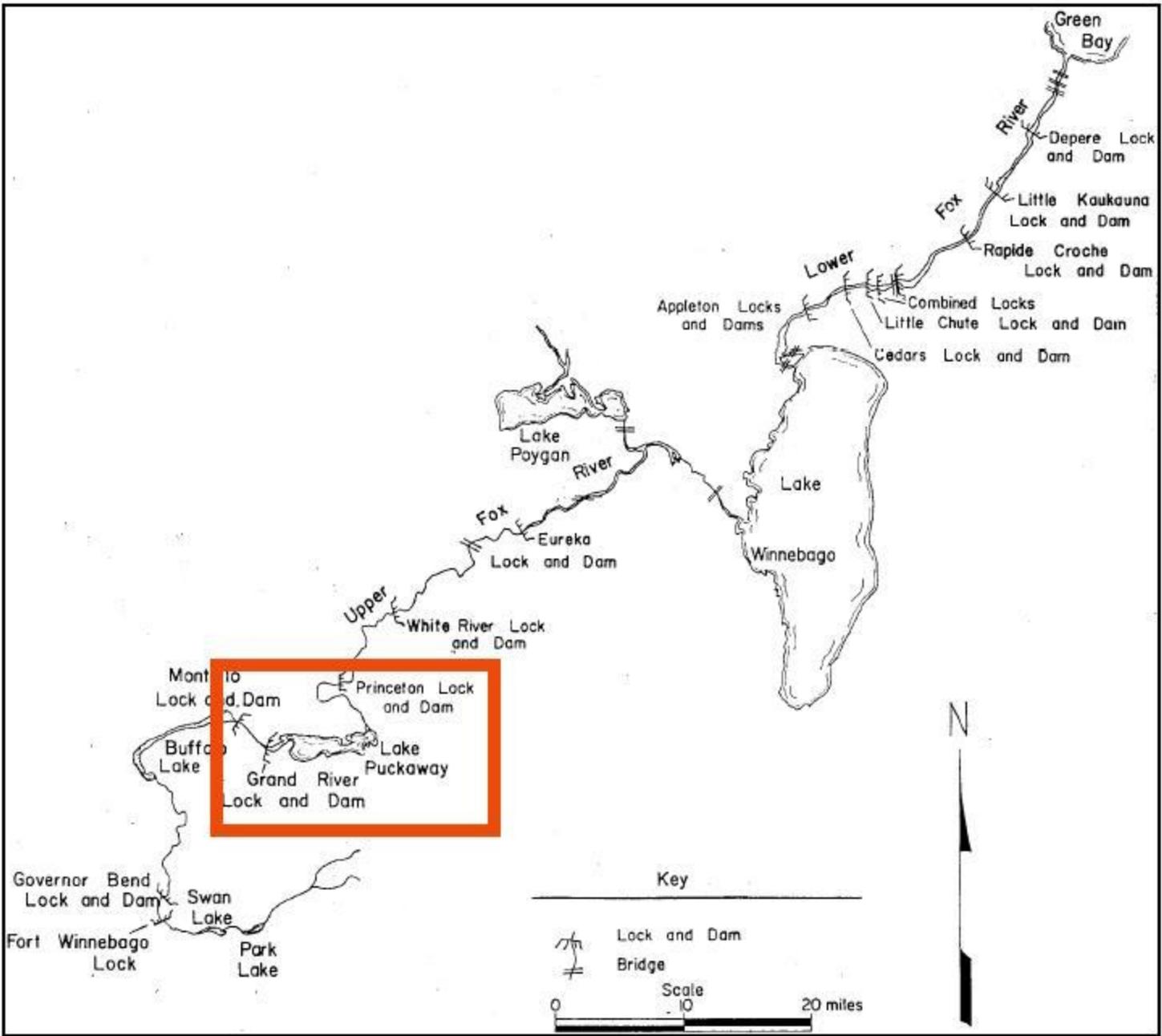
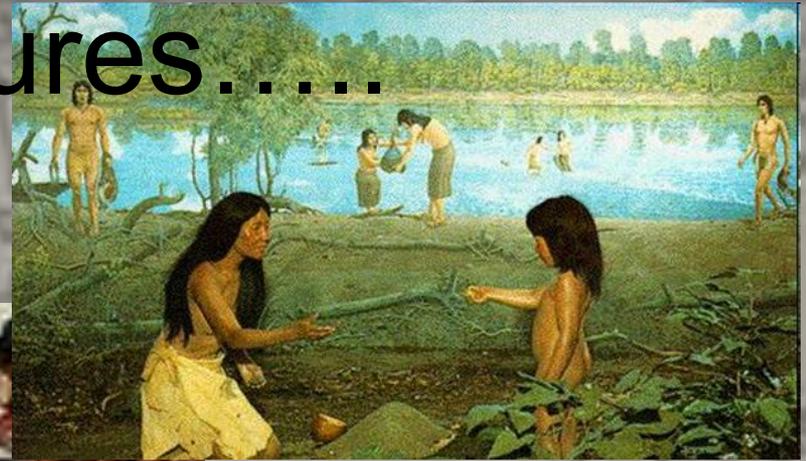


Lake Puckaway's
Vanishing Act.....



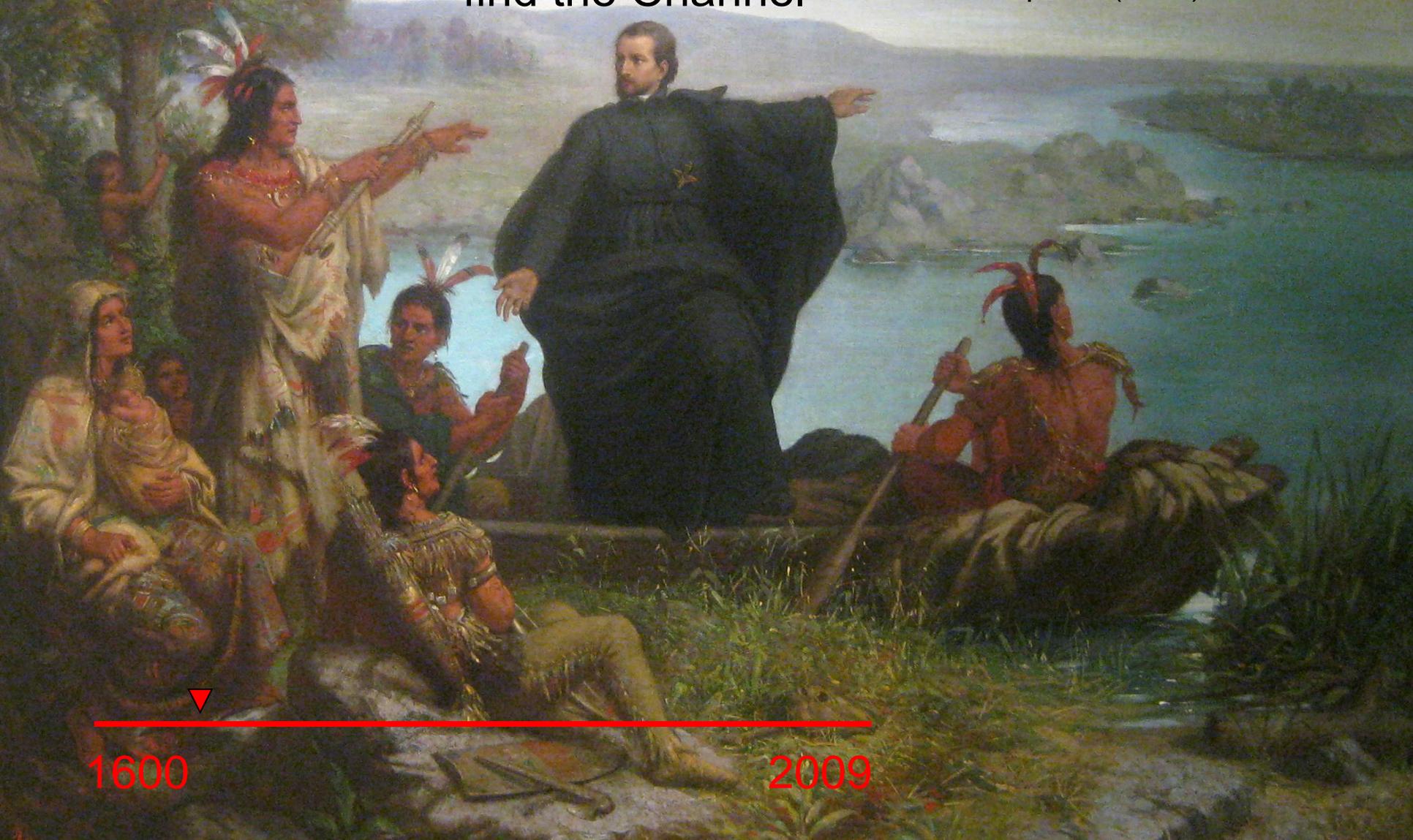


A lake of many cultures.....



Supporting Families for
Thousands of Years

“It is easy to lose one's way, especially as the River leading thither is so full of wild rice that it is difficult to find the Channel” Father Marquette (1673)



1600

2009

**The Expeditions of Zebulon Montgomery Pike
(1805-1807) – “The lake is three leagues long (9
miles), this is full of wild rice, and has a a great
many fowl in their season.”**



“Wau-bun” (1855)

This lake has its name from the long flags or rushes which are found in its waters in great abundance, and of which the squaws manufacture the coarse matting used in covering their wigwams.

Besides this, the wild rice abounds to such an extent in many places, that it almost completely obstructs the progress of even a moderate-sized boat, so that a passage through its tangled masses is with difficulty forced by the oars.

1600

2009



Nee Pee Nauk Duck Hunting Club, whose diary tells of members around 1885:
“Shooting lousy. We killed only 30 canvasback, 50 bluebill, 21 pintail, and 18 redhead.”
“Fishing only fair. We caught 63 smallmouth and 66 pike.”

1600

2009



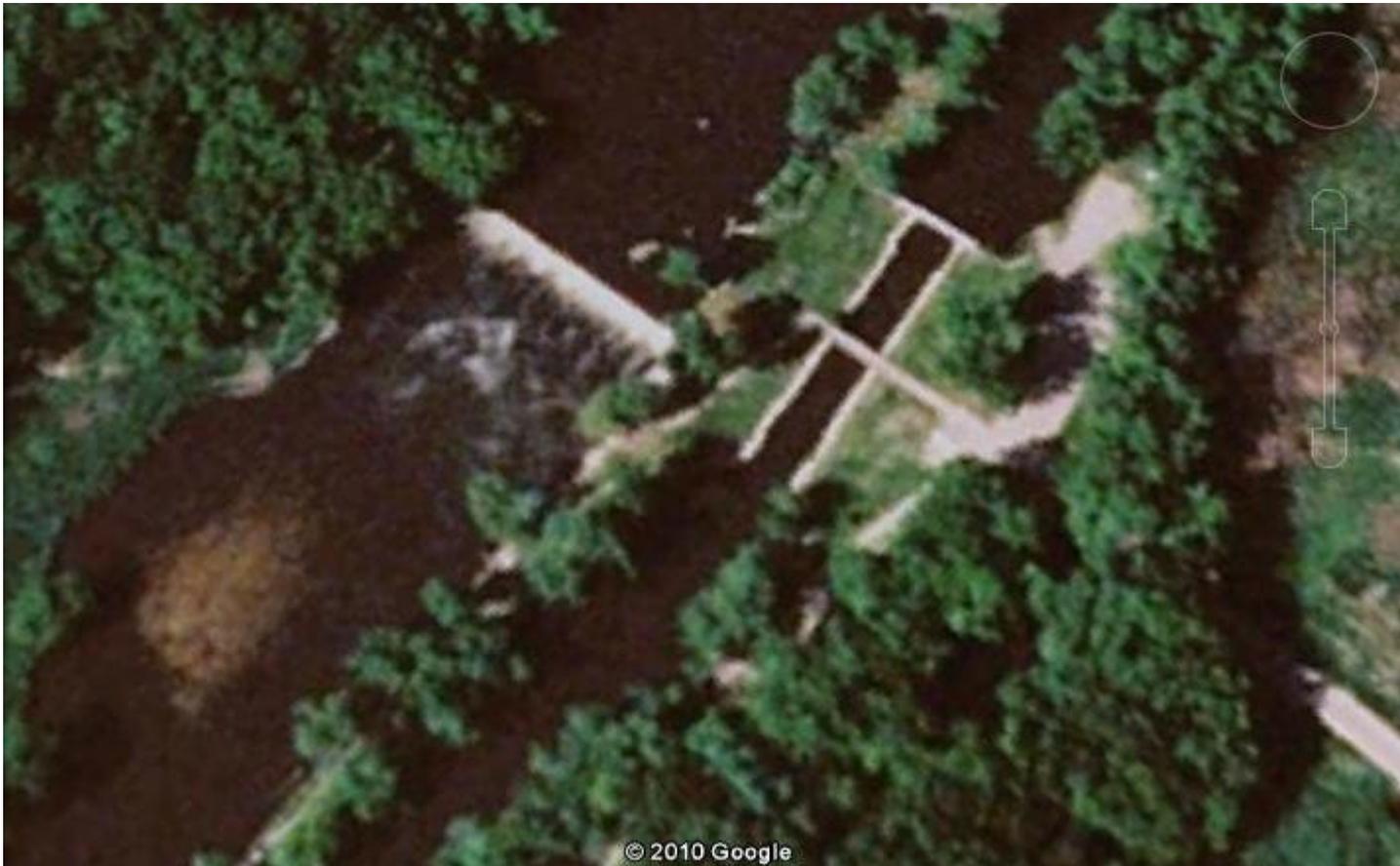
“The boys were fed up with puddle ducks, and wanted to get into the diving game.” For these reasons the Caw-Caw Club moved to Lake Puckaway, which was found more suitable than Poygan, and most of its history was made on that famous celery lake.

1869

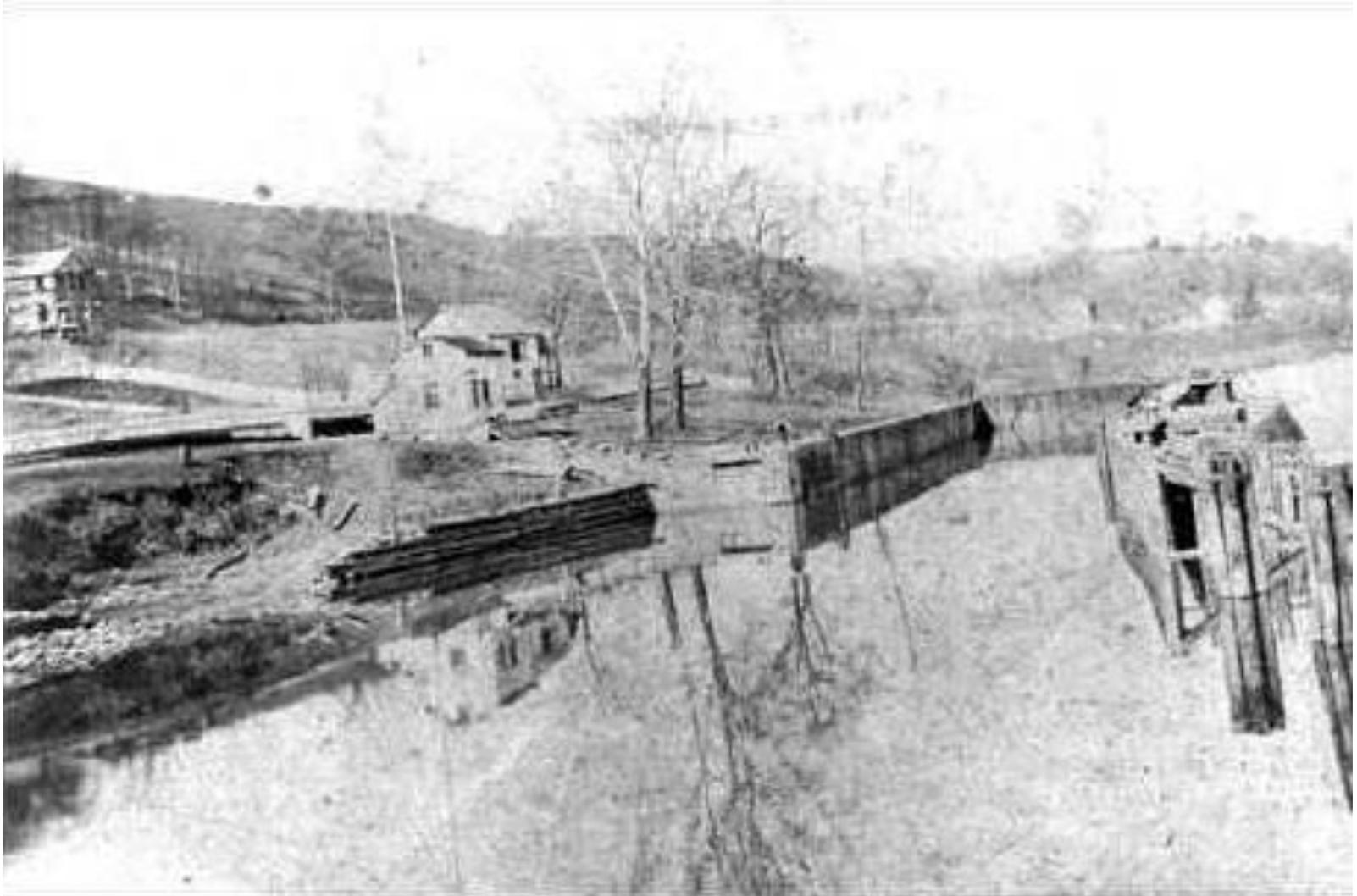
Not far north of Horicon...lies Lake Puckaway, like Koshkonong, this was a famous “wild celery” lake.



“...fantastic bags of game were secured, and sadly it must be confessed that occasionally excess birds, impossible to keep in those pre-refrigeration days were buried under the hillside brush.”



In 1837 and 1839, the Corps examined the waterway's feasibility and recommended a “slack-water” (lock and dam) system. After numerous memorials from the territorial legislature, Congress authorized a land grant for the waterway project in 1846.

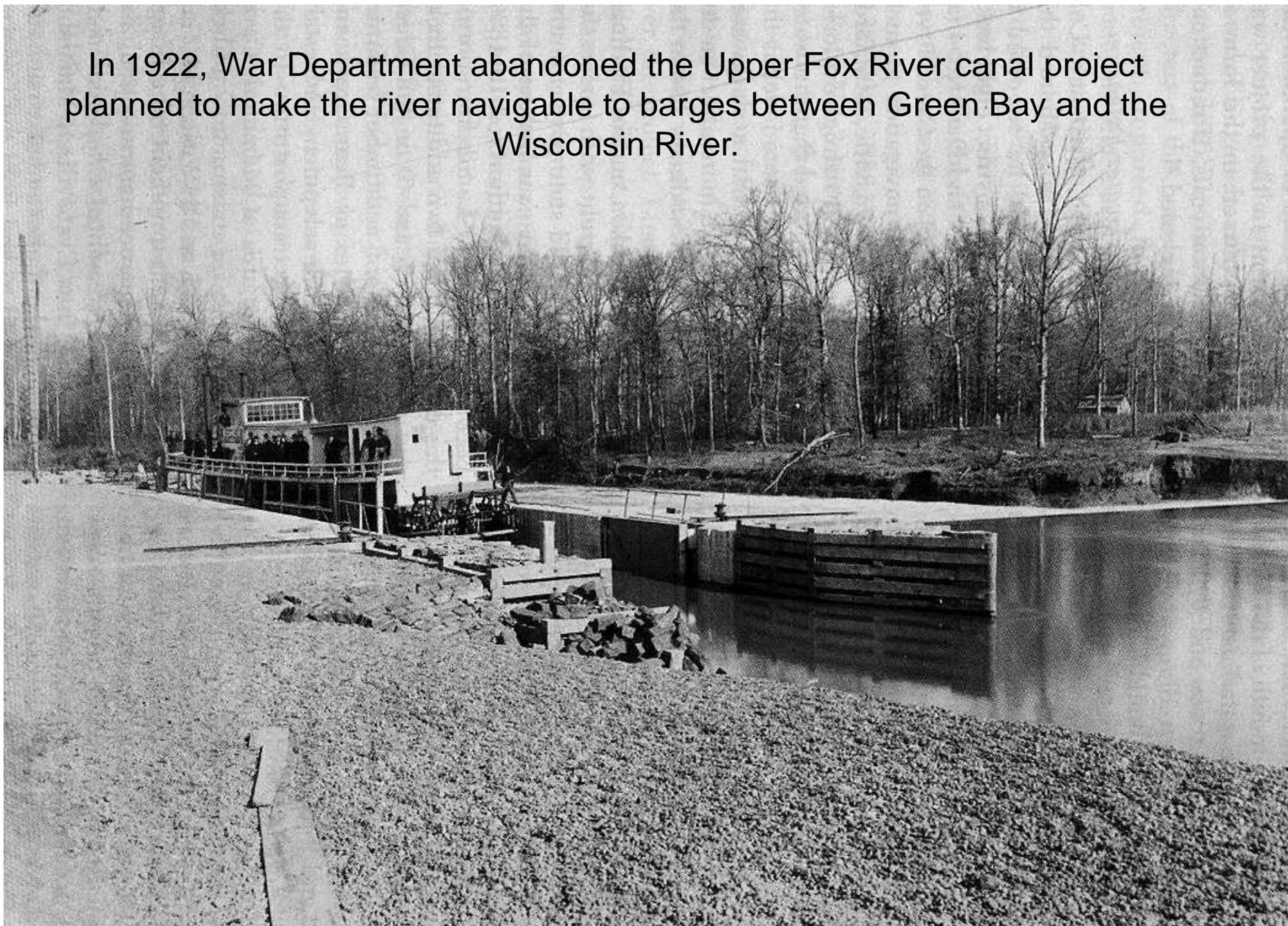


Original Lock and Dam built around 1860 soon fell into disrepair



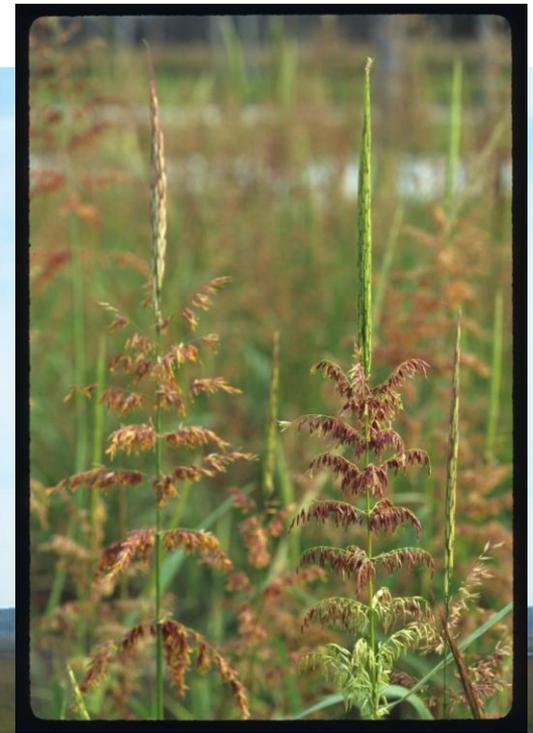
The Princeton Dam was built by the Army Corps of Engineers in 1897 in an effort to provide water deep enough for commercial freight steamers.

In 1922, War Department abandoned the Upper Fox River canal project planned to make the river navigable to barges between Green Bay and the Wisconsin River.



1941

Wild rice emerged along the entire shoreline. It formed an almost impenetrable bed throughout the eastern basin, with only the navigation channel remaining open.



1600

2009



By 1946, local residents noticed a significant decline in aquatic plants, and water quality was reduced

Historical Management

- 1946 – Puckaway Restoration League attempts to improve declining emergent plants by planting hundreds of lbs of wild rice.
- 1949 – Large expanses of open water start to develop.

Historical Management

- 1951: “Only 2550 Acres” of Emergent Plants Remain, Nearly Half of previous decades
- 1950-1951: Water levels are drawn down for 2 consecutive springs to improve plant growth.



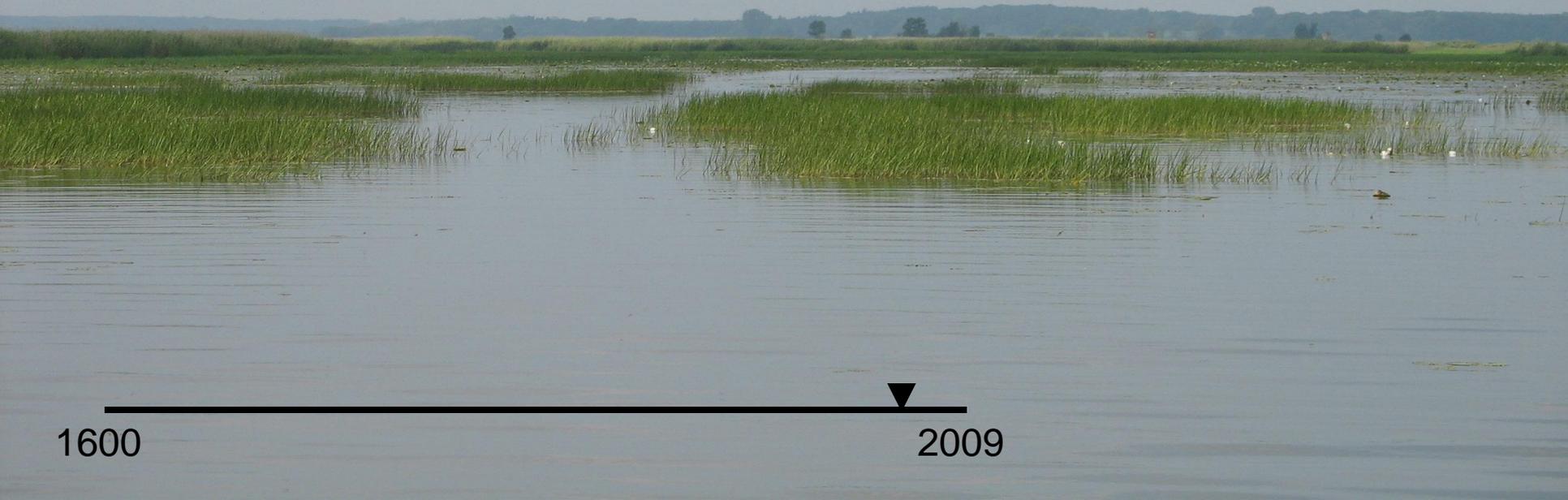
“Should the openings continue to expand, the breakup of this marsh (Lake Puckaway) can be expected with conditions similar to Beaver Dam Lake and Lake Koshkonong appearing. Intensive prosecution of the carp and careful regulation of water levels is necessary to avoid such a development...Largely because of high water the carp are able to invade the shallows which had the best stands of wild rice and arrowhead. Both are now scarce in former areas of abundance. To maintain the marsh ecology of Lake Puckaway a decrease in the water level of 6 inches to 1 foot from what it was on August 11, 1952 is justified.”
(Thompson 1959)

Historical Accounts

- “Wild rice has “precipitously declined” since 1880, whereas is is no longer a dominant species.” - 1959
- “Once famous fish and waterfowl haven into a dead mud puddle” - 1959

1977

- o Almost no submergent plants were present in the muddy waters.
- o Carp comprised of 76% of the fishery.
- o Secchi disc measurements in August were 6 inches.
- o Lake Puckaway Protection & Rehabilitation District (LPPRD) forms



1600

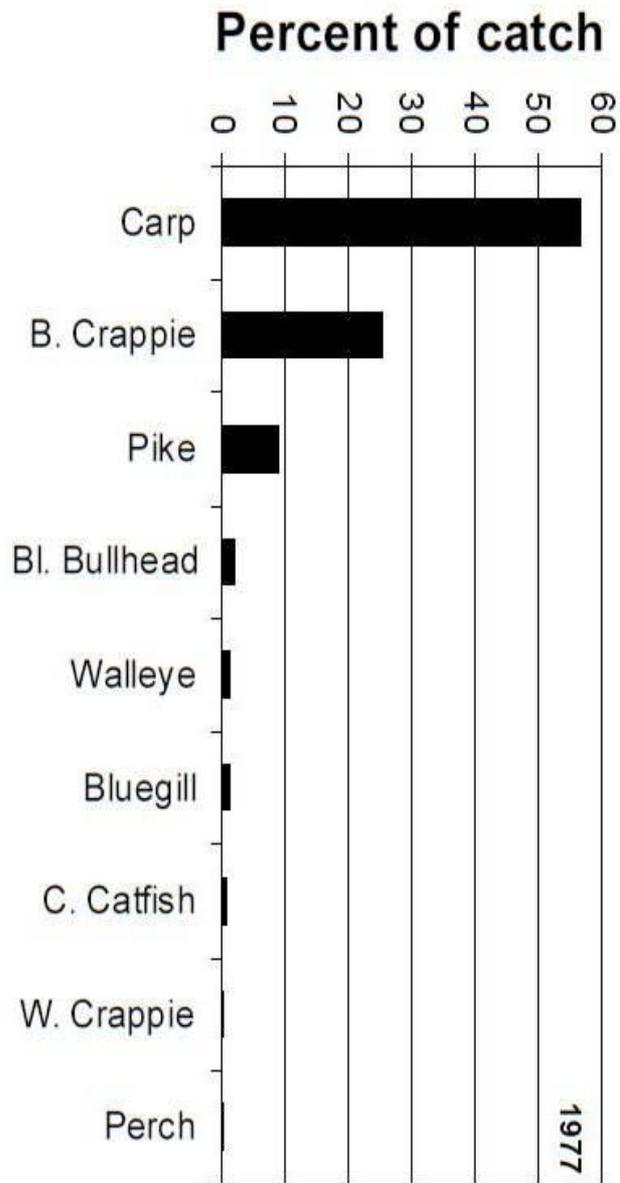
2009

WI DNR worked with LPPRD and LPIA to develop a management plan.

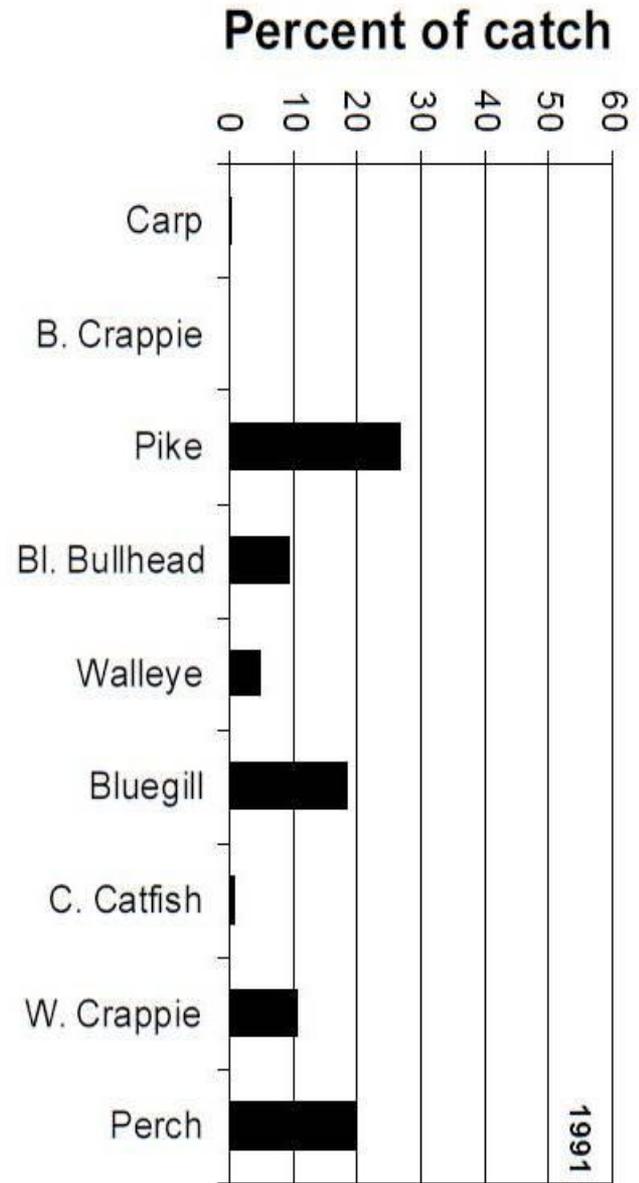
The 1978 Three-phase plan:

- Partial drawdown of the lake
- Mechanical removal of carp
- Restocking of game fish species.

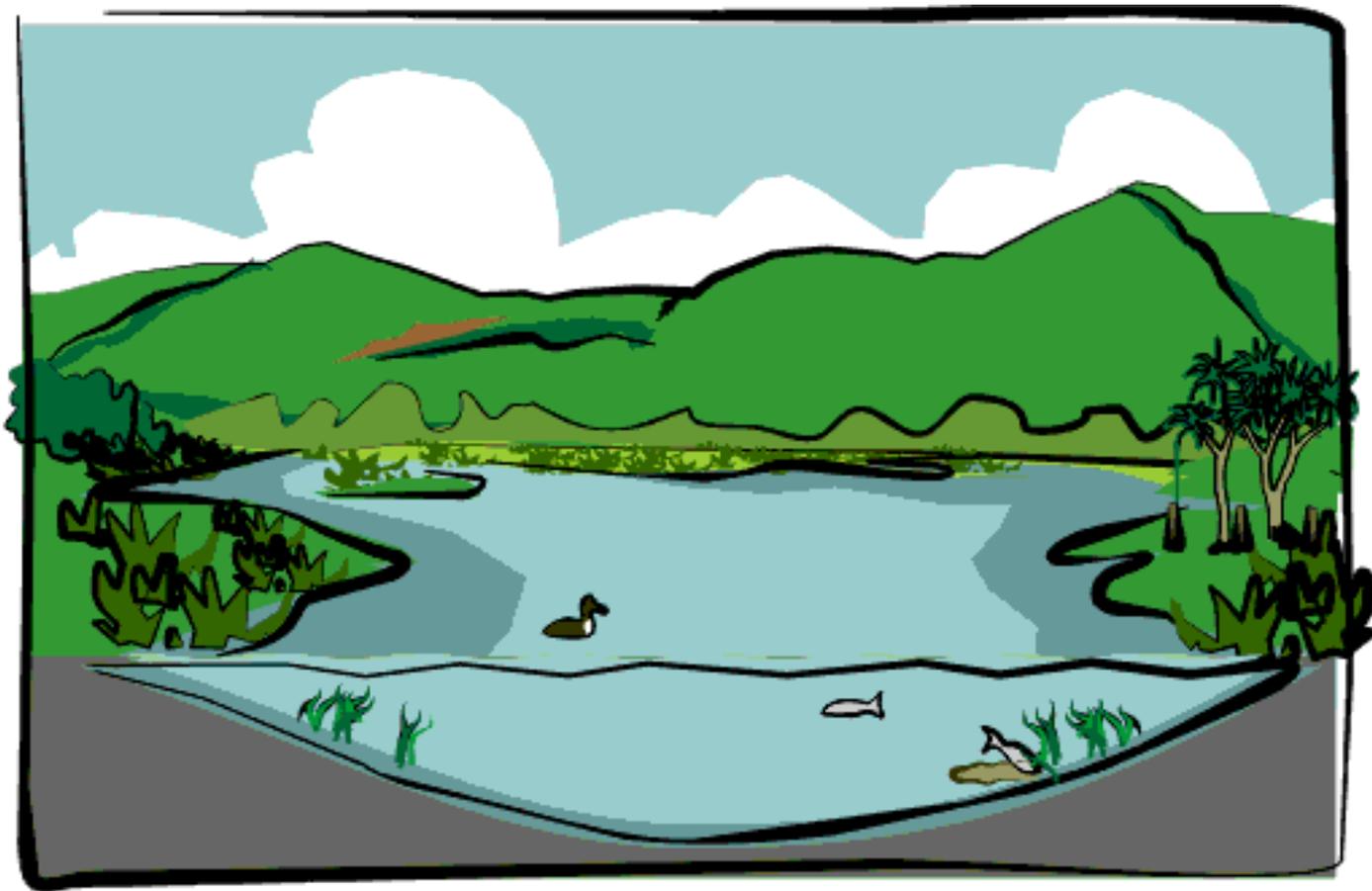




Prior to 1977 Lake Plan Implementation



1991



1. Why do we care about reduction in emergent beds?
2. How do we measure it?
3. What is causing the reduction?
4. How do we manage it?

1. Why do we care about reduction in emergent beds?

A diverse emergent plant community is important to lakes –

Especially in shallow, littoral dominated system, such as Puckaway

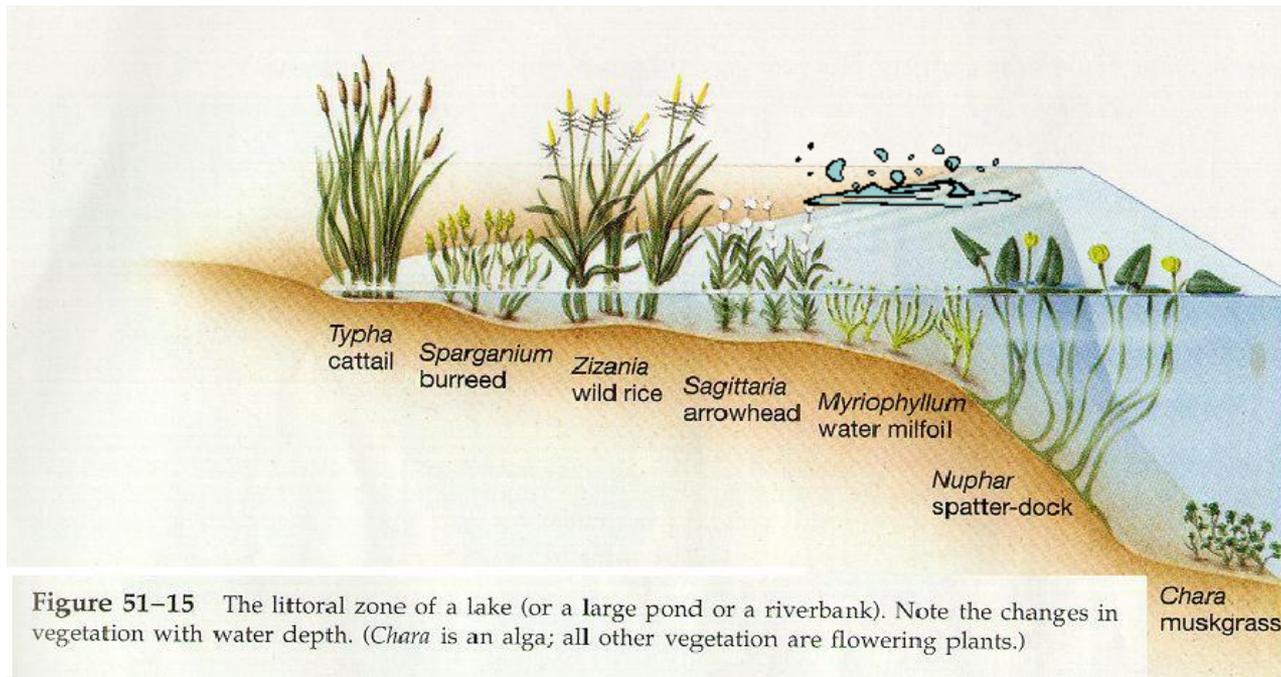
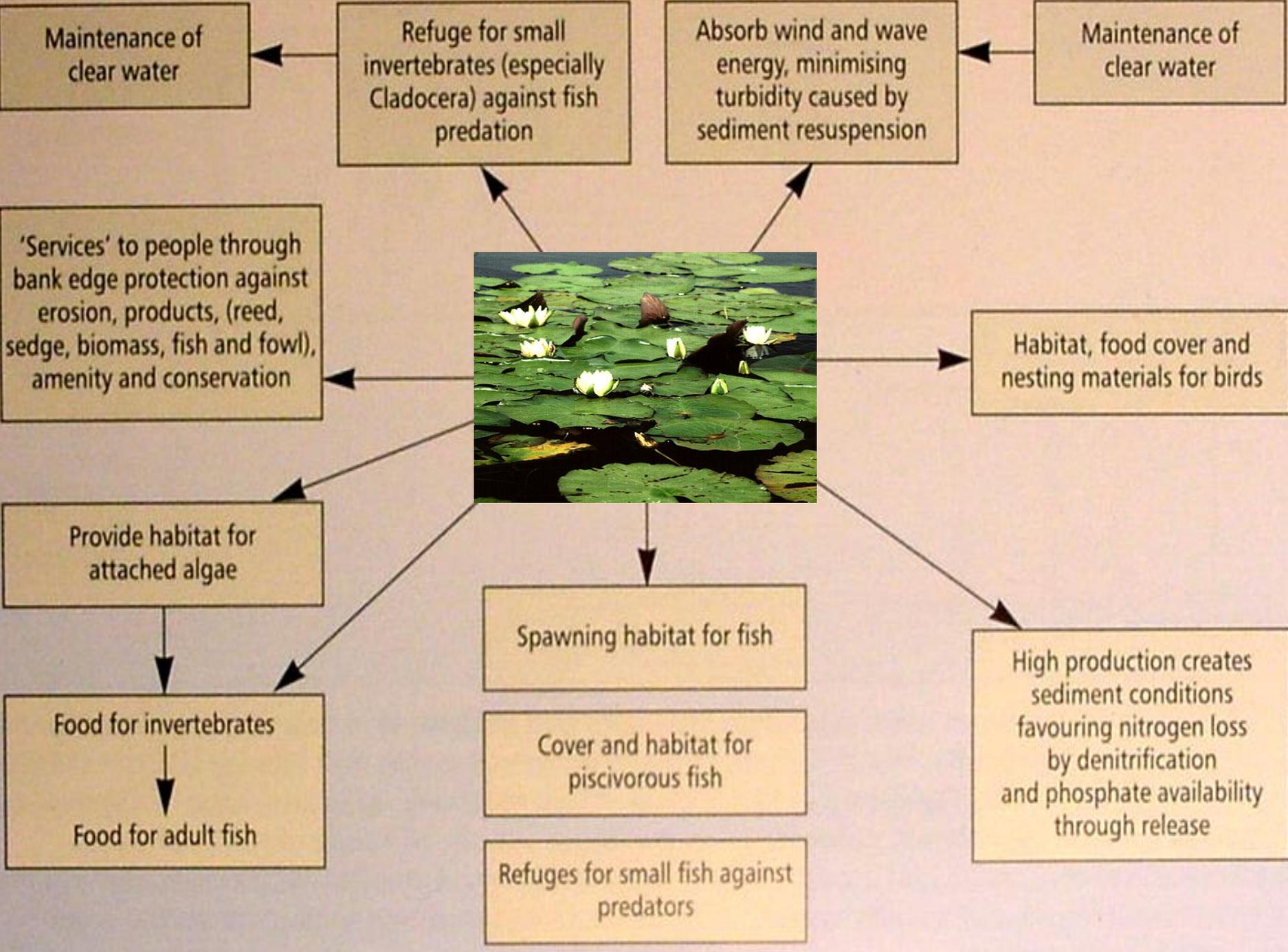


Figure 51-15 The littoral zone of a lake (or a large pond or a riverbank). Note the changes in vegetation with water depth. (*Chara* is an alga; all other vegetation are flowering plants.)



Maintenance of clear water

Refuge for small invertebrates (especially Cladocera) against fish predation

Absorb wind and wave energy, minimising turbidity caused by sediment resuspension

Maintenance of clear water



'Services' to people through bank edge protection against erosion, products, (reed, sedge, biomass, fish and fowl), amenity and conservation

Habitat, food cover and nesting materials for birds

Provide habitat for attached algae

Food for invertebrates

Food for adult fish

Spawning habitat for fish

Cover and habitat for piscivorous fish

Refuges for small fish against predators

High production creates sediment conditions favouring nitrogen loss by denitrification and phosphate availability through release

A lake without plants is like a forest without trees.....



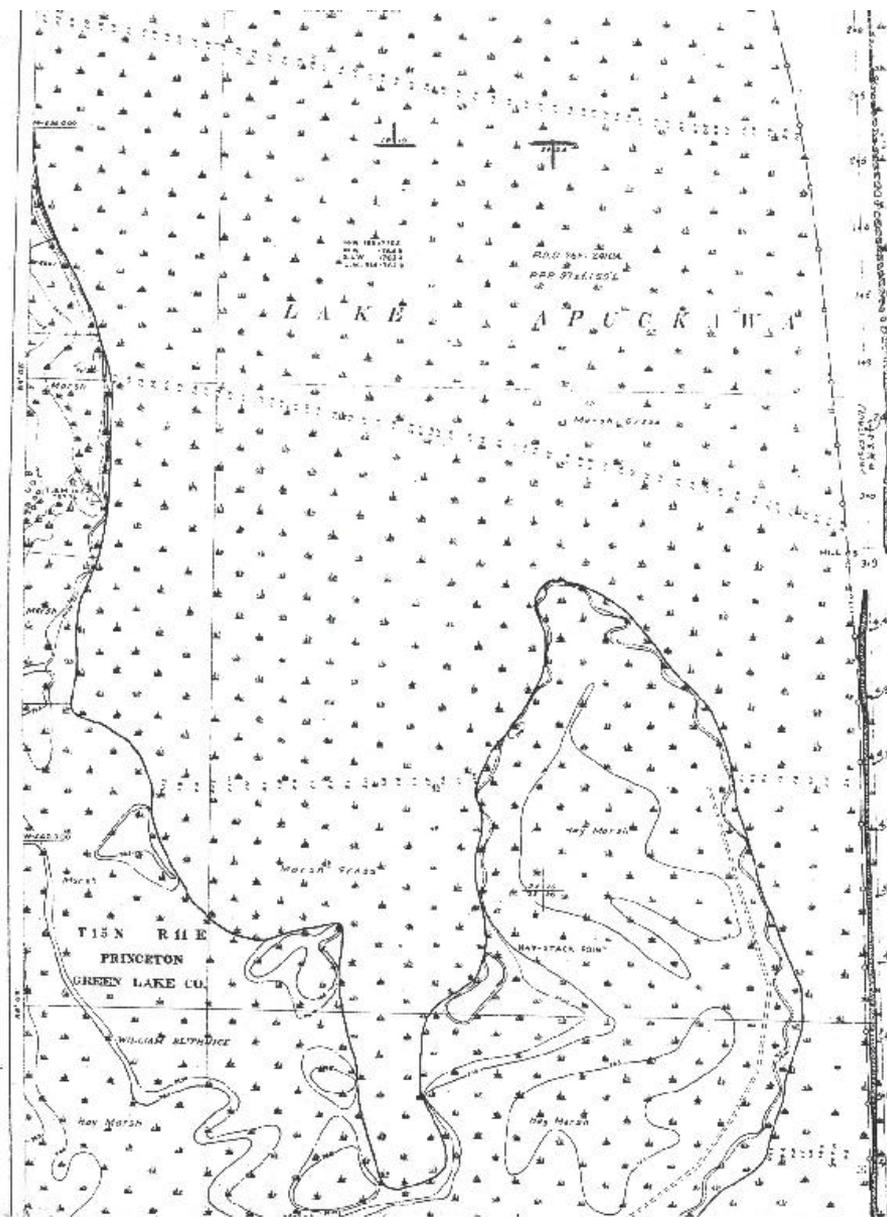


Endangered Species, such as the Foster's Tern, is found on Lake Puckaway, and uses dead emergent vegetation to nest on.

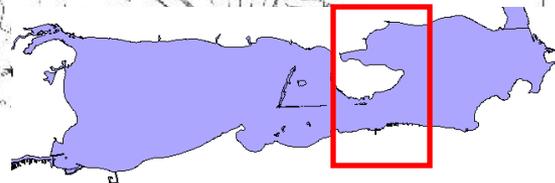
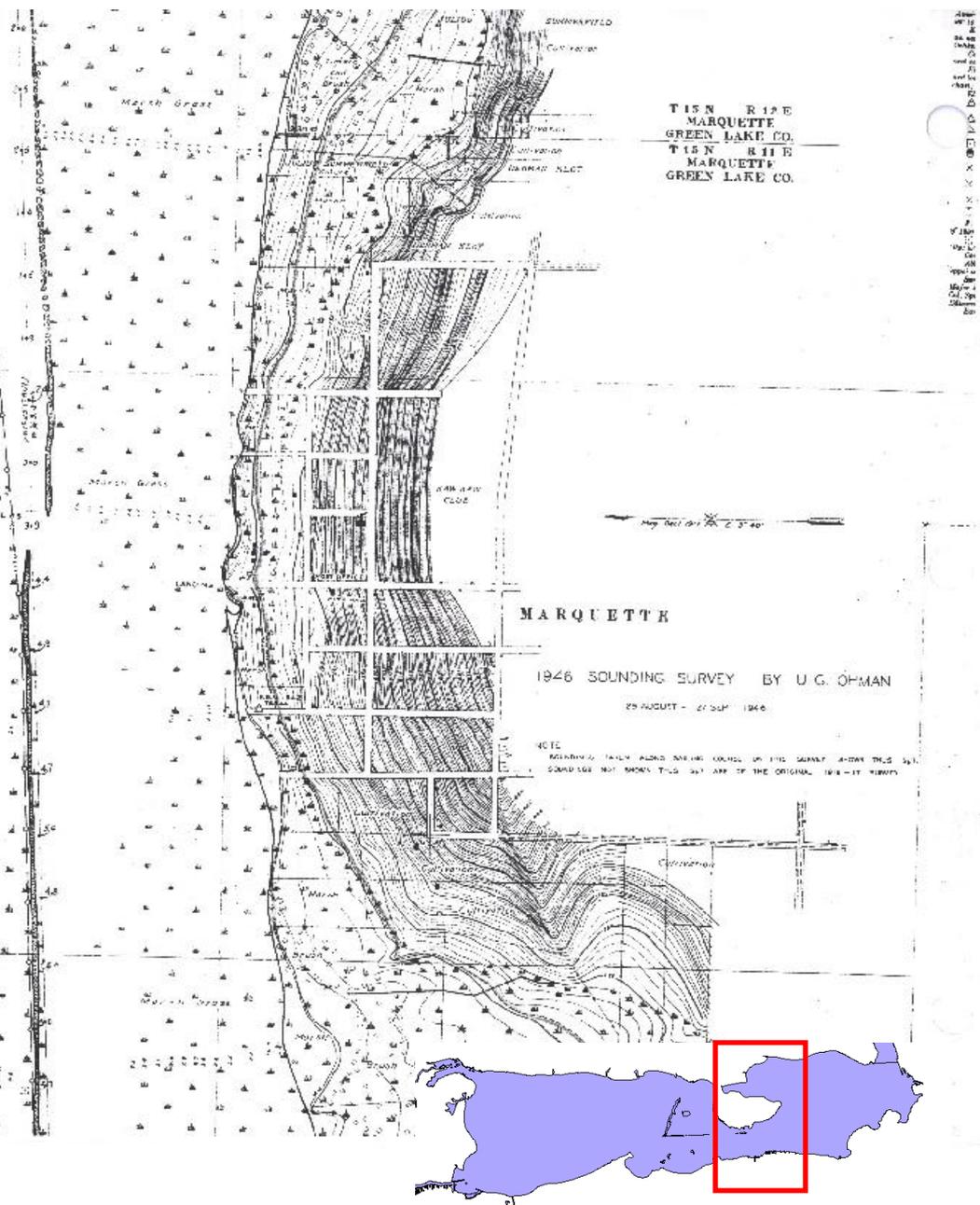
2. How do we measure it?

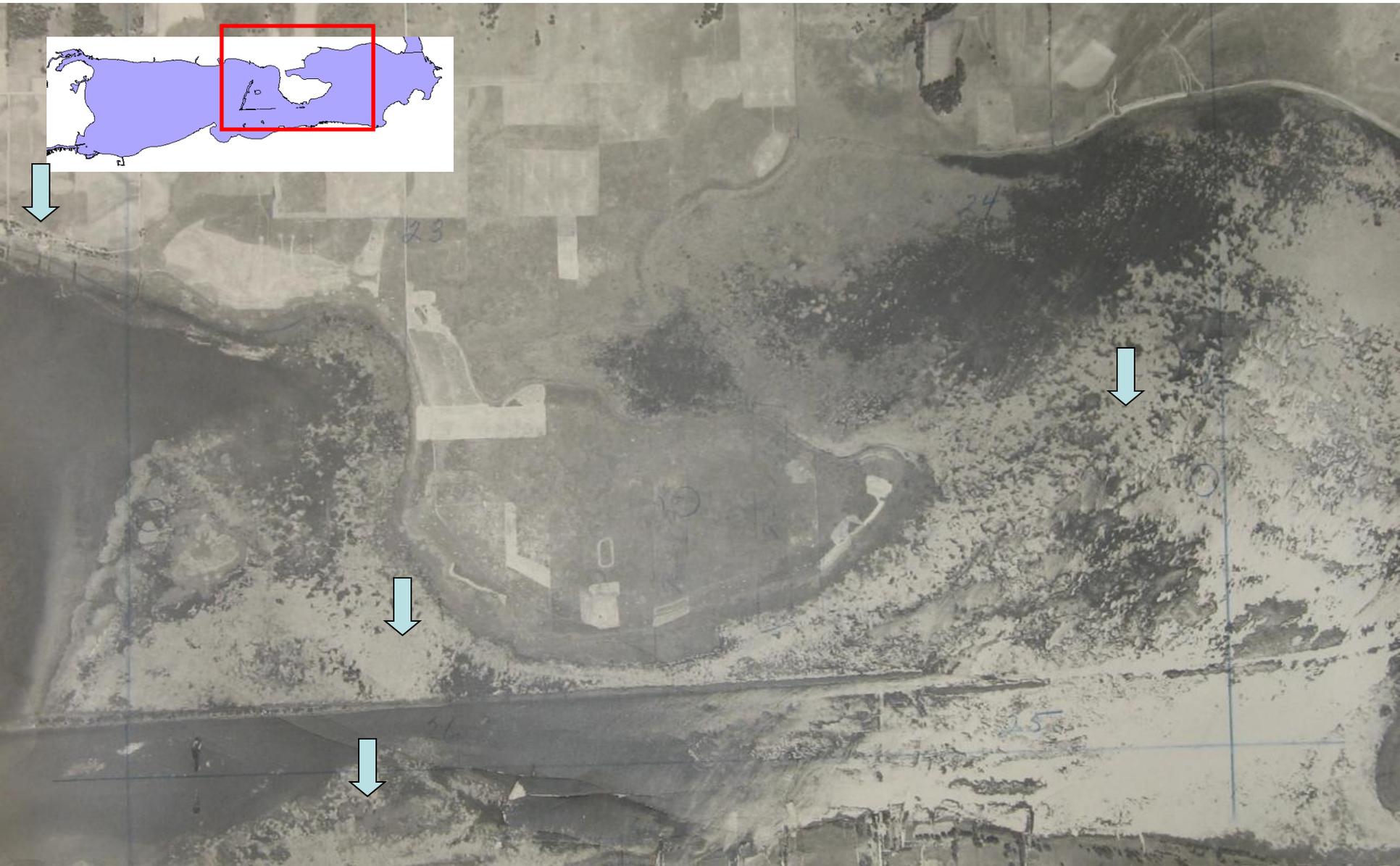
Lakes and Vegetation vary year to year depending on weather patterns.....But....What is the TREND over time?





1946

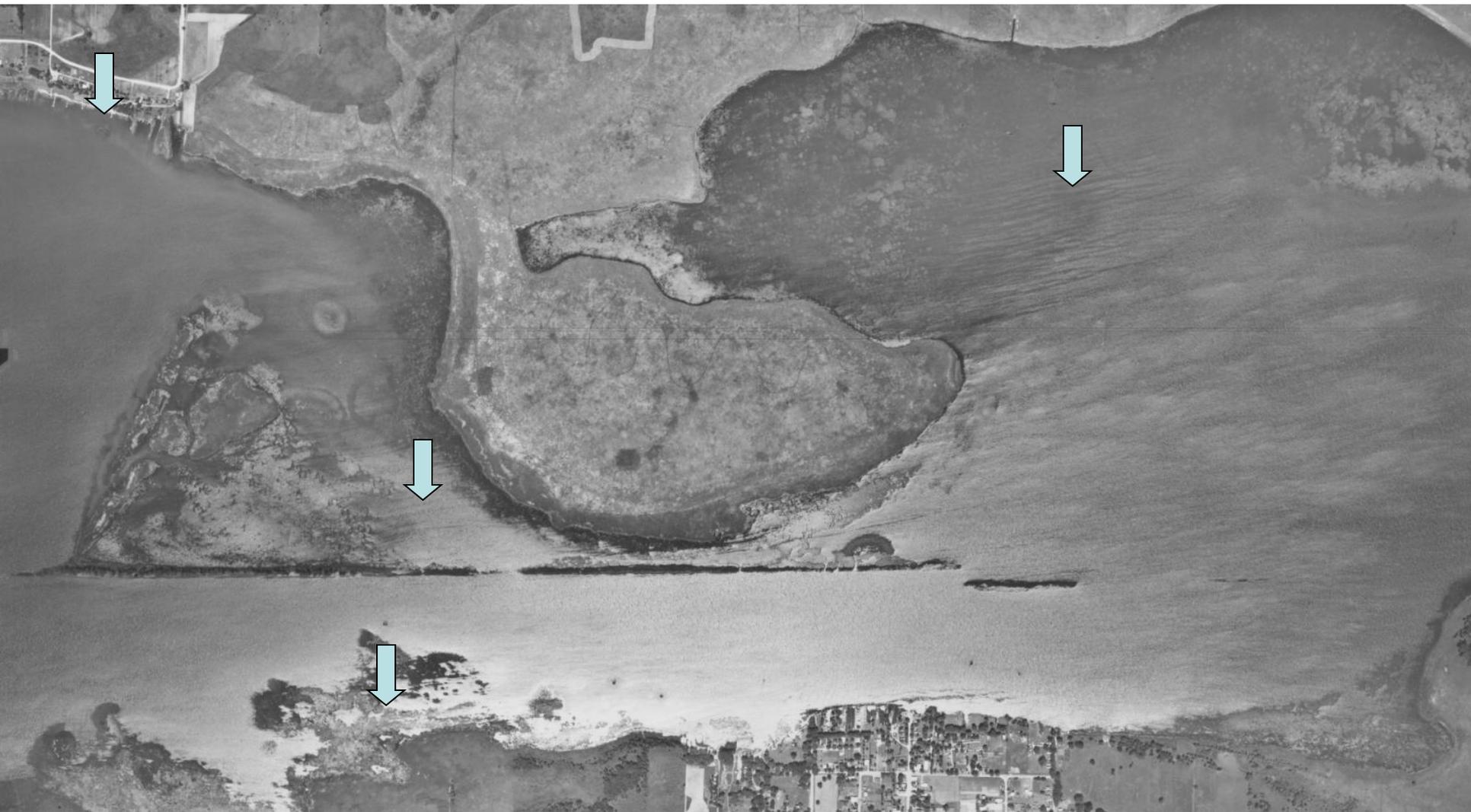




August 23rd 1941



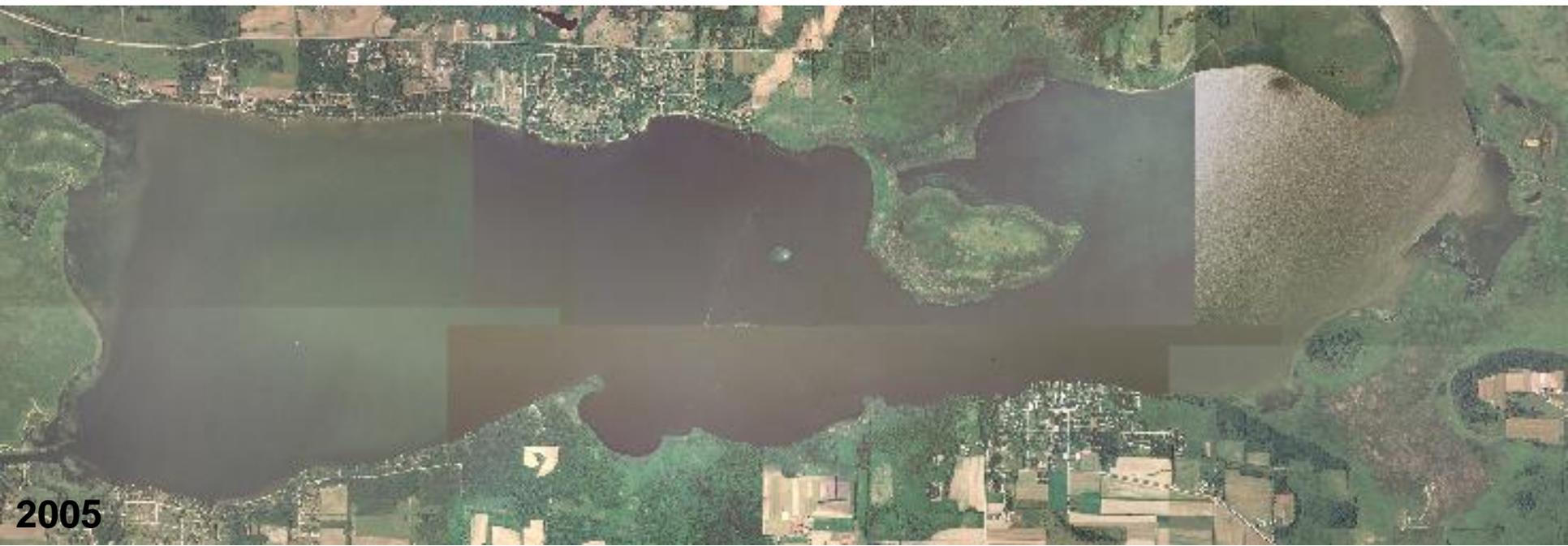
September 23rd 1950



June 25th 1964



September 7th 1971



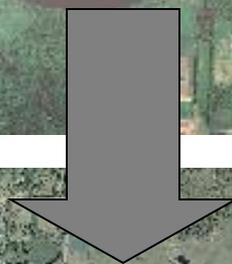
2005



2006



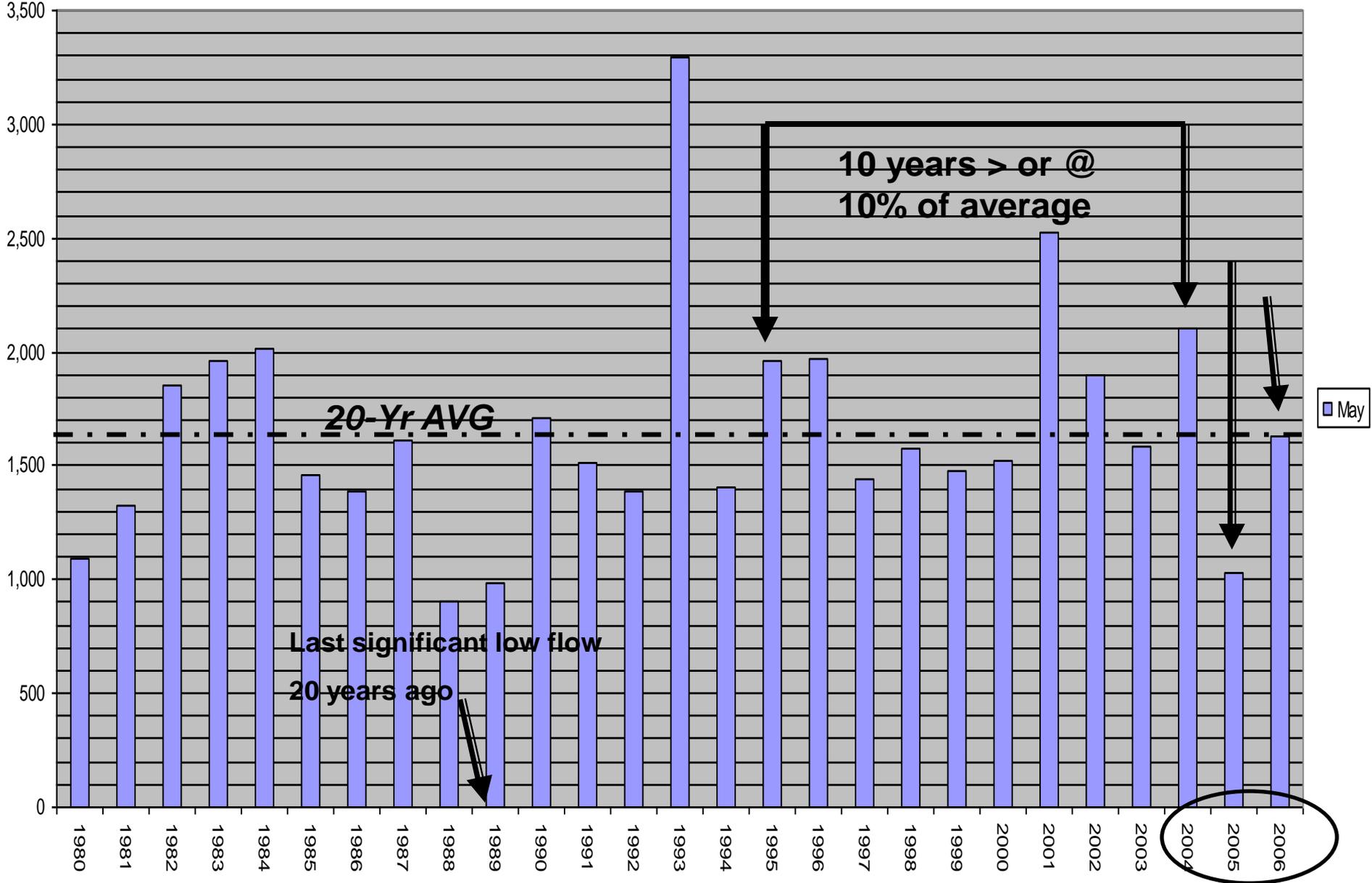
2005

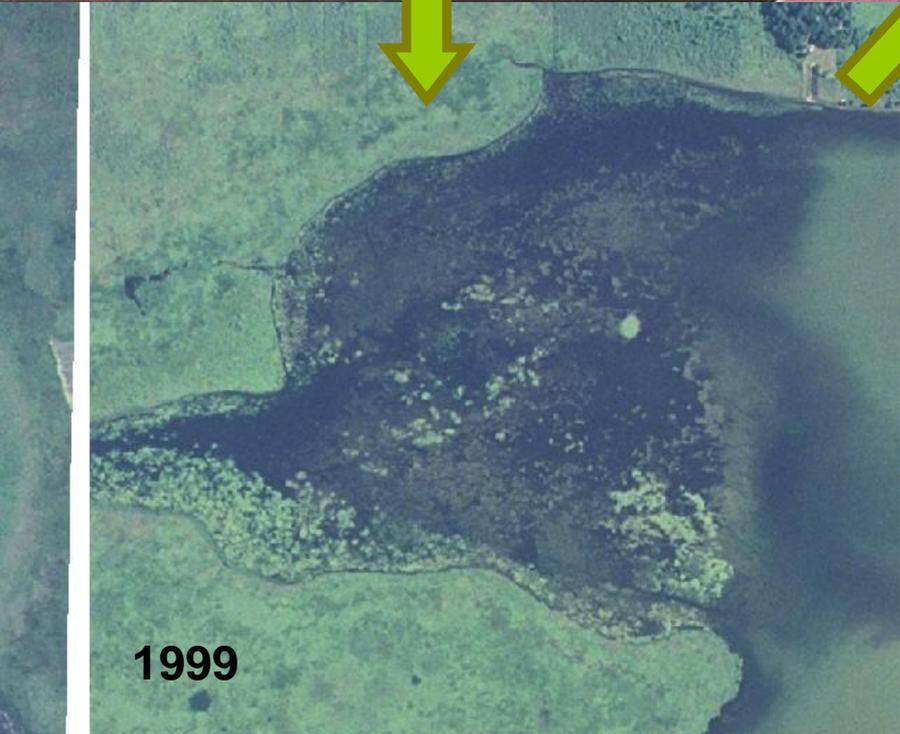
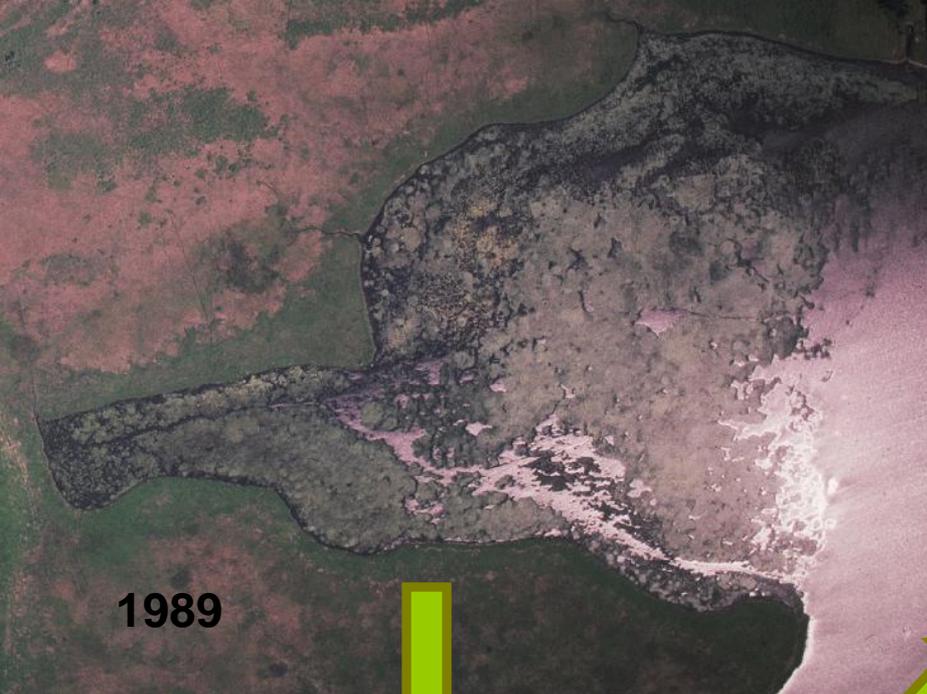


Increased Vegetation Growth Noticed throughout the Lake

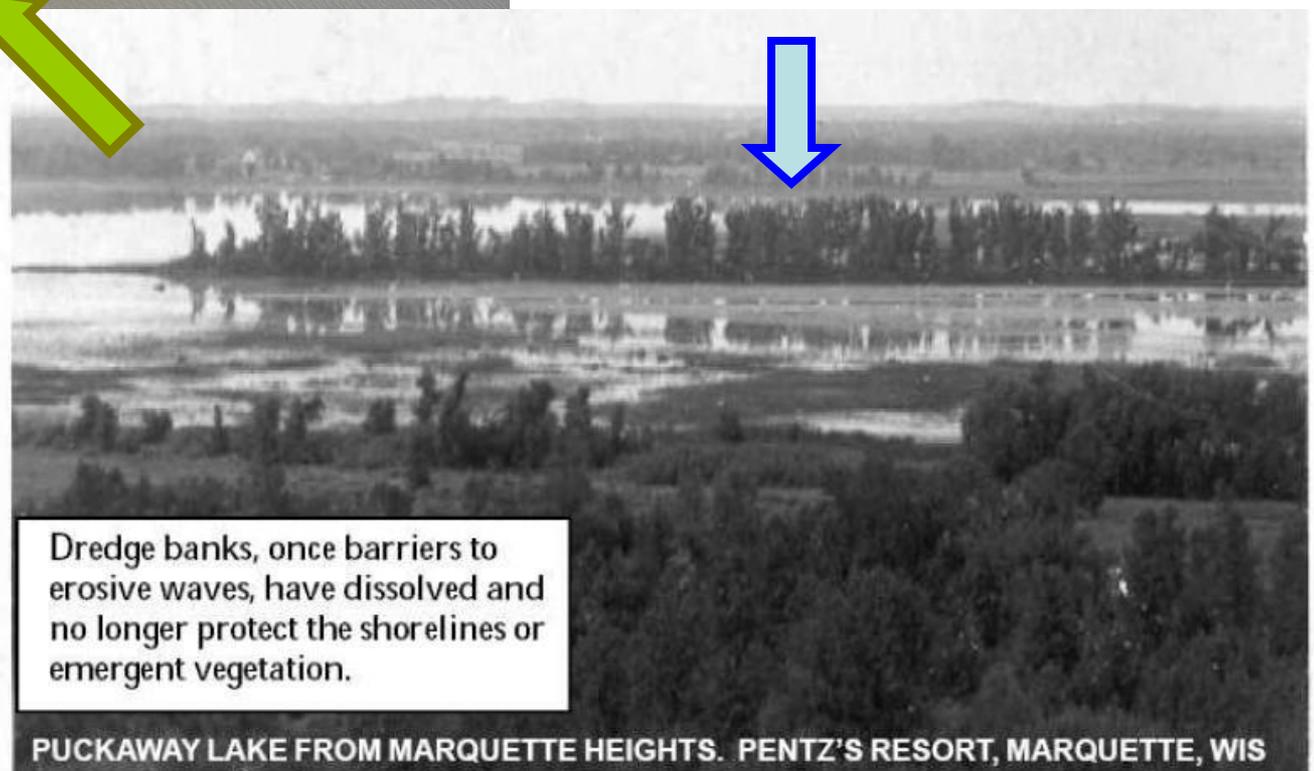
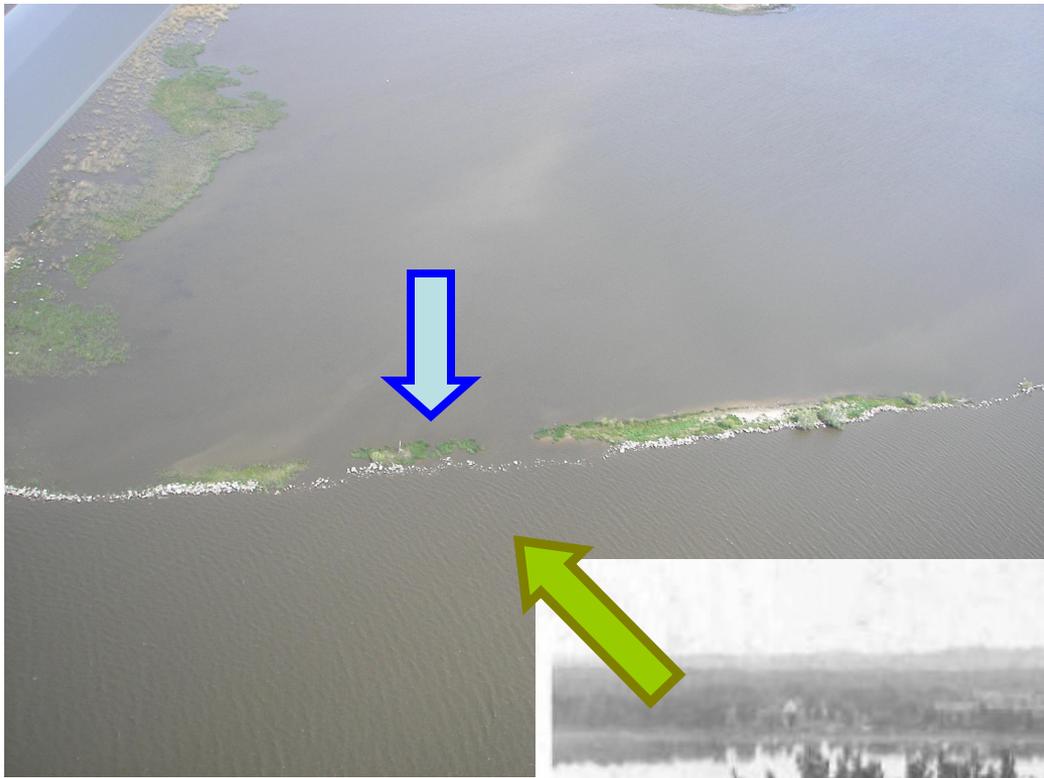
2006

Fox Rvier Discharge at Berlin in May (cfs)









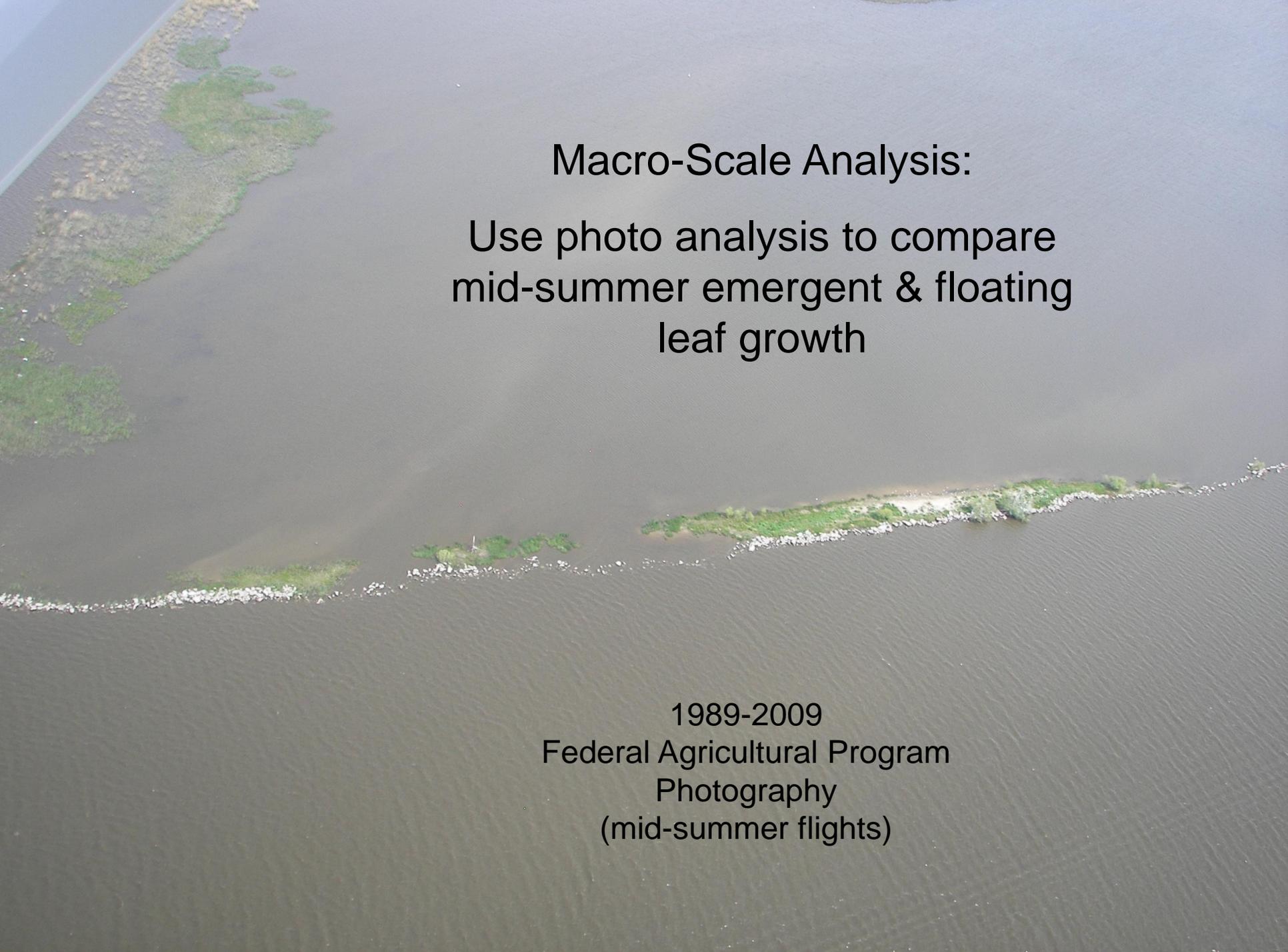
Dredge banks, once barriers to erosive waves, have dissolved and no longer protect the shorelines or emergent vegetation.

PUCKAWAY LAKE FROM MARQUETTE HEIGHTS. PENTZ'S RESORT, MARQUETTE, WIS



How do we Quantify the rate and amount of loss?





Macro-Scale Analysis:

Use photo analysis to compare
mid-summer emergent & floating
leaf growth

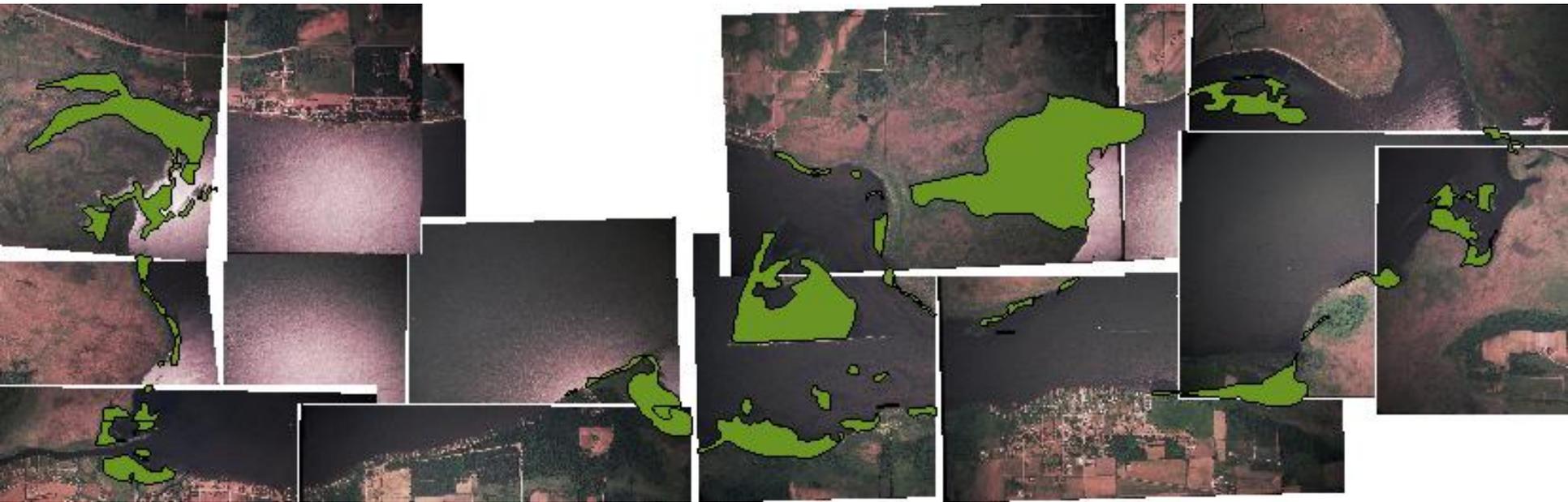
1989-2009

Federal Agricultural Program

Photography

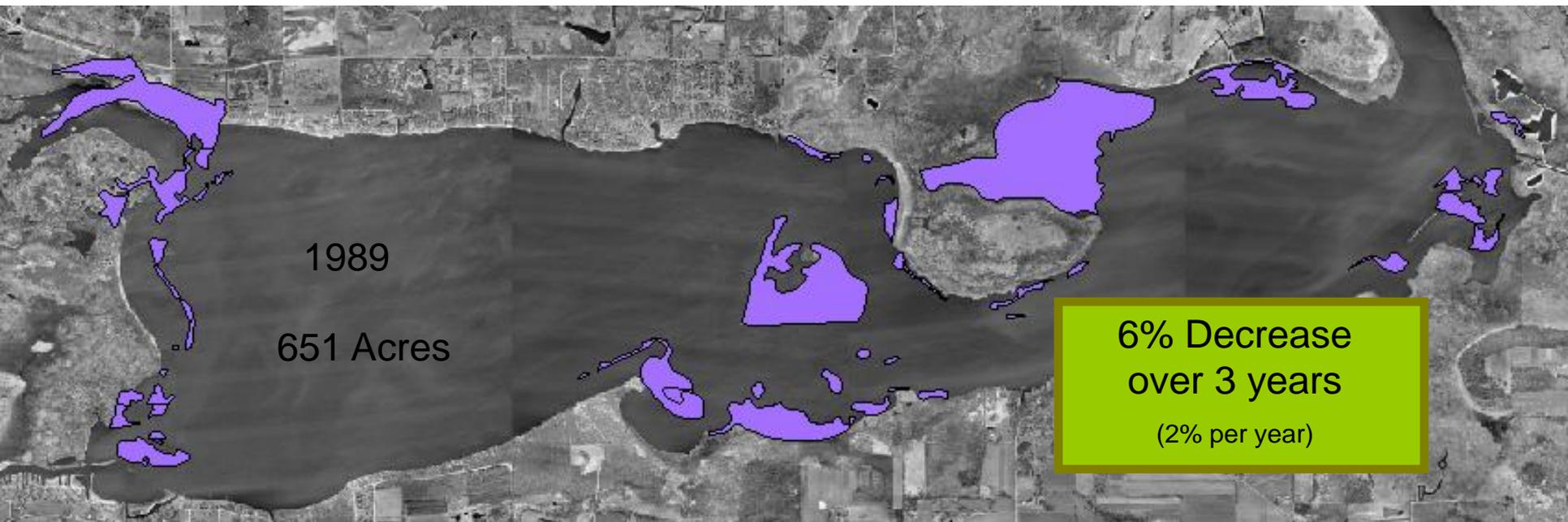
(mid-summer flights)

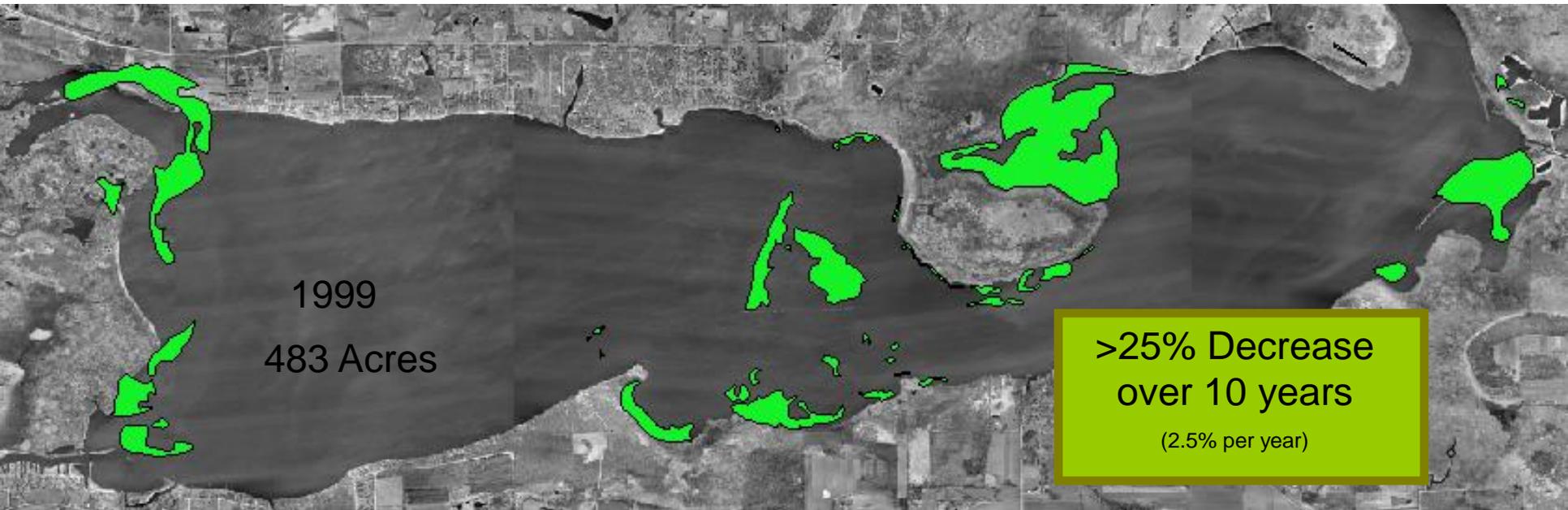
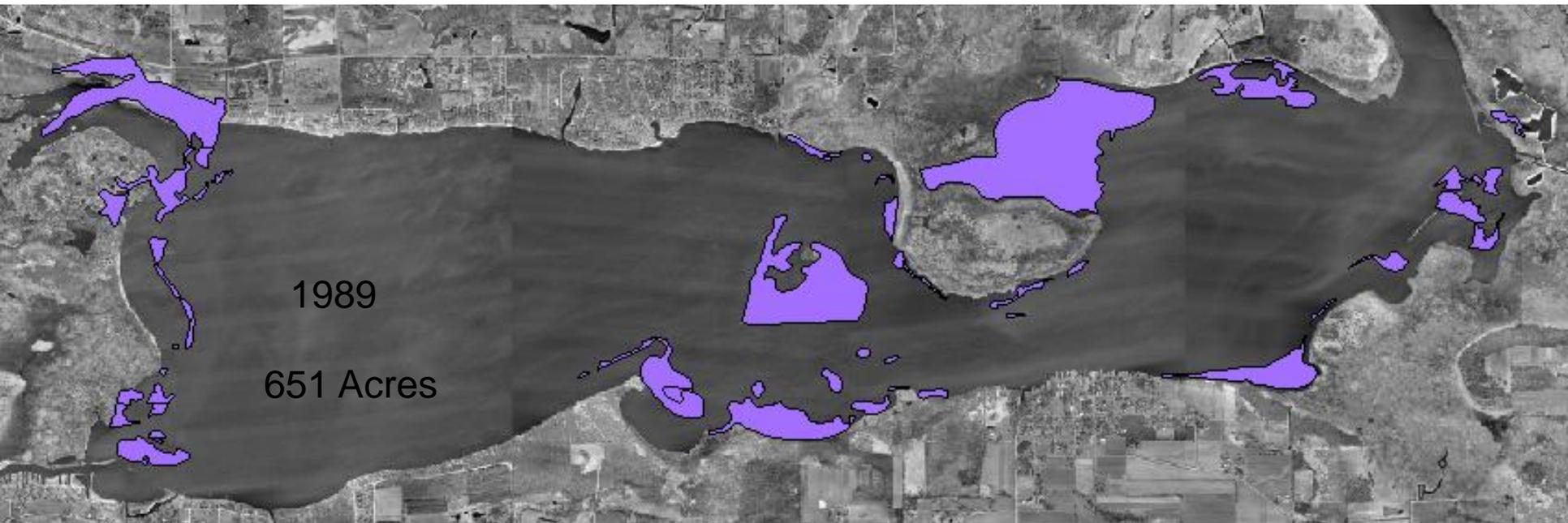
- Scanned and GeoReferenced 7000 Aerial Images
- Created a Composite Image for Each Year
- Used Mapping Software to define each visible plant bed
- Software measures exact acreage of the plant beds

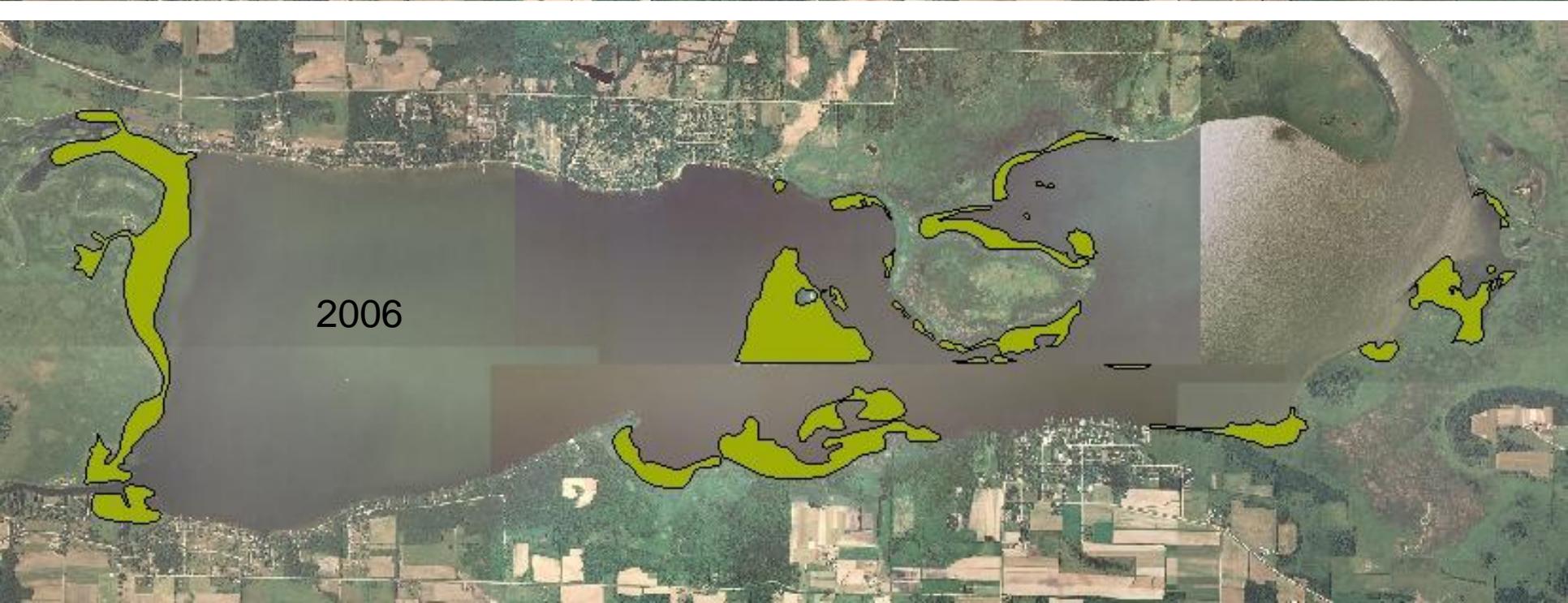


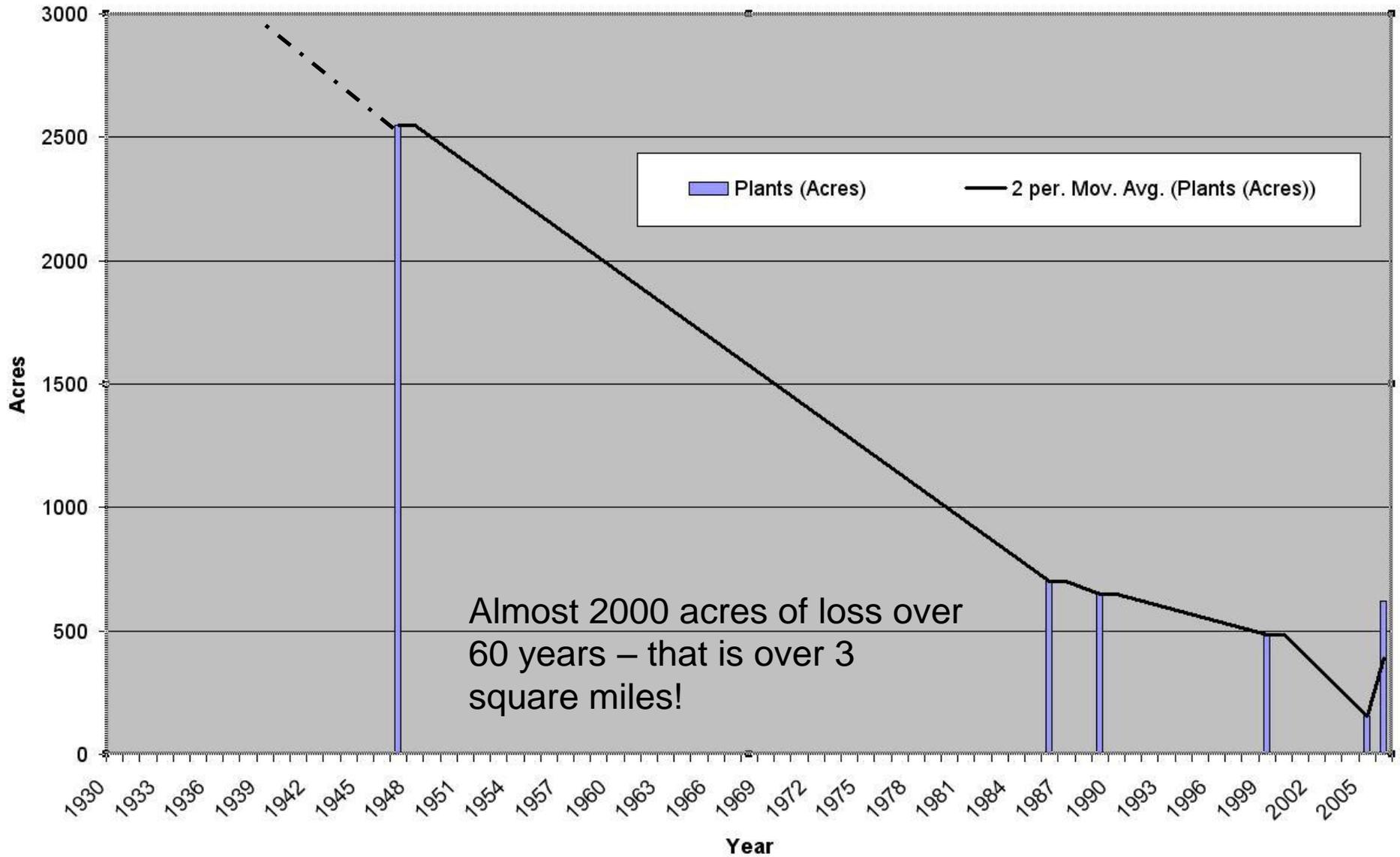
Approx. 651 acres

1989 Photographic
Analysis of visible
emergent and/or floating
leaf aquatic plant beds









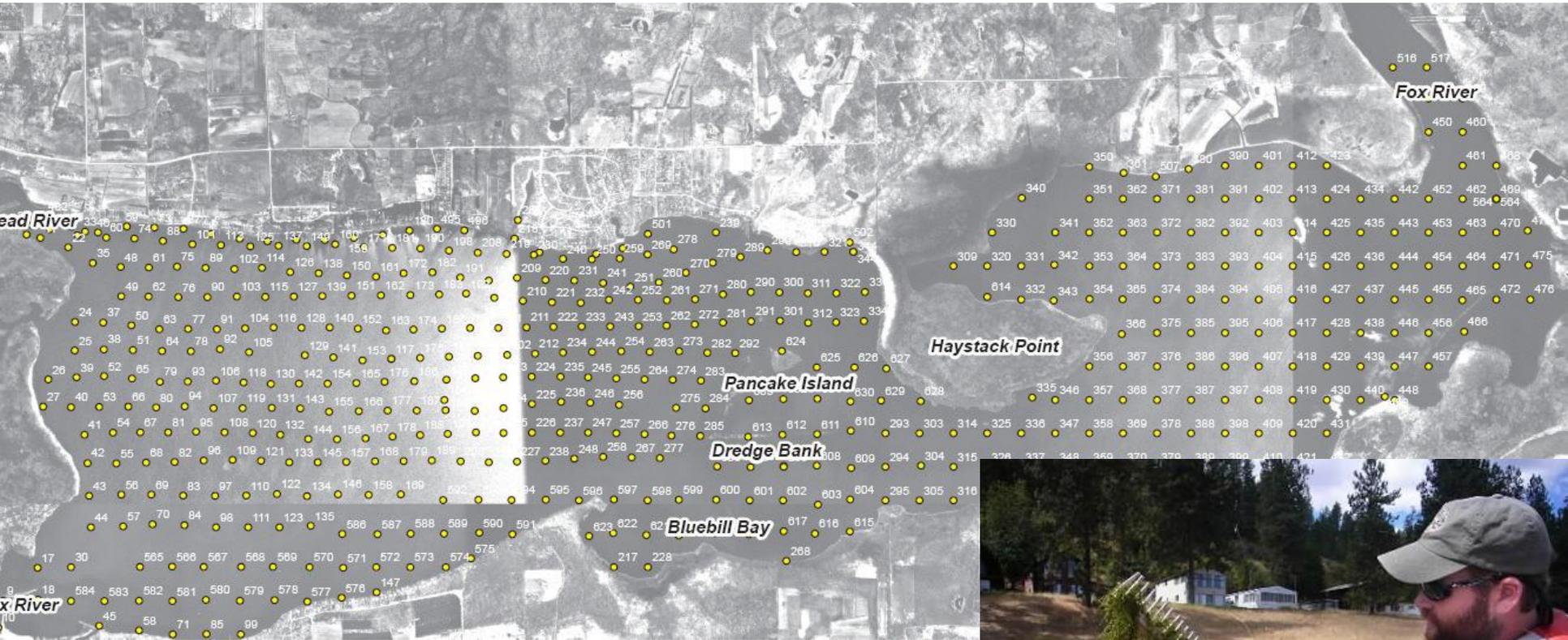
Micro-Scale Analysis:

Establish set sample points throughout the lake and conduct a plant survey annually at the same location.

Use GPS to delineate edge of emergent plant beds for comparison over time.

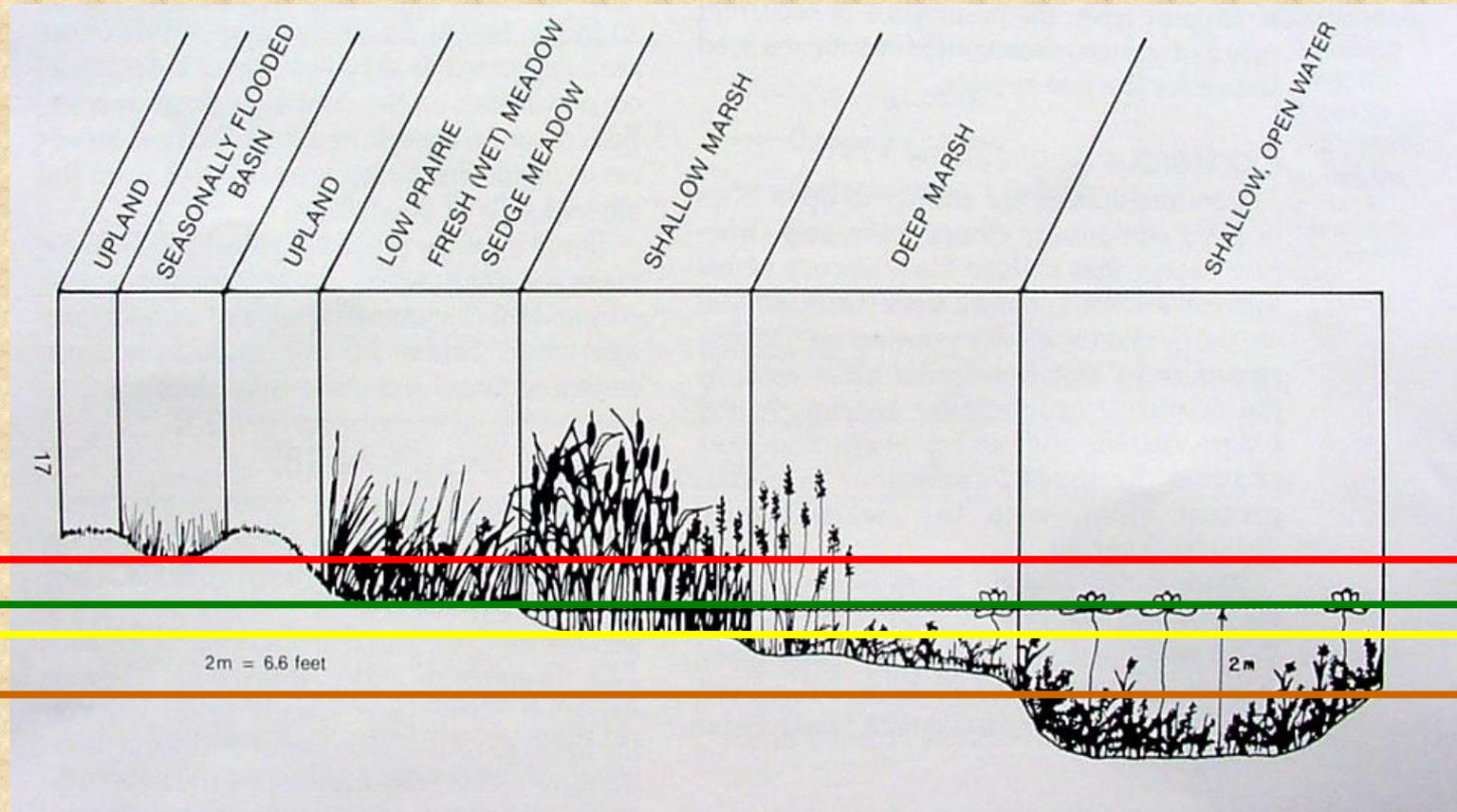
Begin monitoring in 2010.





3. What causing the reduction?

Sensitive to Water levels

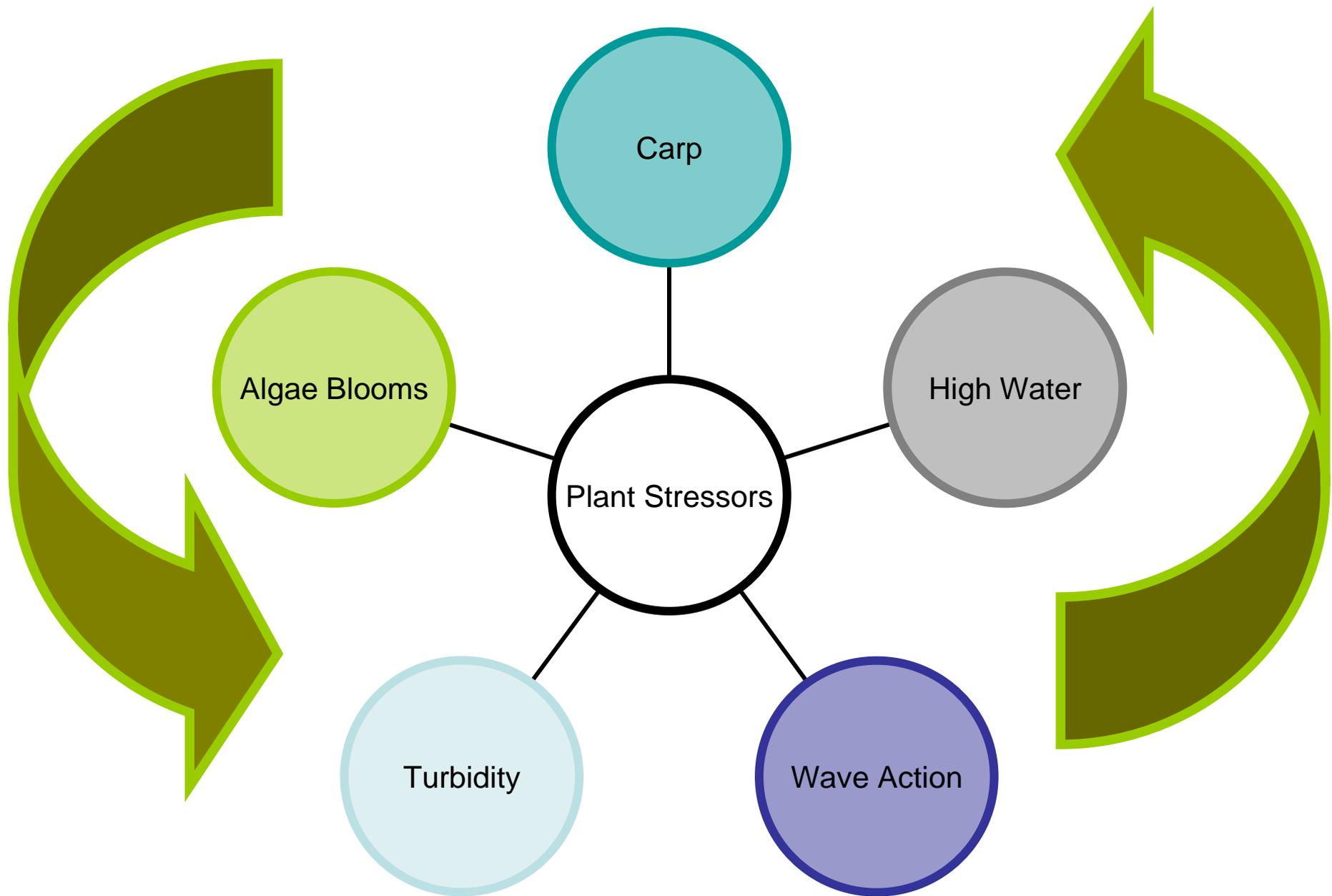


Green = Normal

Red = Flooding

Yellow = Drought

Brown = Extended Drought

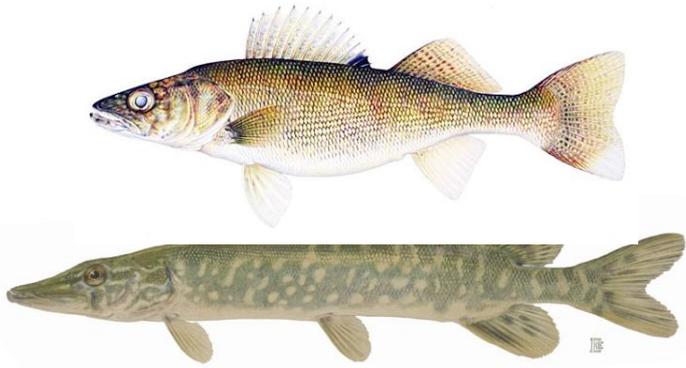


High Water Effects on Plants

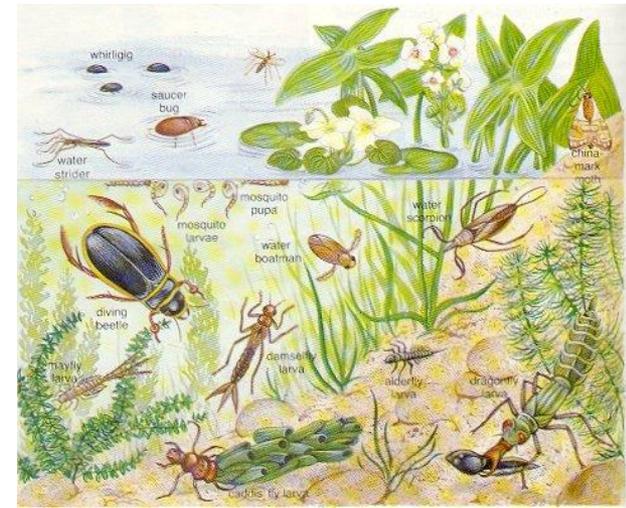
- Decreased Light Penetration
- Increased Turbidity from Wave Action
- Increased Algae Blooms
- Higher Energy Needs to Reach Surface
- Increased Wave Force
- Prop Damage from More Boat Access

Shift in Fish Population???

Sight Feeding Predator Fish

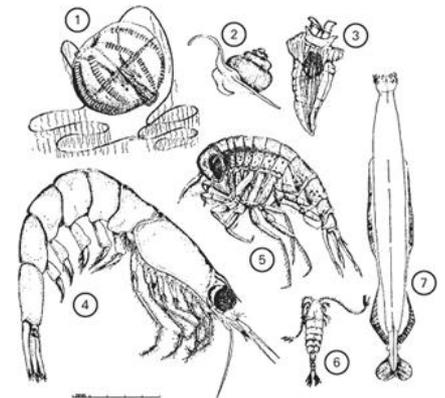
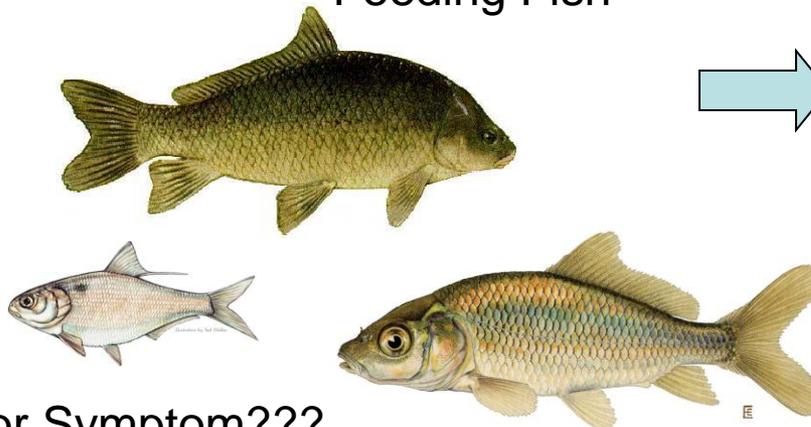


Minnow/Aquatic Insect Eating Fish



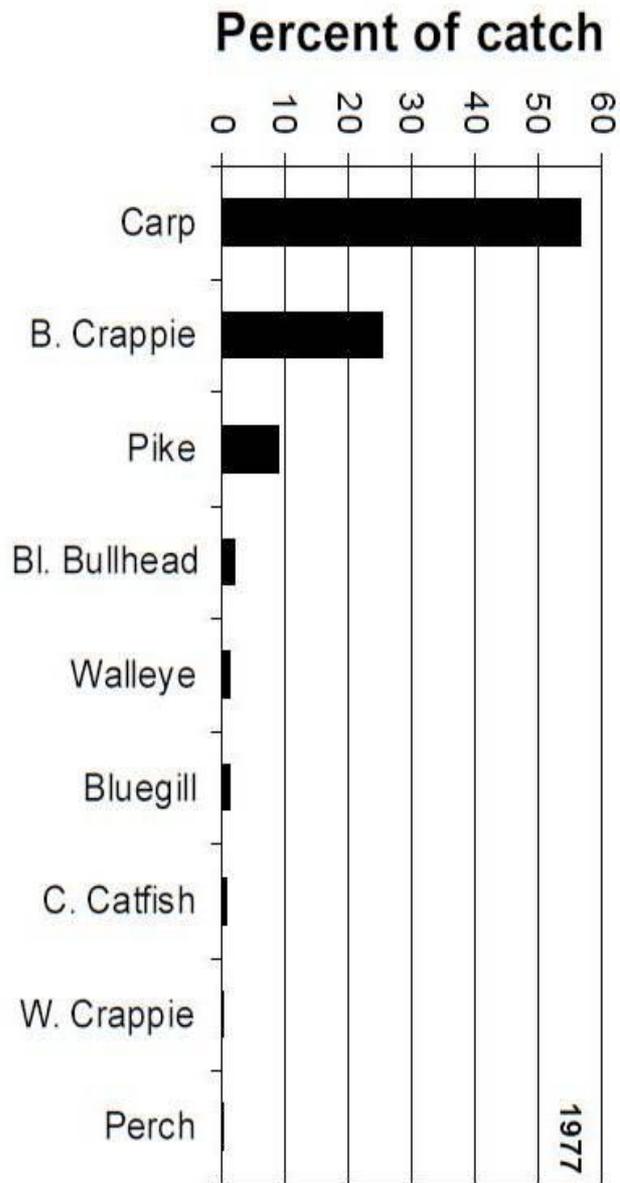
Prey – Aquatic Insects, Littoral

Filter/Benthic Feeding Fish

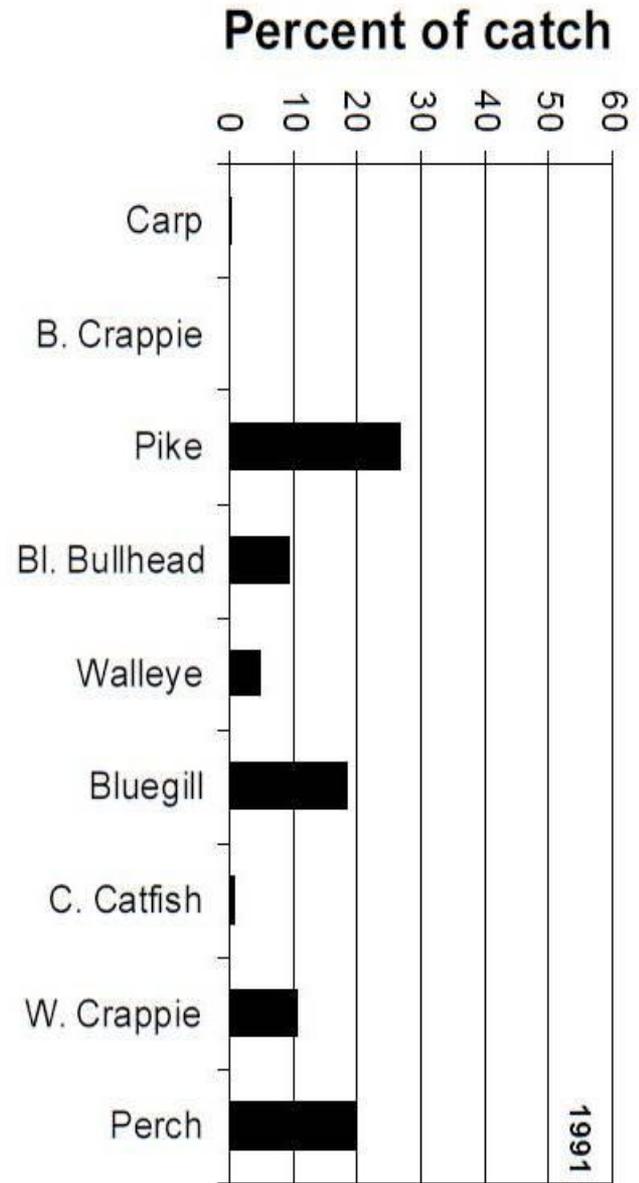


Prey – Zooplankton, Free Floating/Benthic

Cause or Symptom???

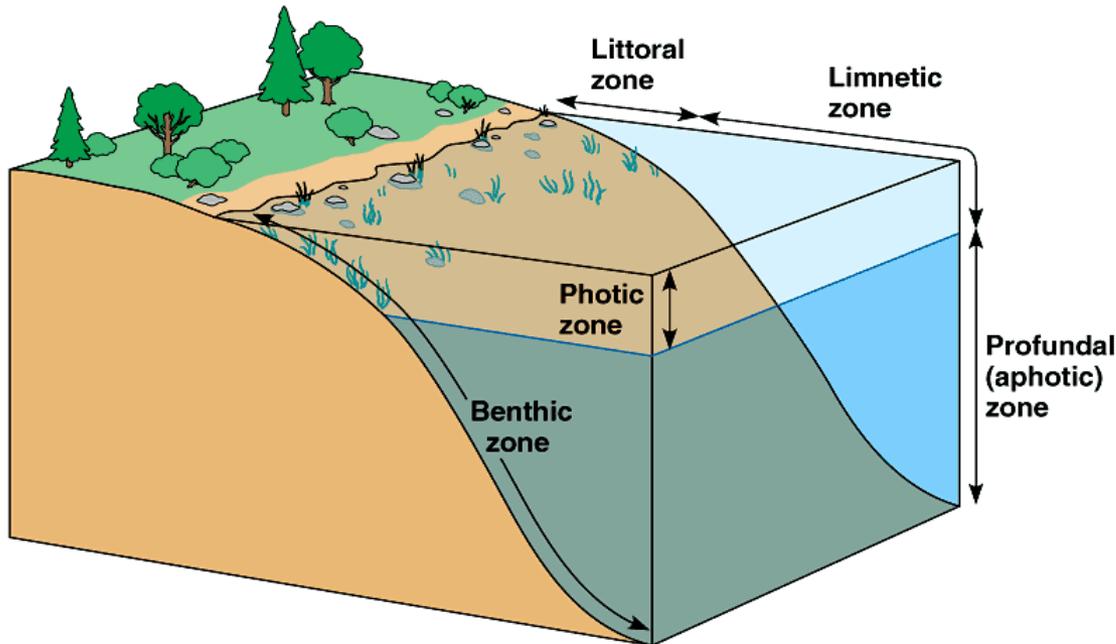
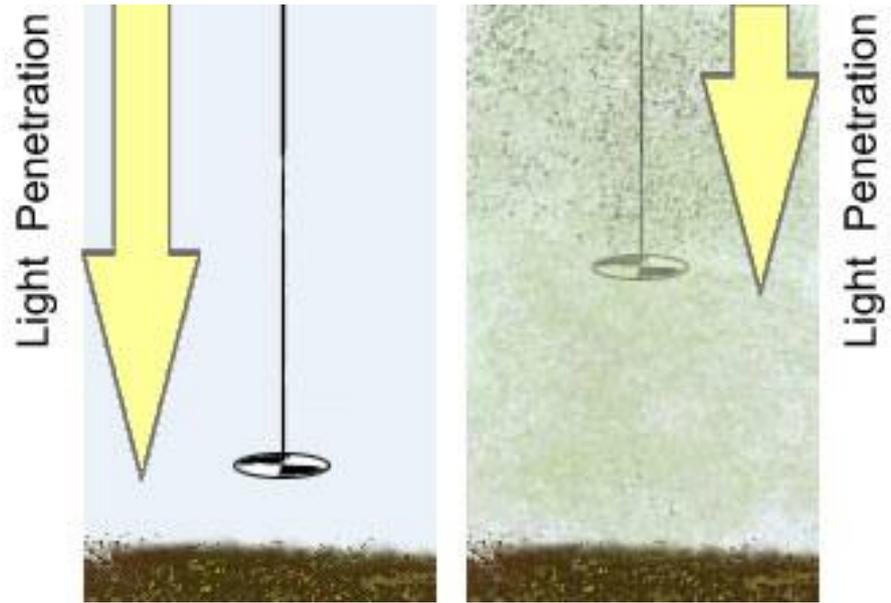


Prior to 1977 Lake Plan Implementation



1991

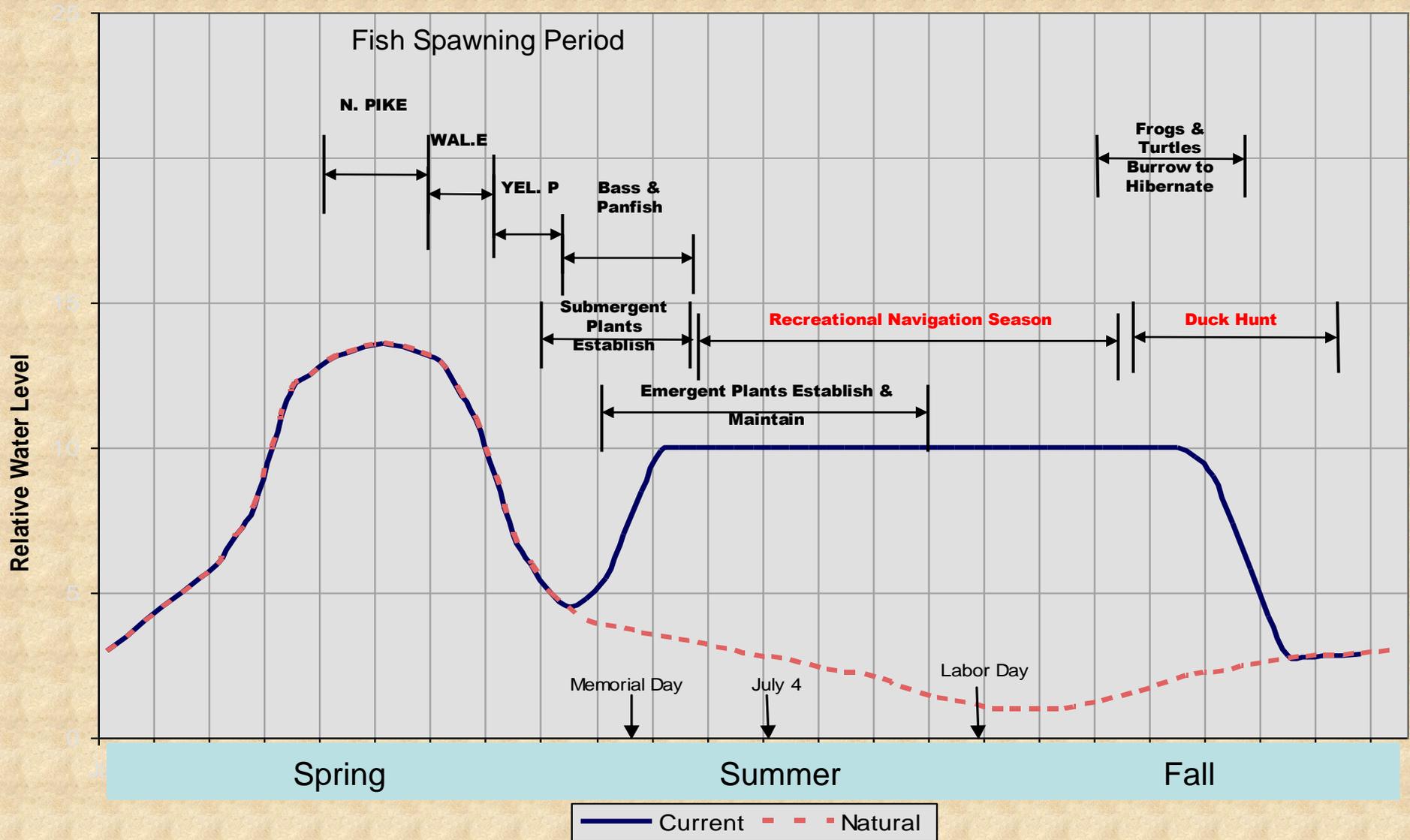
- Algae prevents light from reaching bottom.
- Decreasing water depth allows sunlight to reach bottom
- Rooted plants become established



- Rooted plants utilize phosphorus
- Reduced phosphorus results in less algal blooms
- Reduced algal blooms results in clearer water
- Clearer water allows more sunlight to reach the bottom for rooted plants

Water Level Changes

Fish, Habitat, & Recreation



Resiliency:

a : capable of withstanding shock without permanent deformation or rupture

b : tending to recover from or adjust easily to misfortune or change

Not to be confused with:

Resistant:

a : impervious to being affected

b : resistant to change



Unstable Lake Conditions?



Established Plant Bed



Established Lawn



“Resilience” allows them to “bounce-back”
from flooding/drought/abuse

Established Plant Bed



Established Lawn

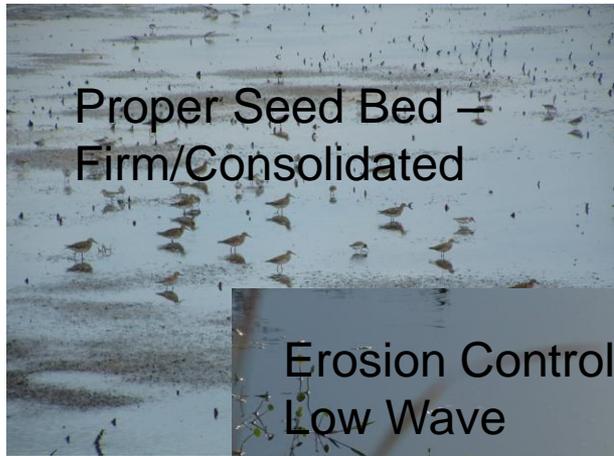


Continual Abuse/Neglect will eliminate desired plants.

Establishing new plant beds require special conditions/care, not unlike establishing a new lawn.....

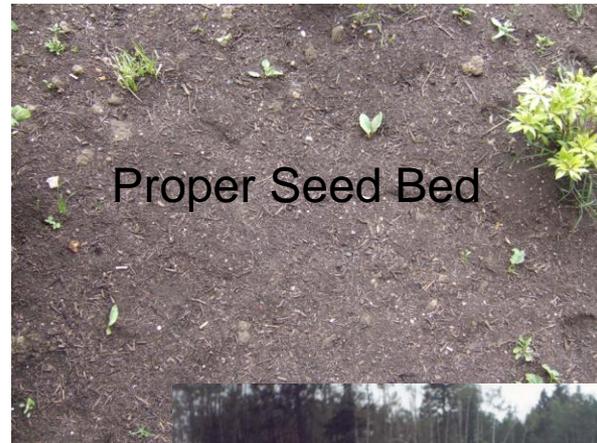


Newly Established Plant Bed



Conducted at
Proper Time of
Year

Newly Established Lawn



Moving Forward by Looking Back...

Establish a Baseline Trend with Historical Data

Set Objectives

Establish Strategy to achieve Objectives

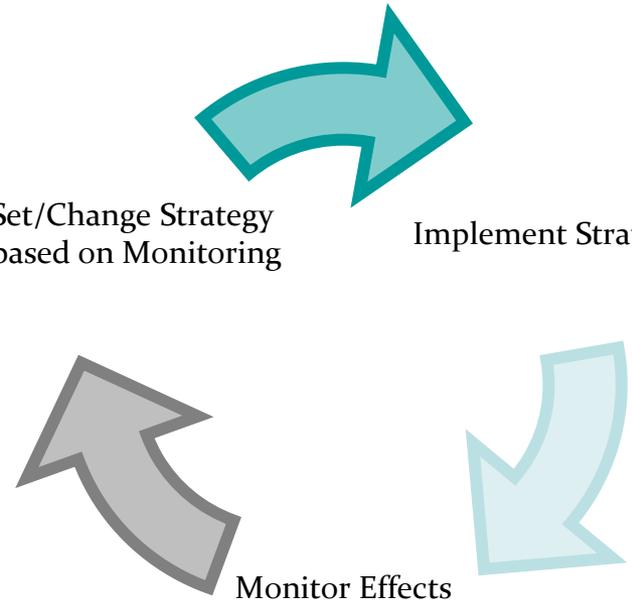
Continuously Monitor and Adjust Strategy



Set/Change Strategy
based on Monitoring

Implement Strategy

Monitor Effects



Adaptive Management
approach that incorporates the
results of a new monitoring
program into management
action in order to adapt and
learn over time.

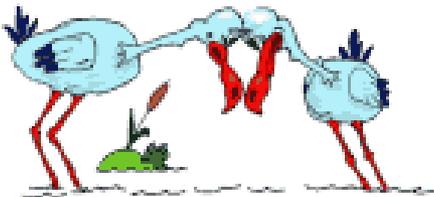
4 Variables of Water Level Fluctuations

Timing (Season)

Magnitude (How Much?)

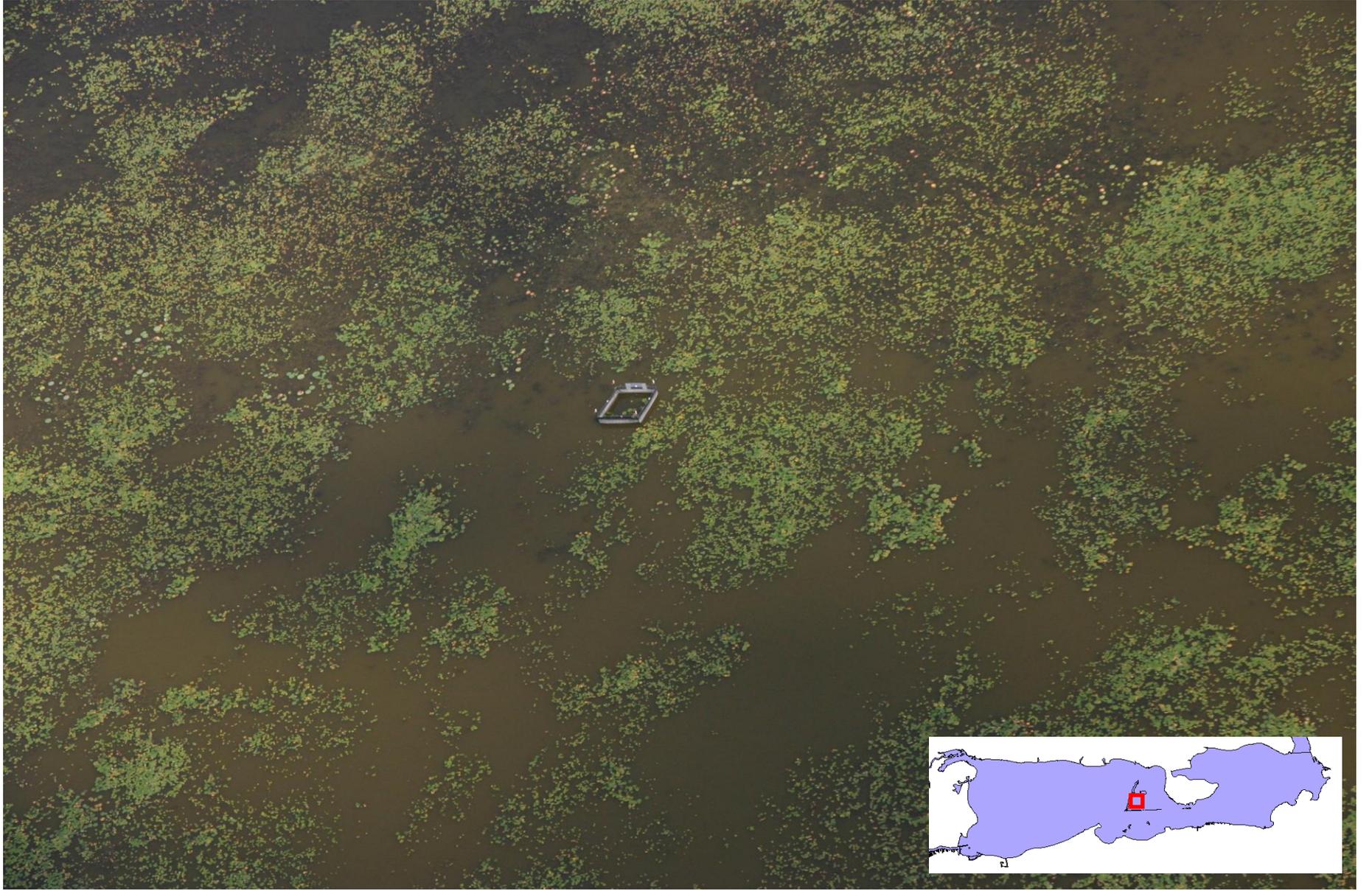
Duration (How Long?)

Frequency



Management Activities

- Historical Photo Analysis
- Increase carp removal
- Dredgebank Enhancement
- Carp Exclosures monitoring plots
- Aquatic Plant Monitoring
- AIS Monitoring
- Water Level Monitoring
- Shoreland Restoration
- Boater Education (maps, kiosk, etc)
- Cormorant Control
- Water Level Manipulation
- Fisheries Study
- Watershed Management (Runoff Control Projects, NMP, etc)
- Historical Data Collection



Take Home Message....

Modified water levels are a lake stressor that needs to be managed.

(i.e. Lakes with artificially manipulated water levels need to be properly managed to meet the needs of the lake to prevent degradation over time.)





Questions?

