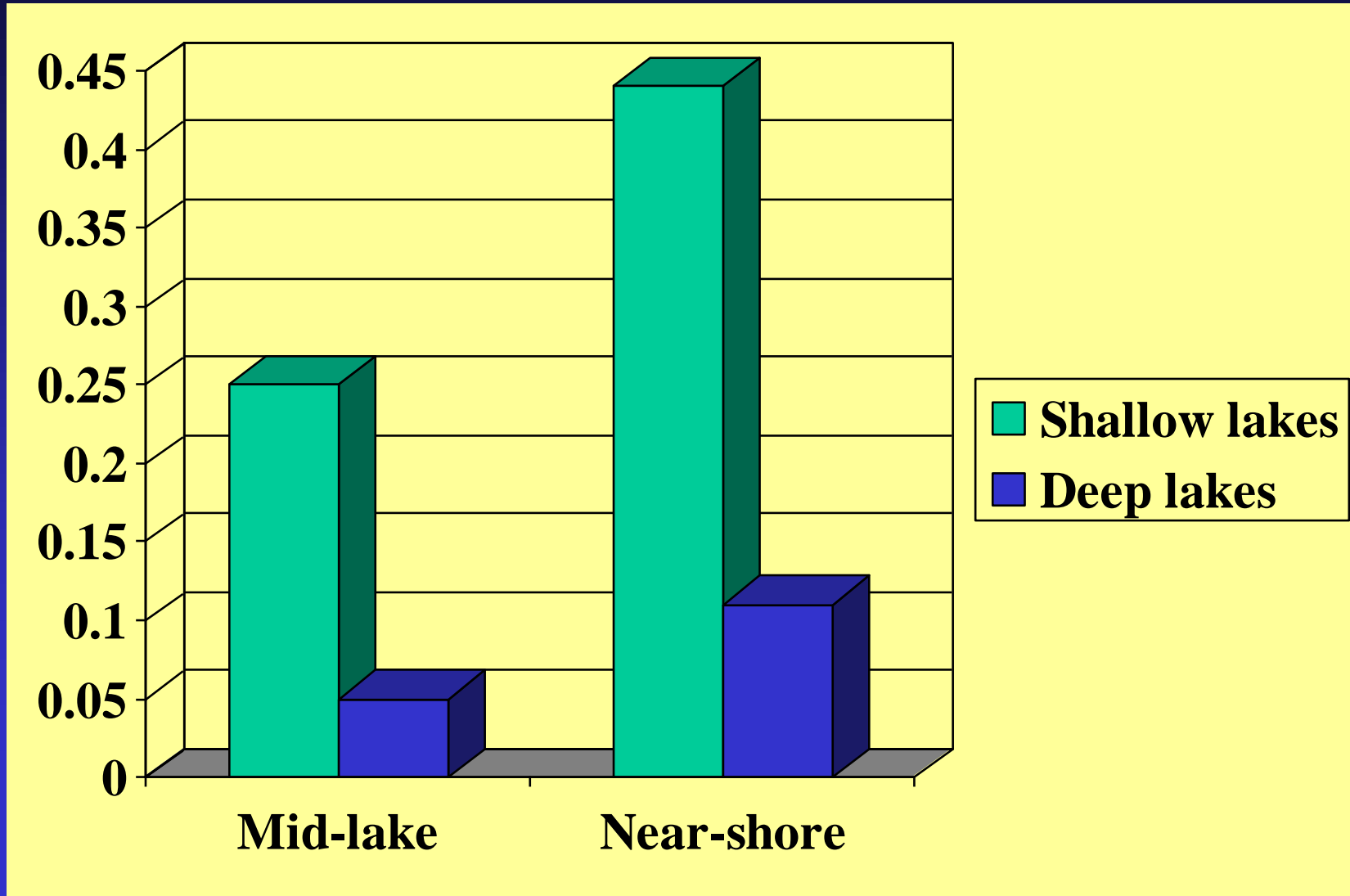
# Boats



# Boating

## Weekday to Weekend Turbidity Change

Turbidity Change (NTU)



# 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**

**EXTERNAL LOADS  
NUTRIENT INACTIVATION**

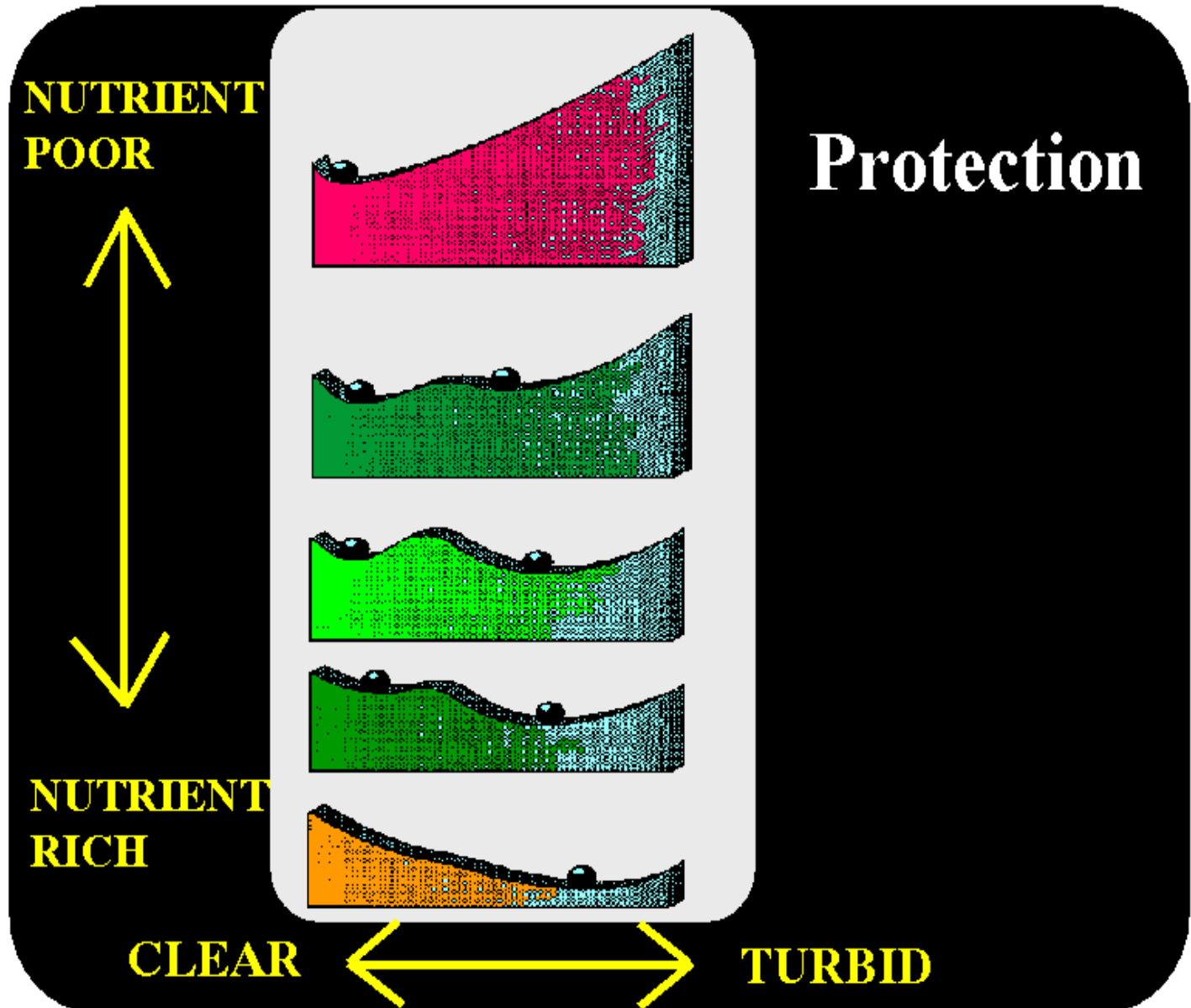
# External Nutrient Loads

BMPs  
Buffers  
Settling basins  
Flow diversion



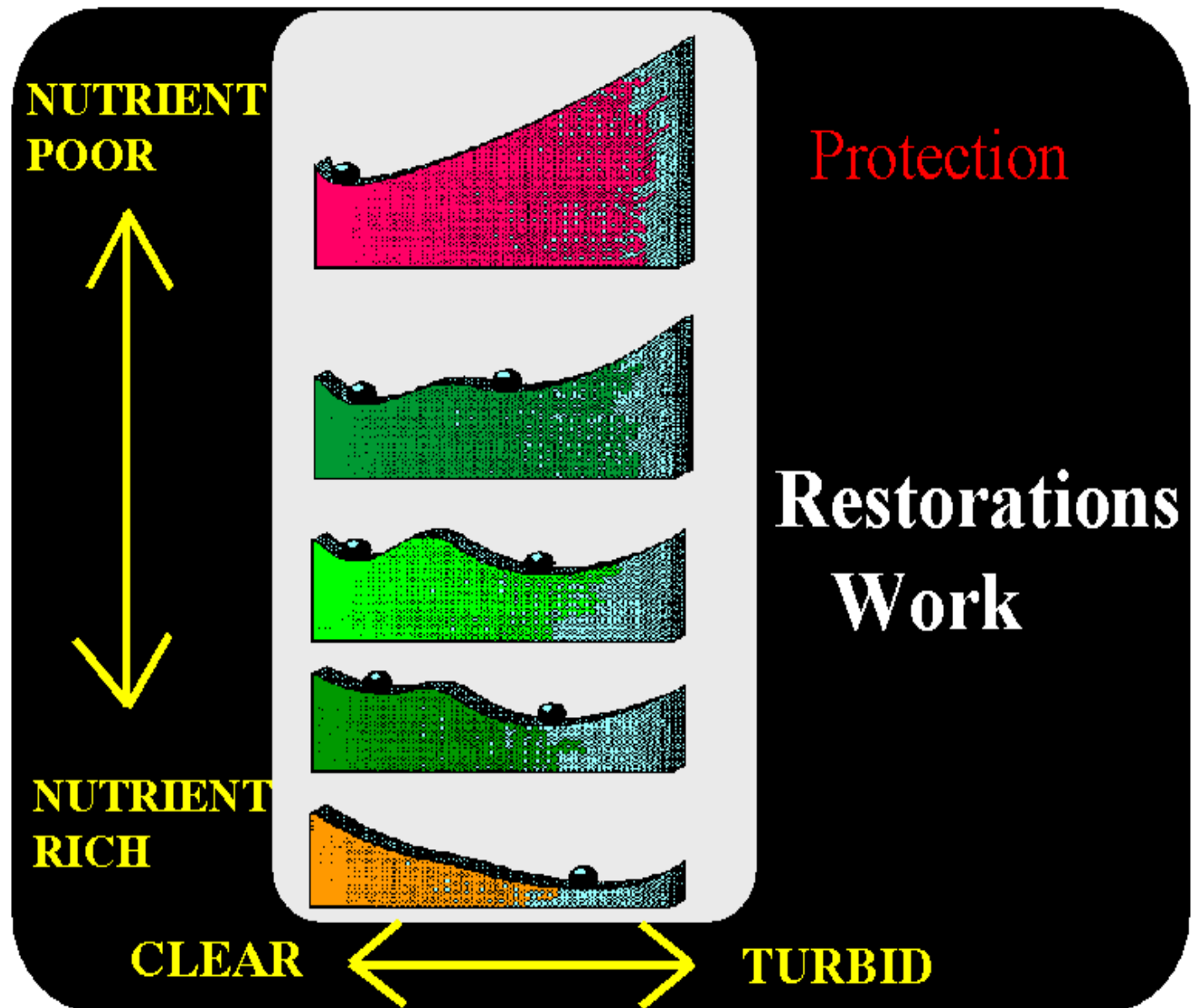
# Shallow Lake Ecology

(From Scheffer et al. 1993)



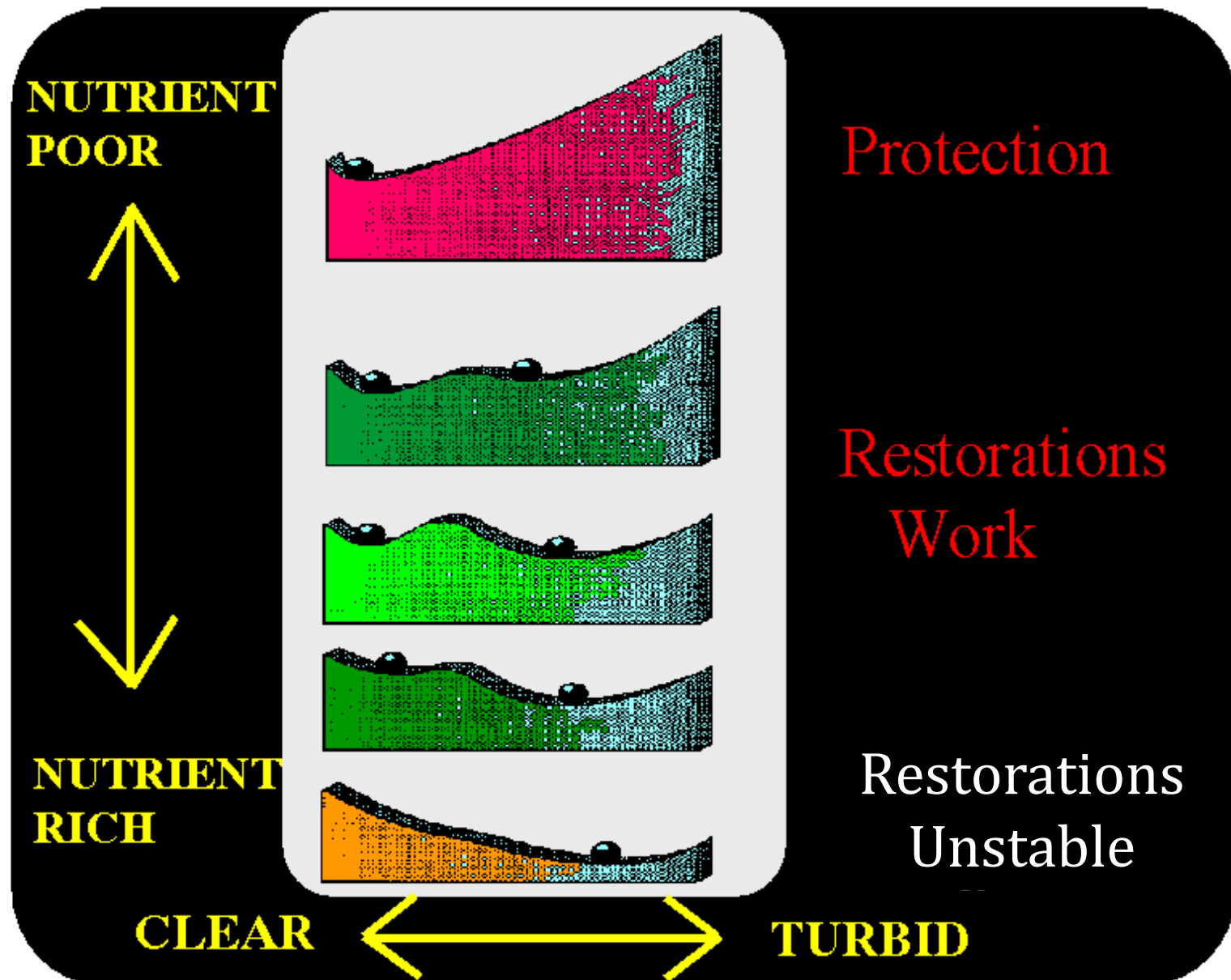
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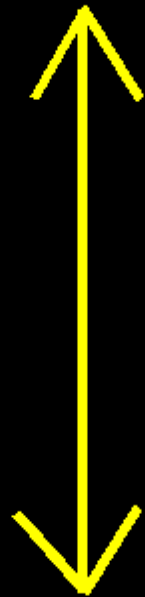




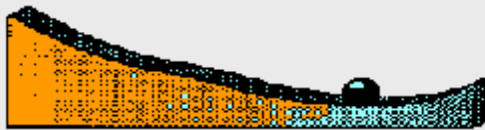
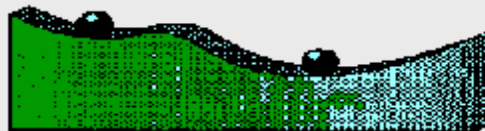
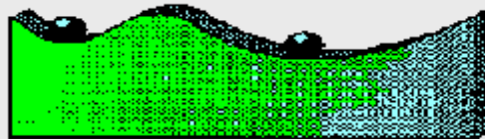
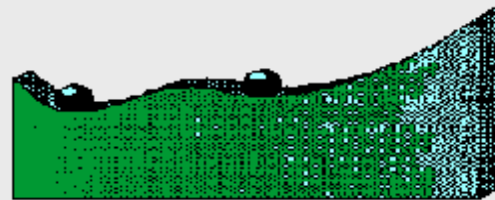
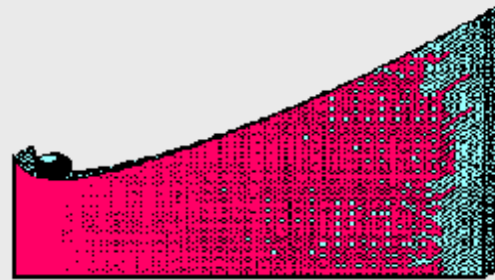
# Shallow Lake Ecology

(From Scheffer et al. 1993)

**NUTRIENT  
POOR**



**NUTRIENT  
RICH**



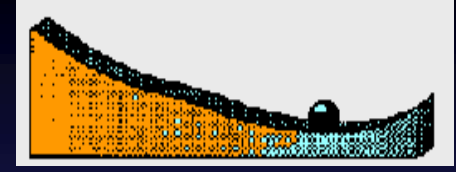
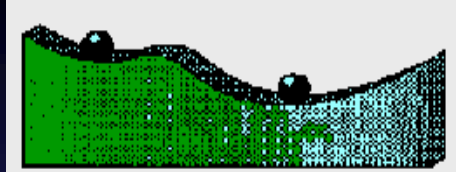
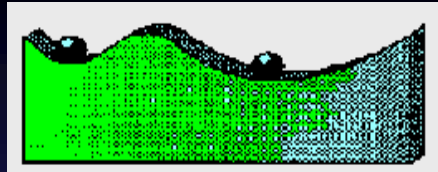
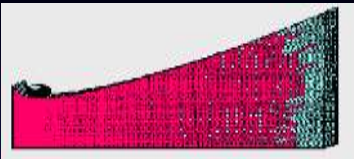
Thunder Lake  
Big Muskego  
Rush Lake  
Lake Puckaway  
Fox Lake  
Beaver Dam Lake  
Sinnissippi Lake  
Lake Koshkonong

**CLEAR**



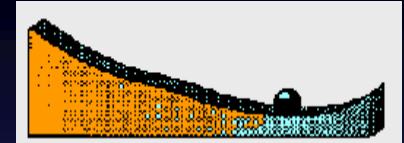
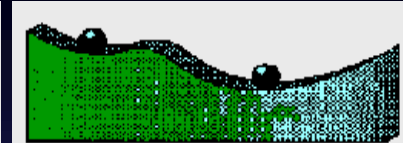
**TURBID**

# Where is Mason Lake at?



# Where is Mason Lake at?

## Attribute



### Ext. Nutrient Load

PRESTO Model 1= 0.30 g/m<sup>2</sup>/yr

PRESTO Model 2= 0.32 g/m<sup>2</sup>/yr

< 1 g/m<sup>2</sup>/yr

1-2 g/m<sup>2</sup>/yr

>2 g/m<sup>2</sup>/yr

### Inlake TP

~100 ug/l

< 100 ug/l

100-250 ug/l

>250 ug/l

### Sediment Resuspension

882 acres, 2.1 mile fetch

< 500 acres

500-5,000 acres

> 5,000 acres

### Hydrologic Connectivity

Big Spring and Pond, Amery  
Pond, Unnamed ditched trib

Muti-basinal isolated  
waterbodies



Direct Connection  
Floodplain/Riverine

### Macrophyte Potential

Max depth= 9 ft.

Mean depth = 7 ft.

>50% surface area



<20% surface area

### Fish Biomass

High (>400 lbs/acre)



Low (<100 lbs/acre)

### Fish Community

High Abundance  
Benthivores/Planktivores



Low Abundance  
Benthivores/Planktivores