Little Lake, Wells, VT

Water quality status and options for management

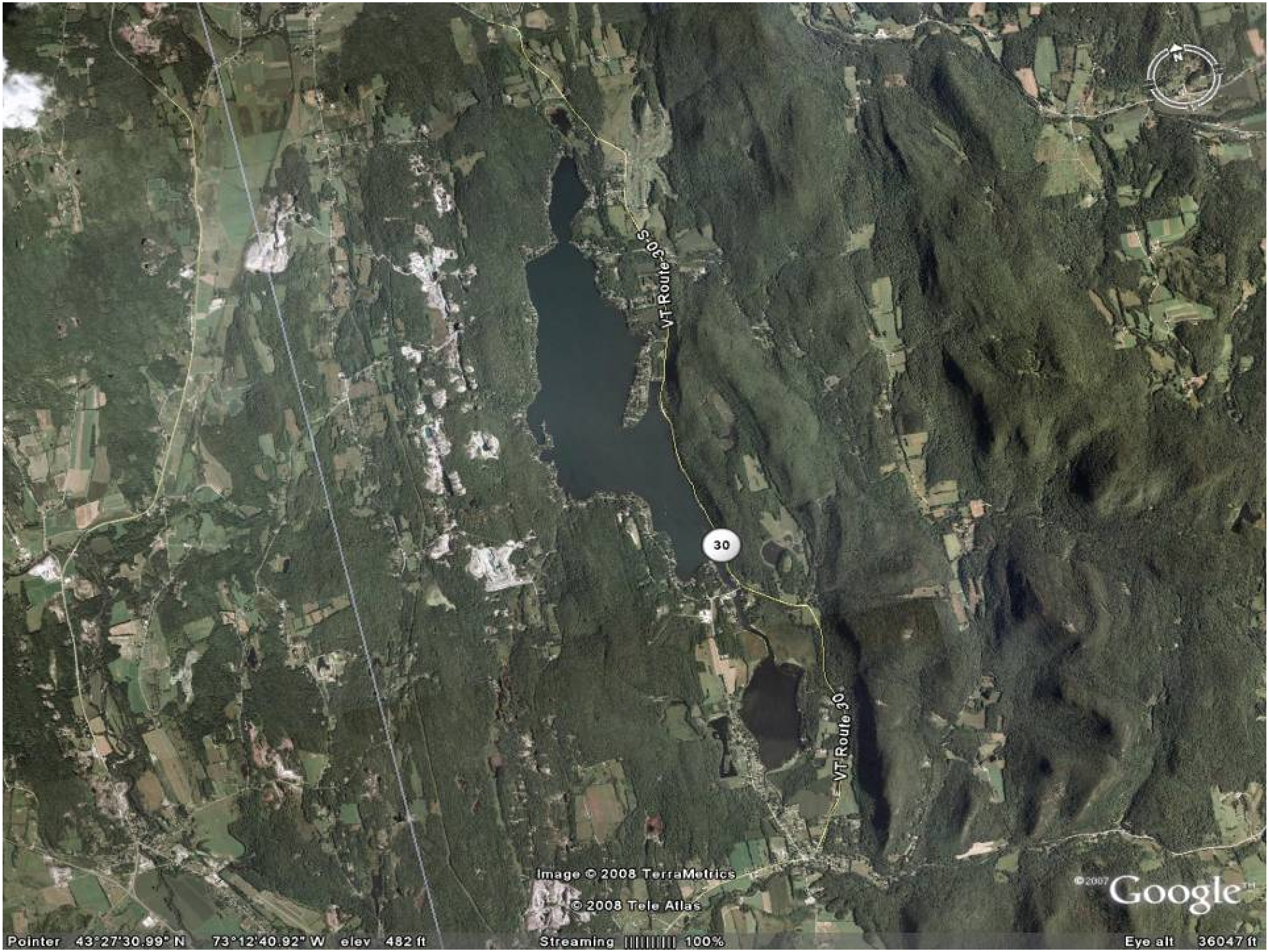
VT Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division

9-5-2008

Goals for this evening's presentation

- Summarize what DEC knows of the history of this lake
- Water Quality 101
- What do alternative management approaches mean for the water quality status of Little Lake?
- Describe how DEC can assist in the assessment and management of Little Lake

This presentation does not address nuisance aquatic plant management


VT Route 30 S
30
VT Route 30
Image © 2008 TerraMetrics
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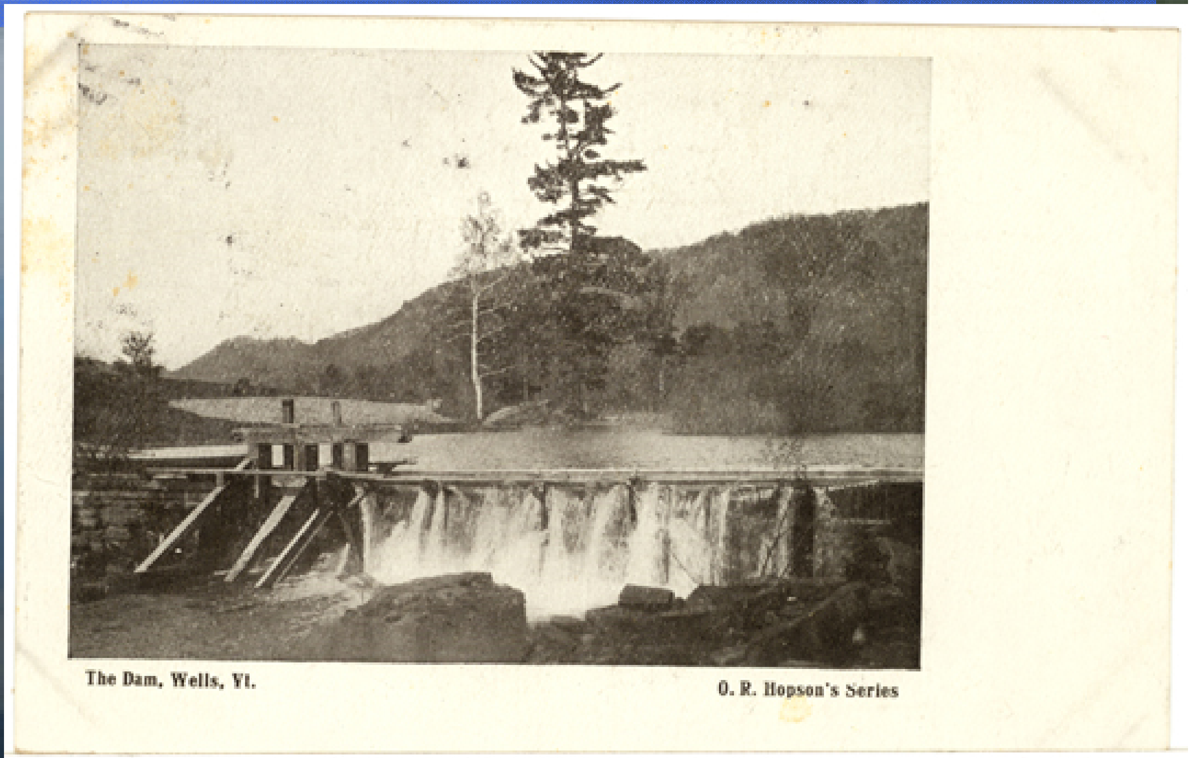
Pointer 43°27'30.99" N 73°12'40.92" W elev 482 ft
Streaming |||||||||| 100%
Eye alt 36047 ft

Geologic perspective

- Part of the northern Taconics
- Bedrock is ancient “Cambrian” shales underlain by younger “Ordivician” shists
- Landscape is the product of glaciation
- St. Catherine is a glacial relict lake

A historical perspective

- VTDEC Dam inventory indicates initial construction ~1900
- Impounded 7 feet of water
- Owned by VT F+W, managed for recreation
- Photo: 1908



A historical perspective

- Created a 162-acre impounded wetland
- Maximum depth at the time would have been the wetland water depth + 7’

- Note these non-existent development pressures in the ~1910’s
- What portion of the watershed is deforested at this time?

A historical perspective

- Development pressures still low in the ~1970's

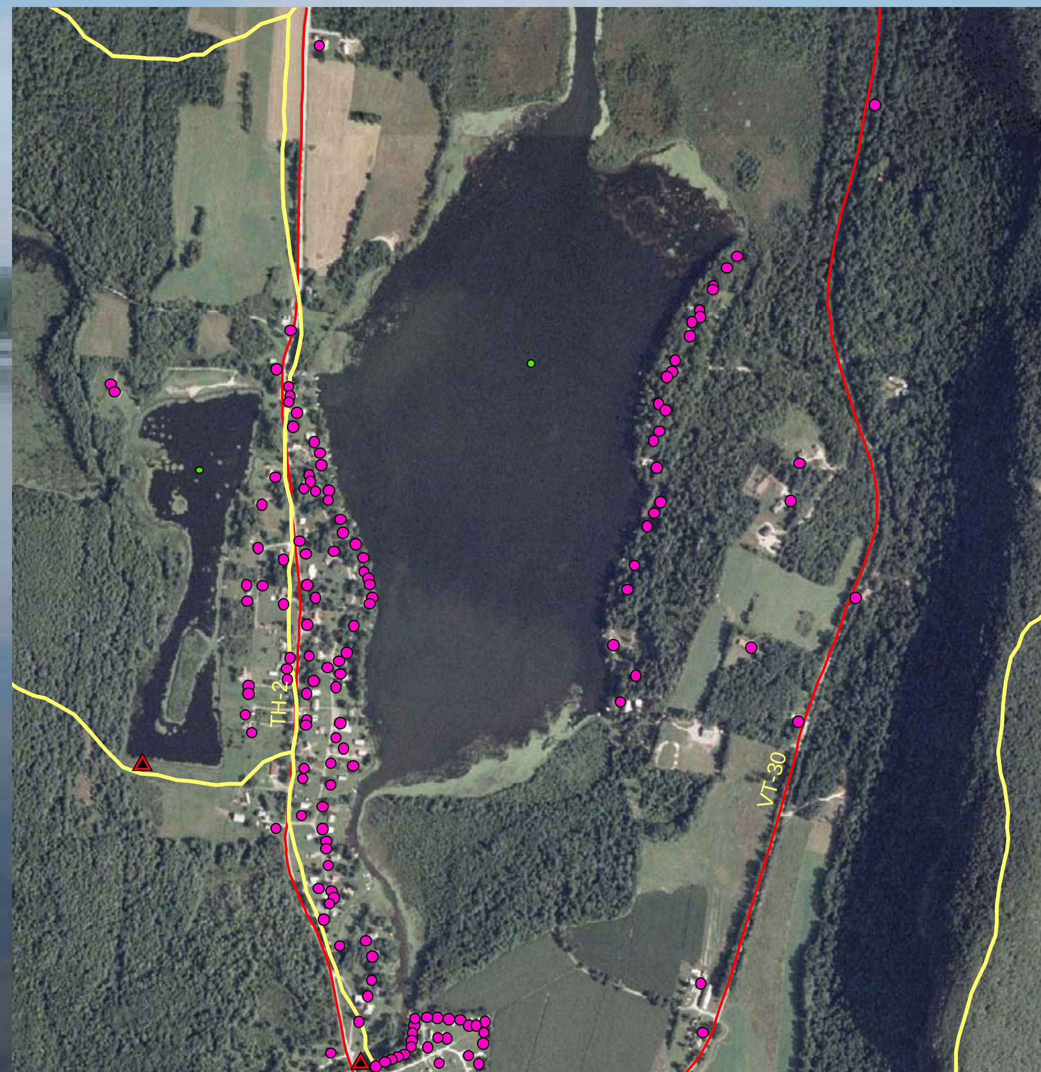
And now?

- In 2007, much of what was once buffered farmland is now multi-tiered development with “perforated” buffers.

A similar situation for St. Catherine

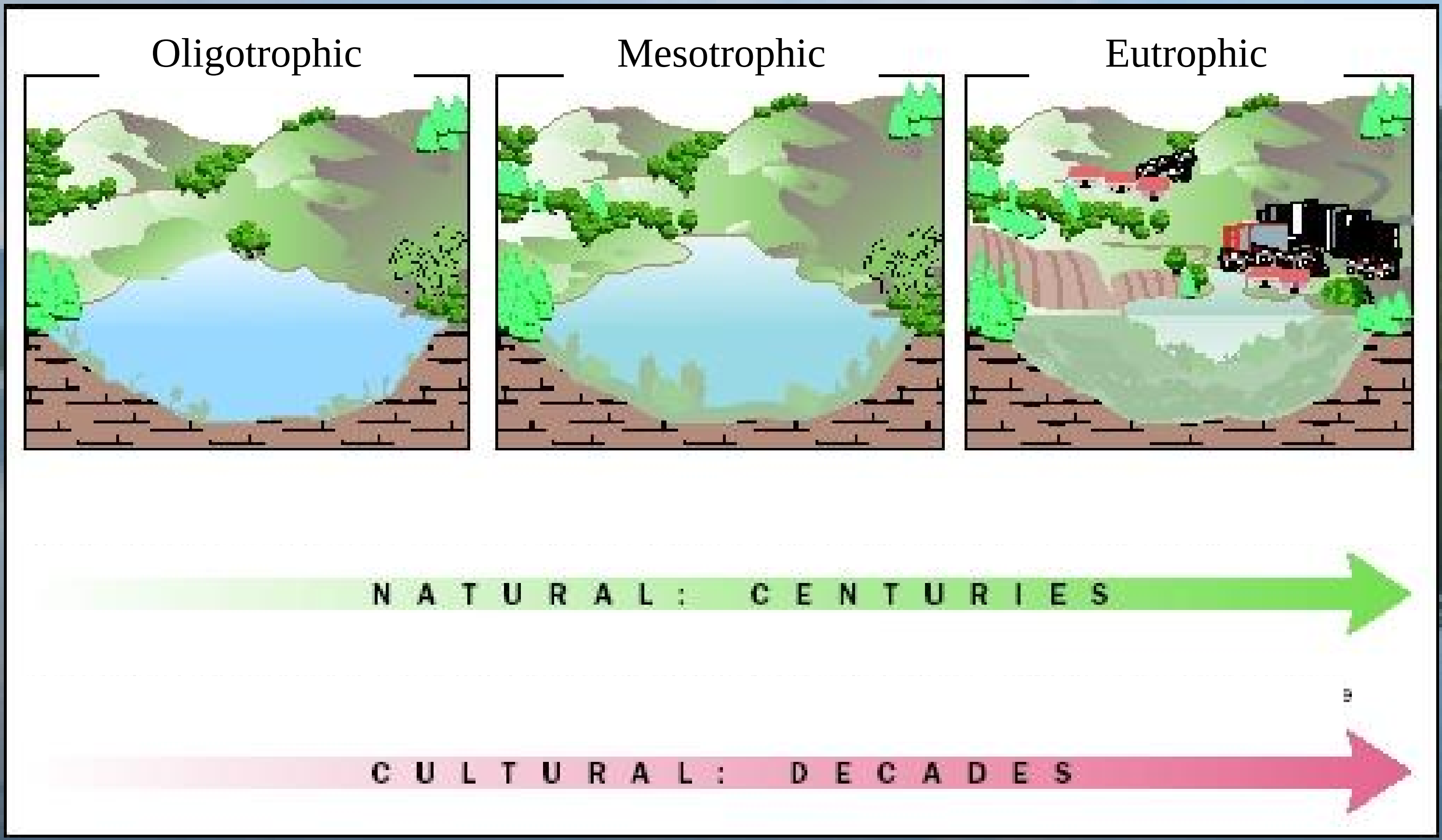
Here are the "E911" locations proximal to the Little Lake shoreline

- 147 E-911 addressed locations w/in 100m of Little Lake's shoreline.




Water quality and lakes

The story of ***eutrophication***



- Trophic state reflects ***primary production*** in lakes

Phosphorus (P)

- Essential nutrient for most life on earth (can't make proteins without it).
- *"Limiting nutrient"* for nearly all north-temperate freshwaters; responsible for primary production.
- Small increases in P result in potentially important algae growth.
- Excessive P brings algal scums, odors, drinking water problems, and even presence of toxins.
- In some lakes, excess P brings excessive aquatic plant growth instead of algae growth.

In the ocean, nitrogen is the limiting nutrient, in excess it can cause toxic "Red Tides"

In northern lakes, P is the limiting nutrient, in excess it can cause toxic blue green algae

Images thanks to N.C. State Univ.

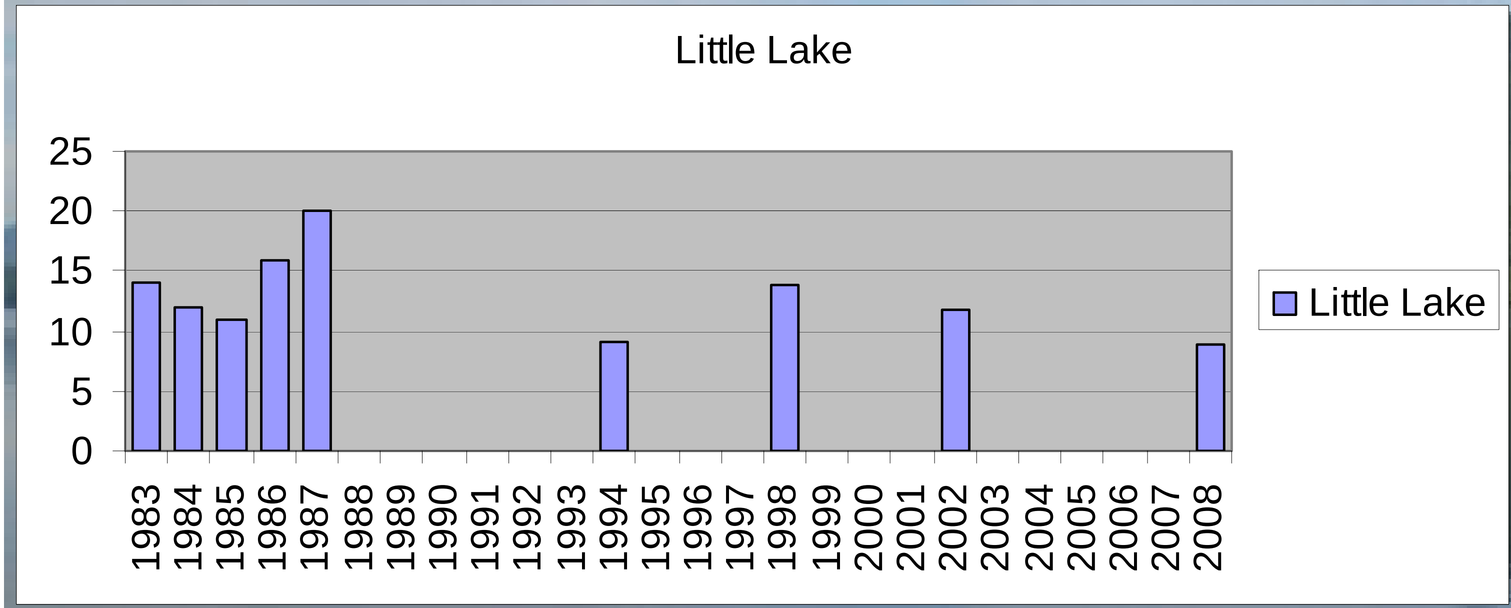
Where does the P come from?

- Phosphorus mostly travels attached to soil particles;
- Therefore, the major phosphorus source is land disturbance;
- ***Non-point*** sources include roads, agricultural operations, uncontrolled stormwater runoff;
- Some free (or dissolved) phosphorus dissociates from particles in lakes
- ***Point sources*** include WWTF's and septic systems, and this P is usually "free" P. Manure is also a source of "free" P.
- Algae blooms are favored by a preponderance of "free" P.
- Particulate P is typically used by plants instead of algae.

How VTANR measures P statewide – the Spring Phosphorus Program

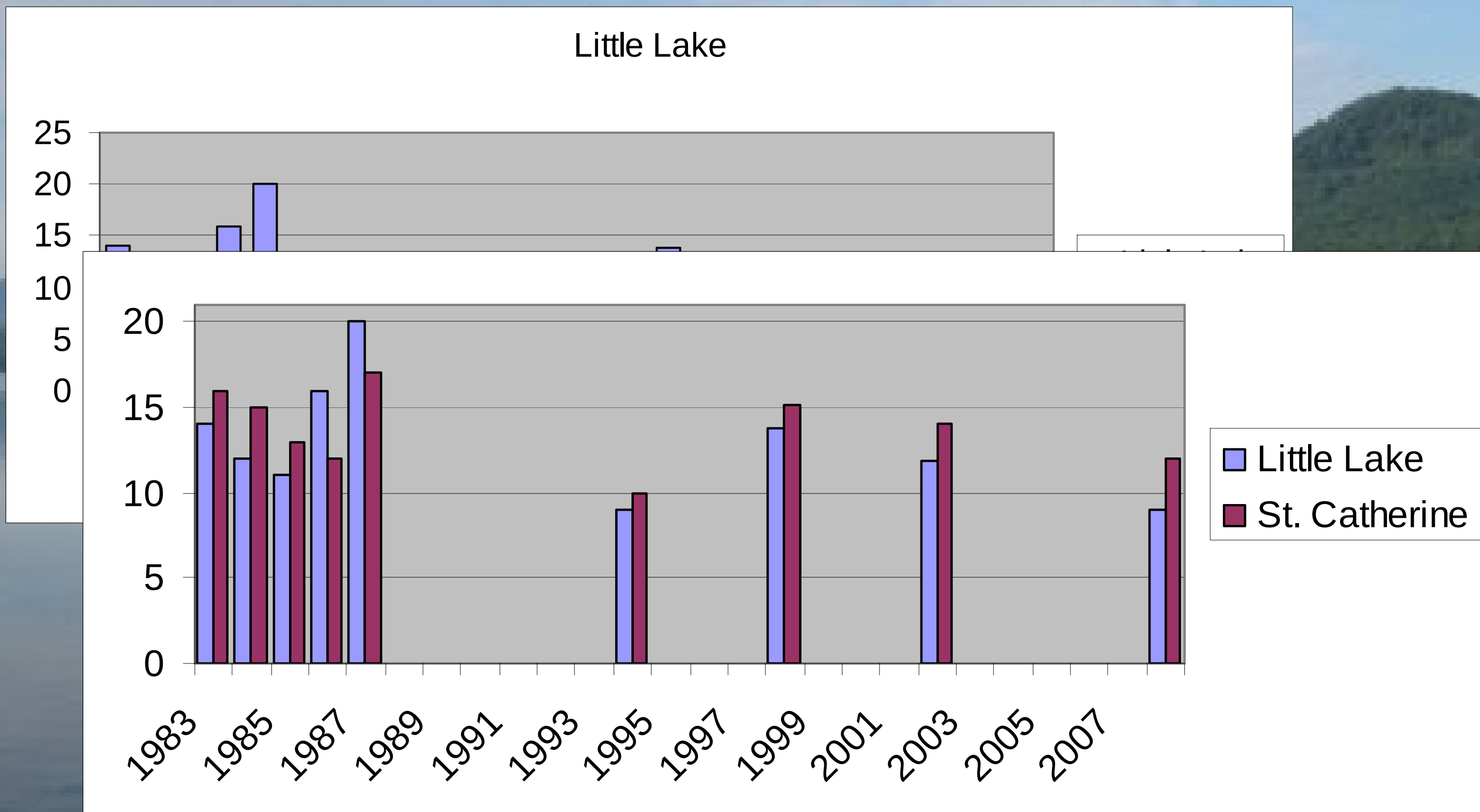
- Annually at ice-out, and on a rotation, we measure:
  - Phosphorus
  - Nitrogen (another important nutrient)
  - Basic water chemistry variables
- Why these tests?
  - Allows VTANR to track lake eutrophication status relative to other lakes statewide
  - Provides ecological insight into lake ecosystem functioning

Spring phosphorus in Little Lake



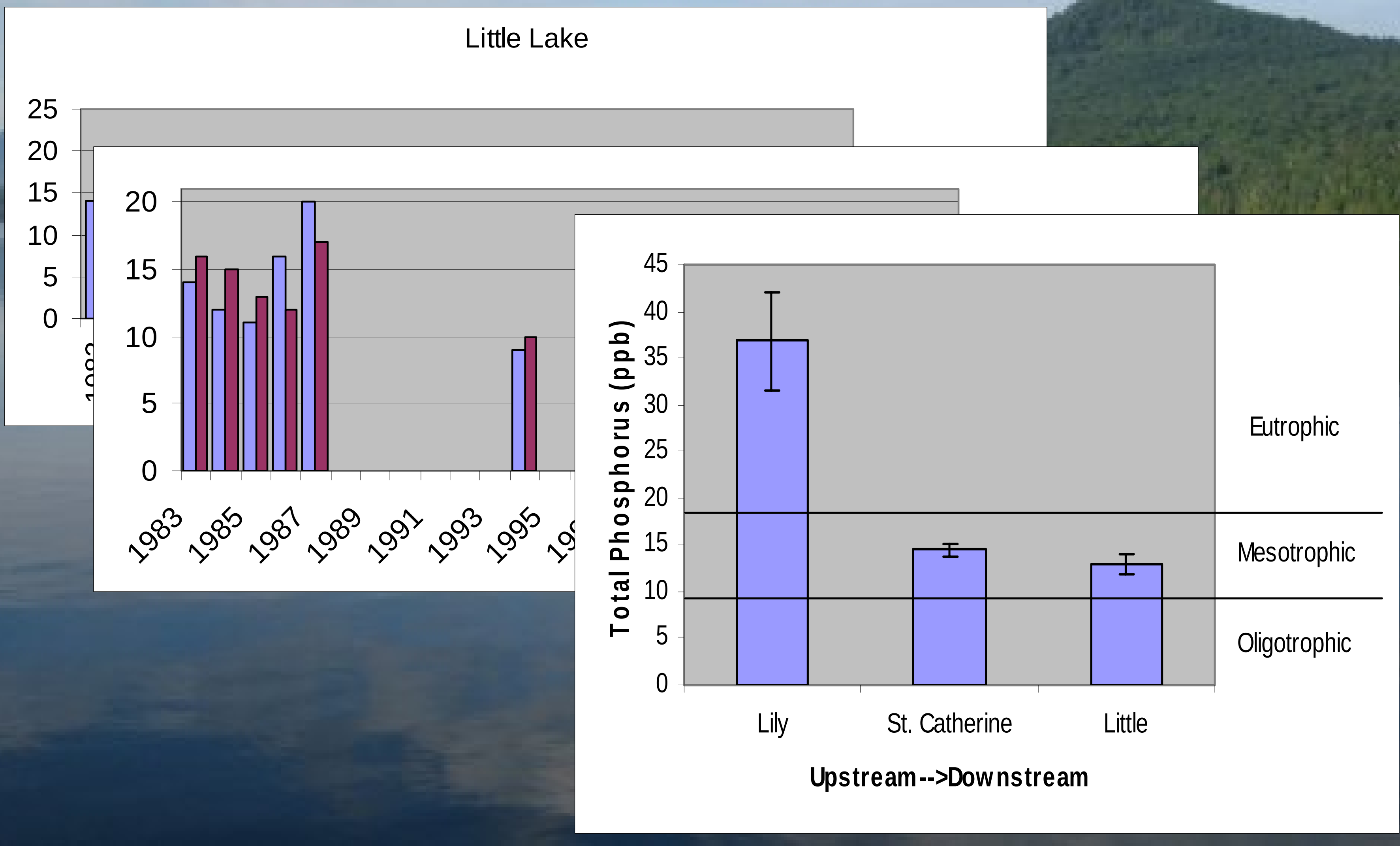
- Phosphorus has declined slightly with time

Spring phosphorus in Little Lake

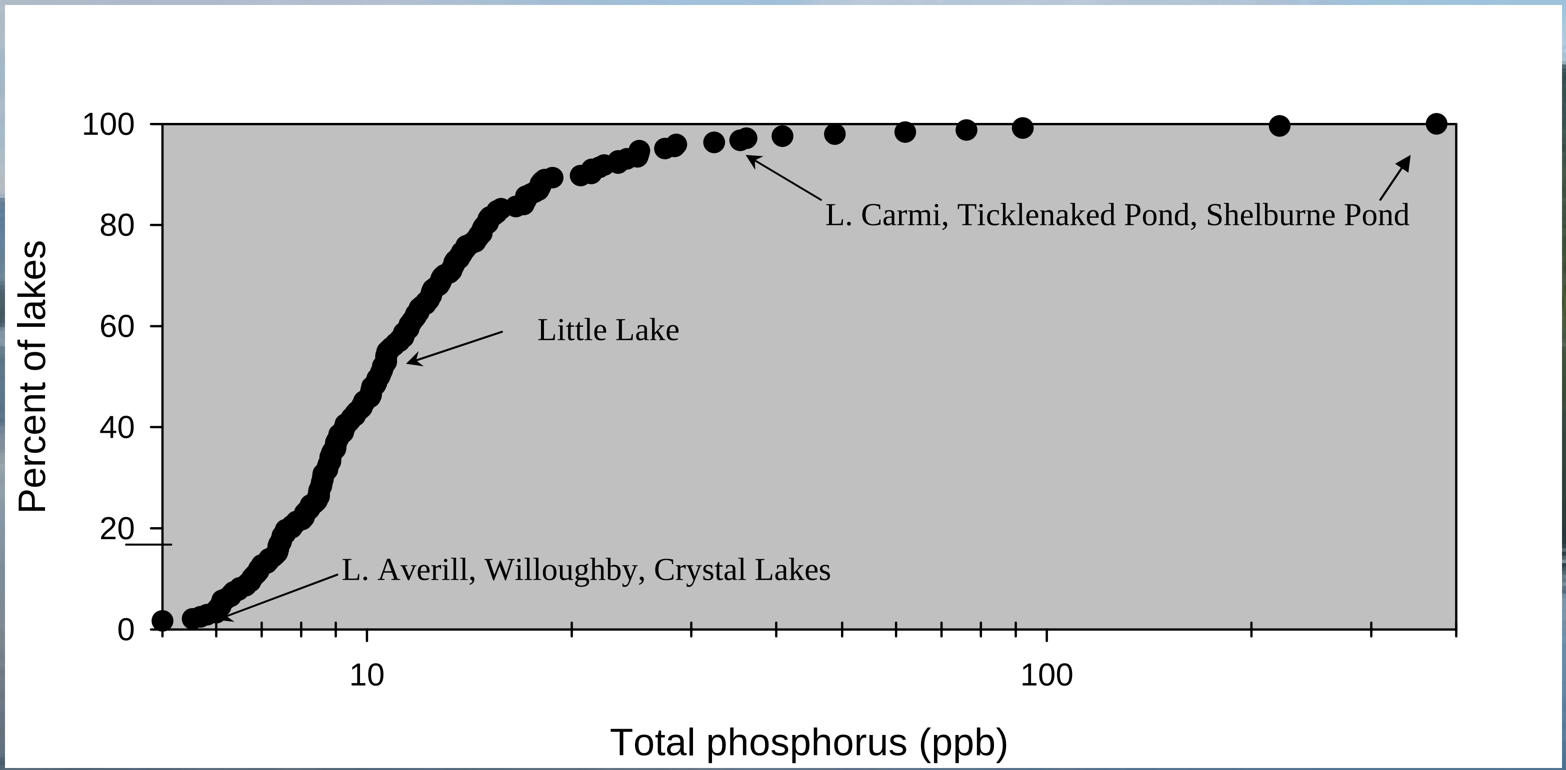


- Phosphorus is related to upstream St. Catherine values, and mostly slightly lower

Spring phosphorus in Little Lake



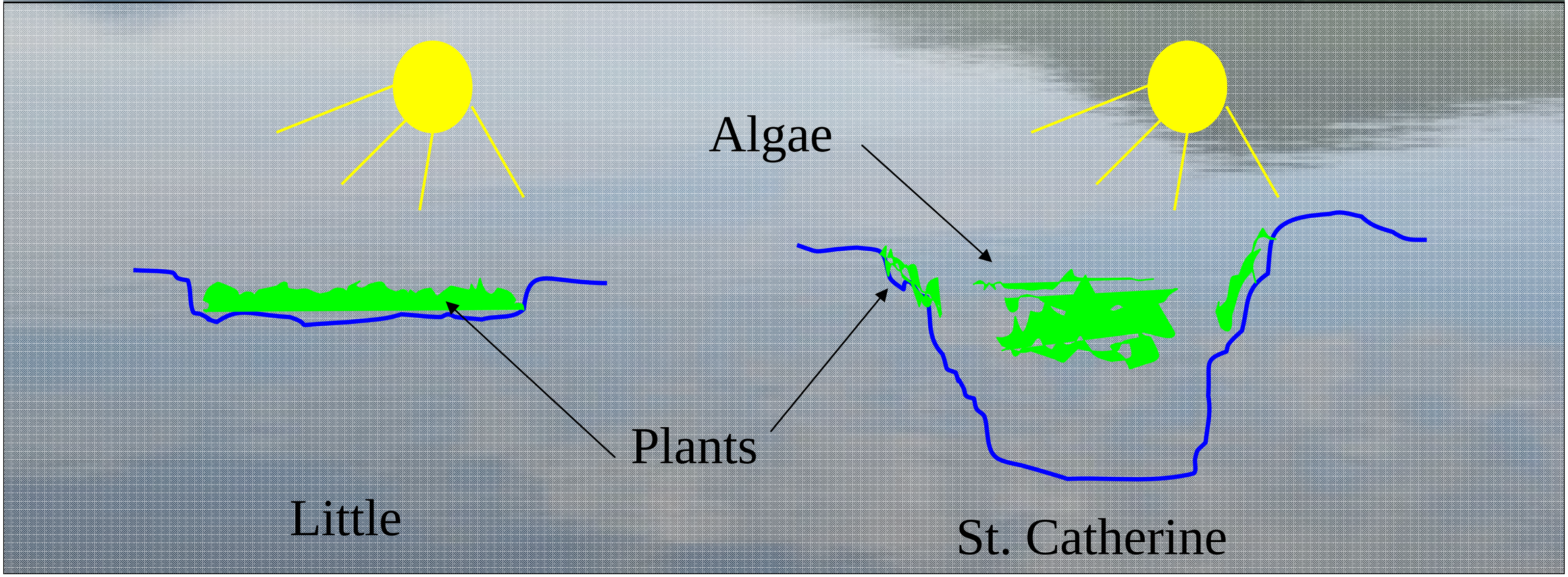
How Little Lake Lake ranks statewide



- Little is about in the 50th percentile for lakes in Vermont

Yet, the lake "looks" eutrophic!

- In lakes, productivity will partition in different compartments, and light plays a critical role
- Some lakes are algae dominated
- Others are plant dominated.



These are called stable states

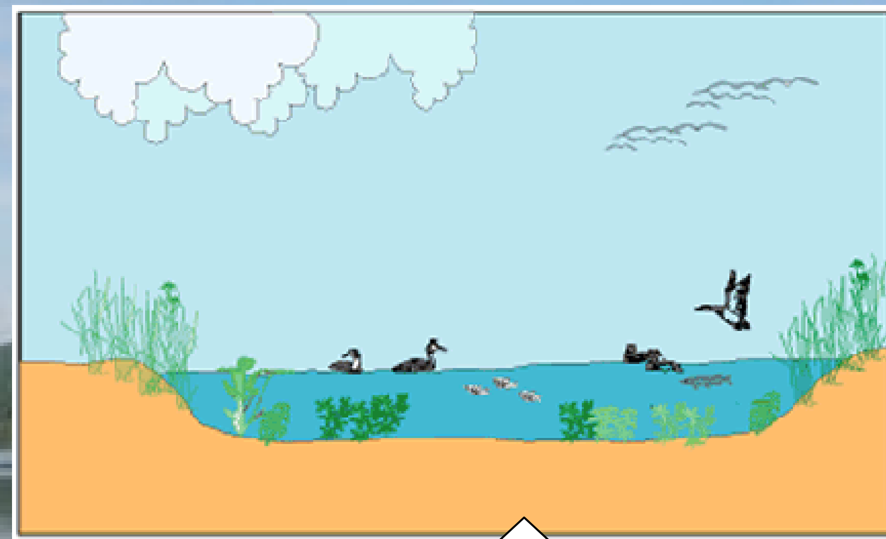
- Ecological theory tells us that primary production can fuel equally stable and sound communities that take different forms.

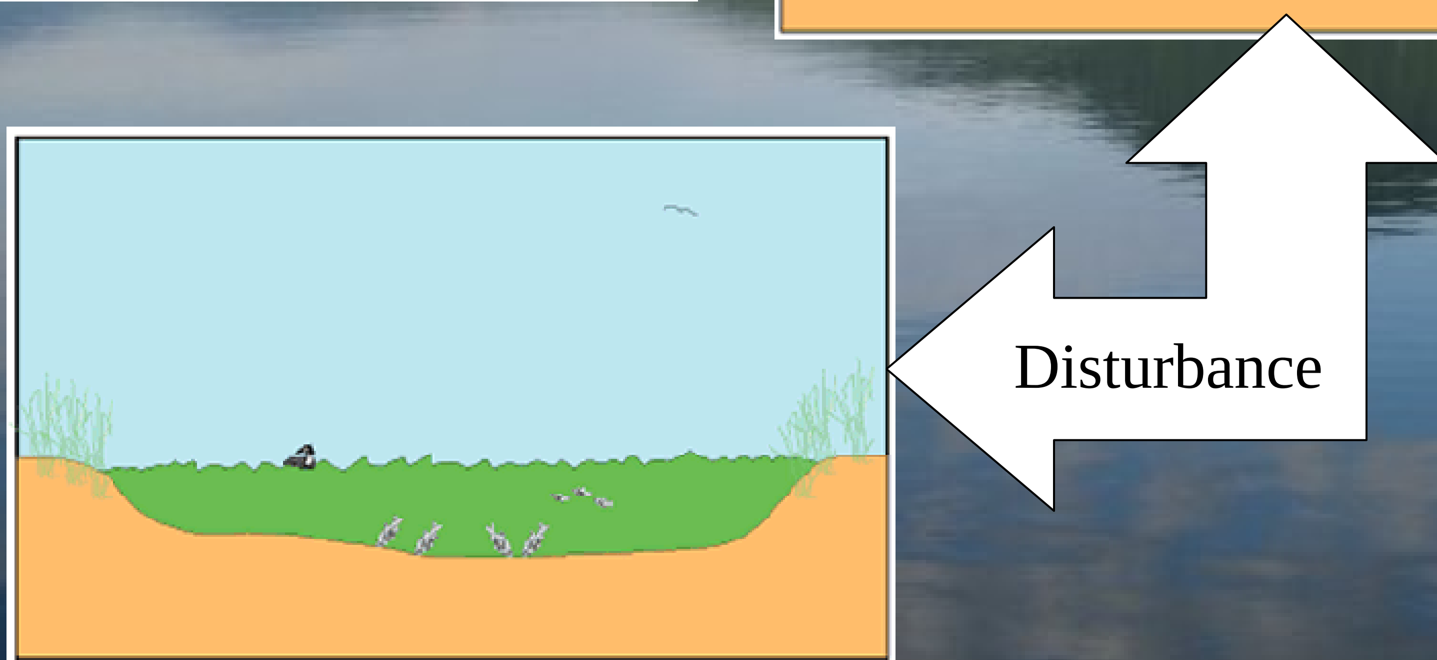
- In the face of perturbation, a system can change from one stable state to another. This is known as a stable state shift.

- The ***alternate stable state*** can persist thru geologic timescales

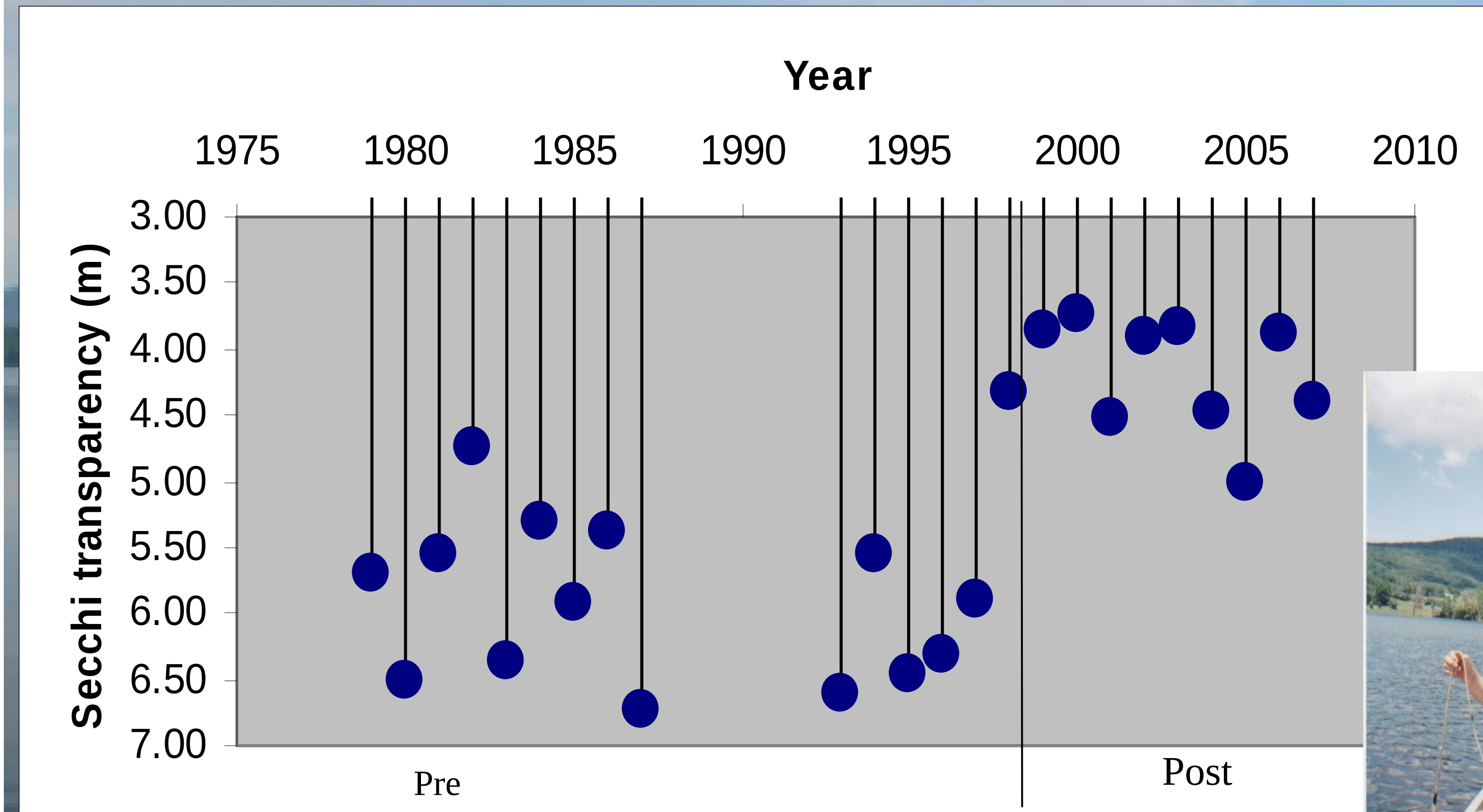
Alternate stable states

When disturbance disrupts a species' ability to occupy an ecological niche, other organisms compete for the vacated resource.





Stable state shift in St. Catherine



- Alewife introduction altered stable community function toward dominance by algae instead of algae-eating plankton

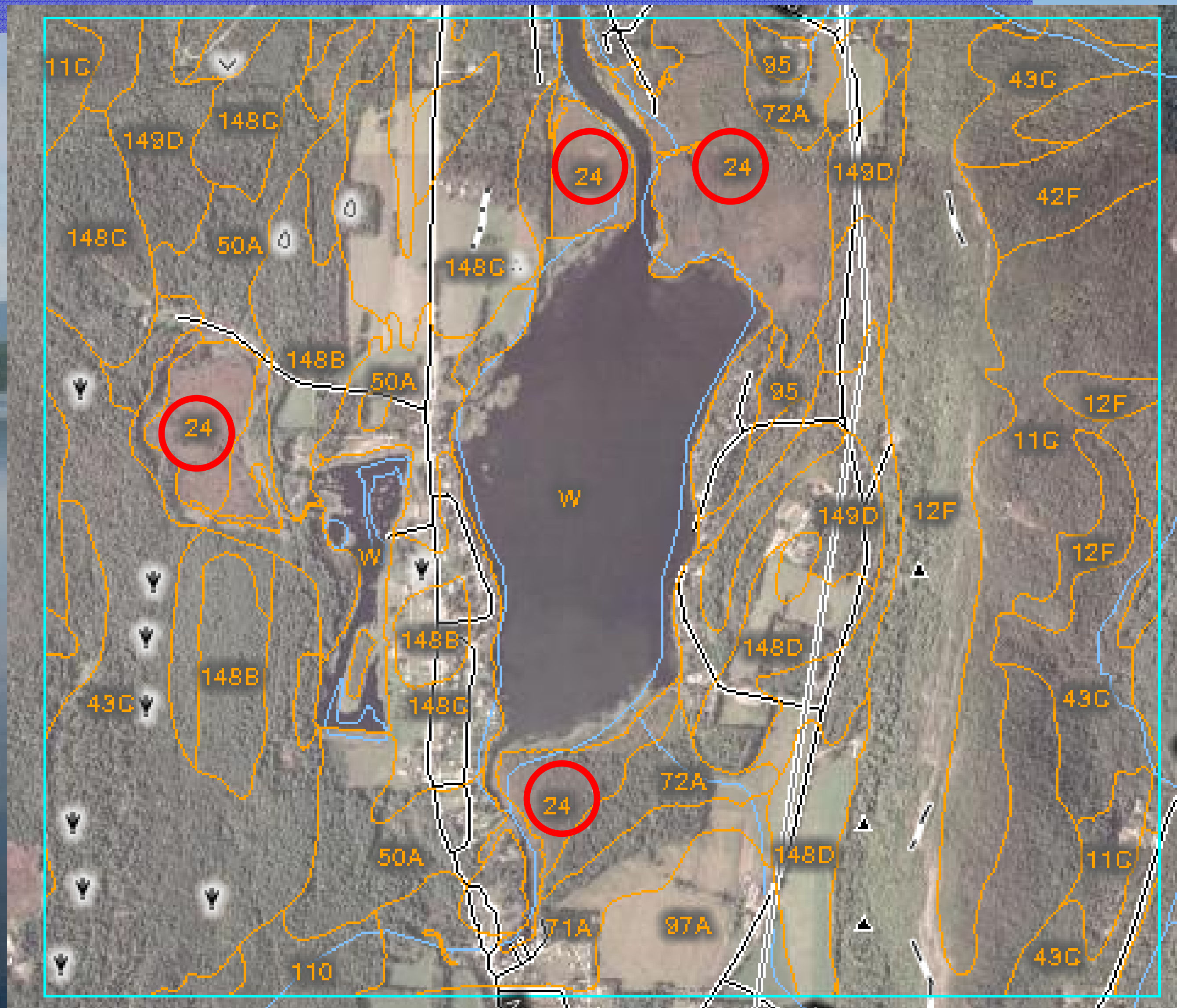
Alternate states in shallow lakes

- ***Clear-water phase***
  - Productivity compartmentalized into aquatic plants.
  - What algae exist die-off, they providing their nutrients to the sediments, thereby feeding plants.
- ***Turbid-water phase***
  - Productivity is compartmentalized into algae.
  - There is so much algae that they limit light availability to plants.

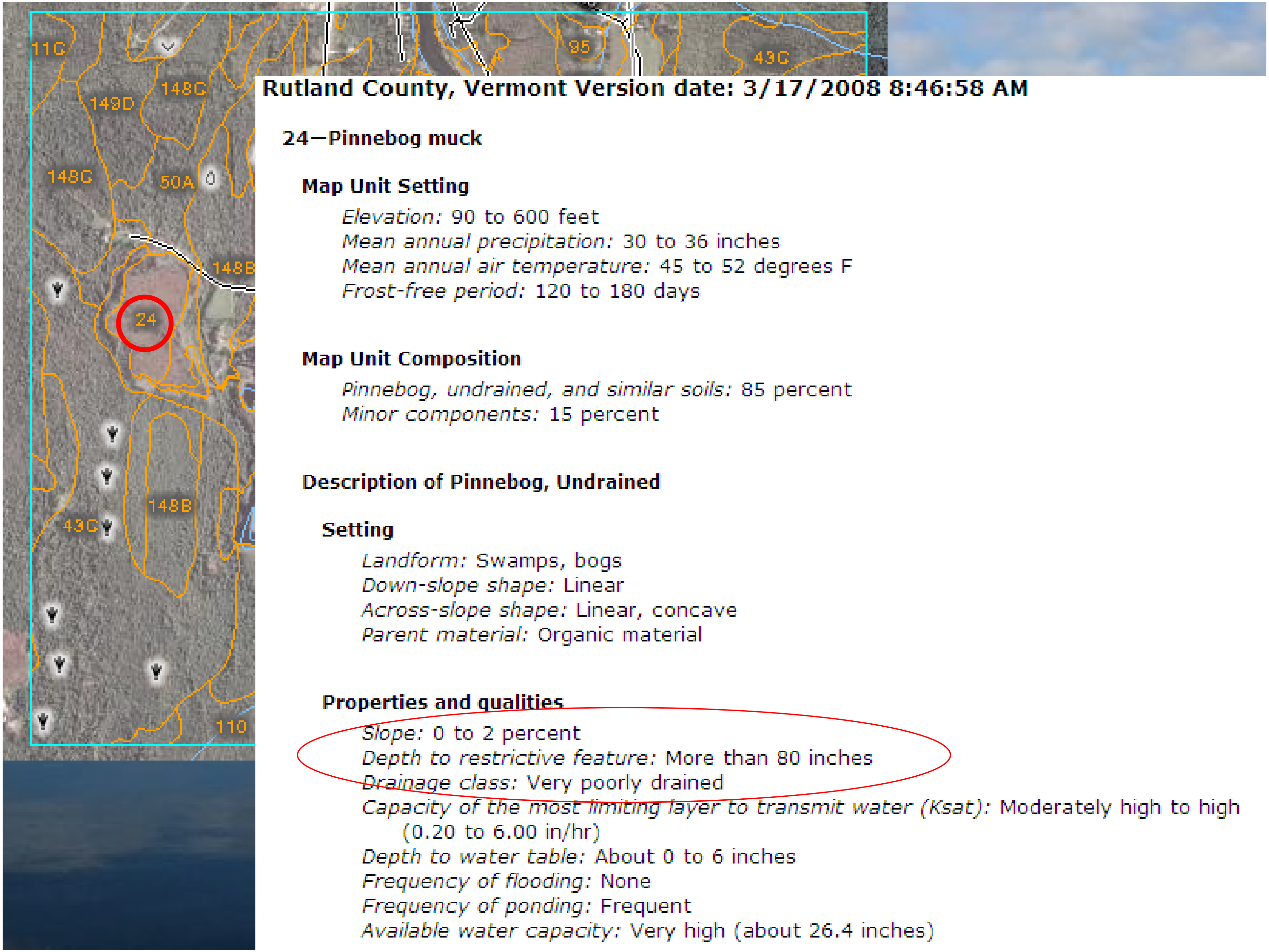
Little Lake was created by a massive perturbation!

- When lands are impounded to form reservoirs or lakes, major quantities of organic matter are immediately made available to the aquatic system.
- If the impounded area is a wetland, then there is already plenty of organic matter in-place.

Soils in the vicinity of Little Lake



NRCS Soil Survey Data for Rutland County



Rutland County, Vermont Version date: 3/17/2008 8:46:58 AM

24—Pinnebog muck

Map Unit Setting

Elevation: 90 to 600 feet
Mean annual precipitation: 30 to 36 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 120 to 180 days

Map Unit Composition

Pinnebog, undrained, and similar soils: 85 percent
Minor components: 15 percent

Description of Pinnebog, Undrained

Setting

Landform: Swamps, bogs
Down-slope shape: Linear
Across-slope shape: Linear, concave
Parent material: Organic material

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water capacity: Very high (about 26.4 inches)

Expectations of the original Little Lake

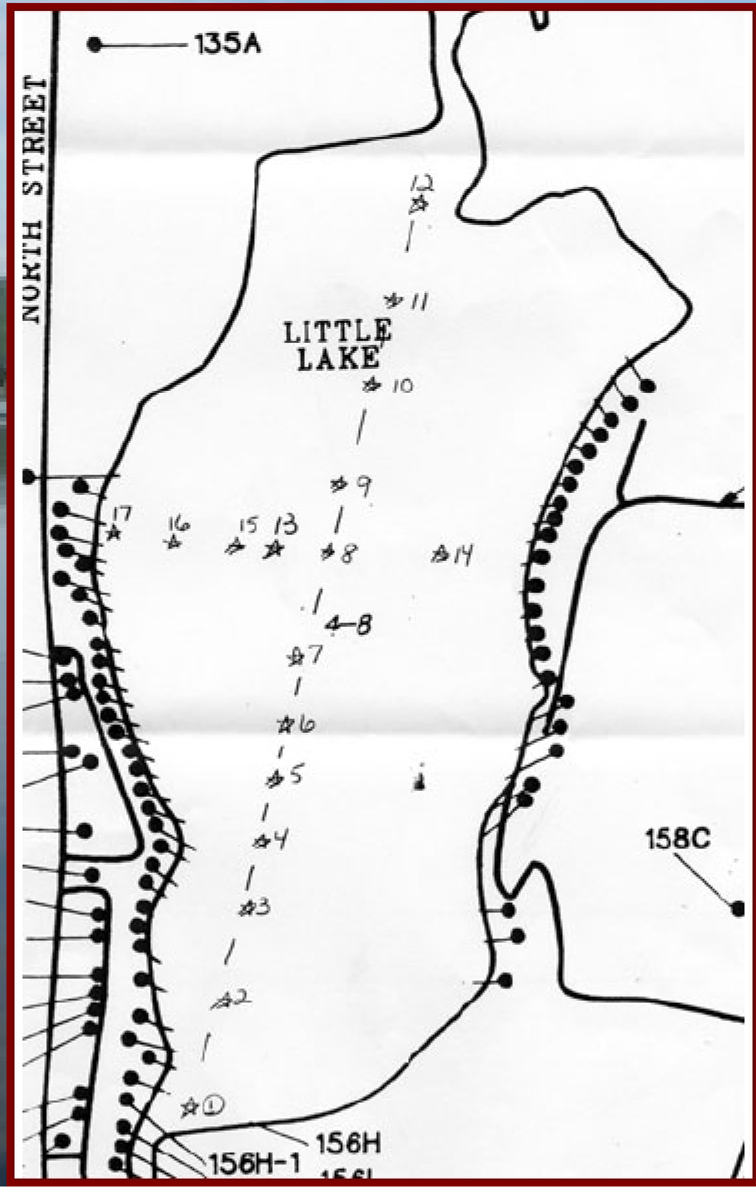
- The expectation for Little Lake is therefore a shallow-water pond system with high primary productivity, and lots of sediment.
- Fortunately, Little Lake currently exhibits characteristics of a clear-water phase.

Meet "Old Marsh Pond"

- 131 acre natural wetland, impounded
- Glacial valley origin
- Very little development pressure

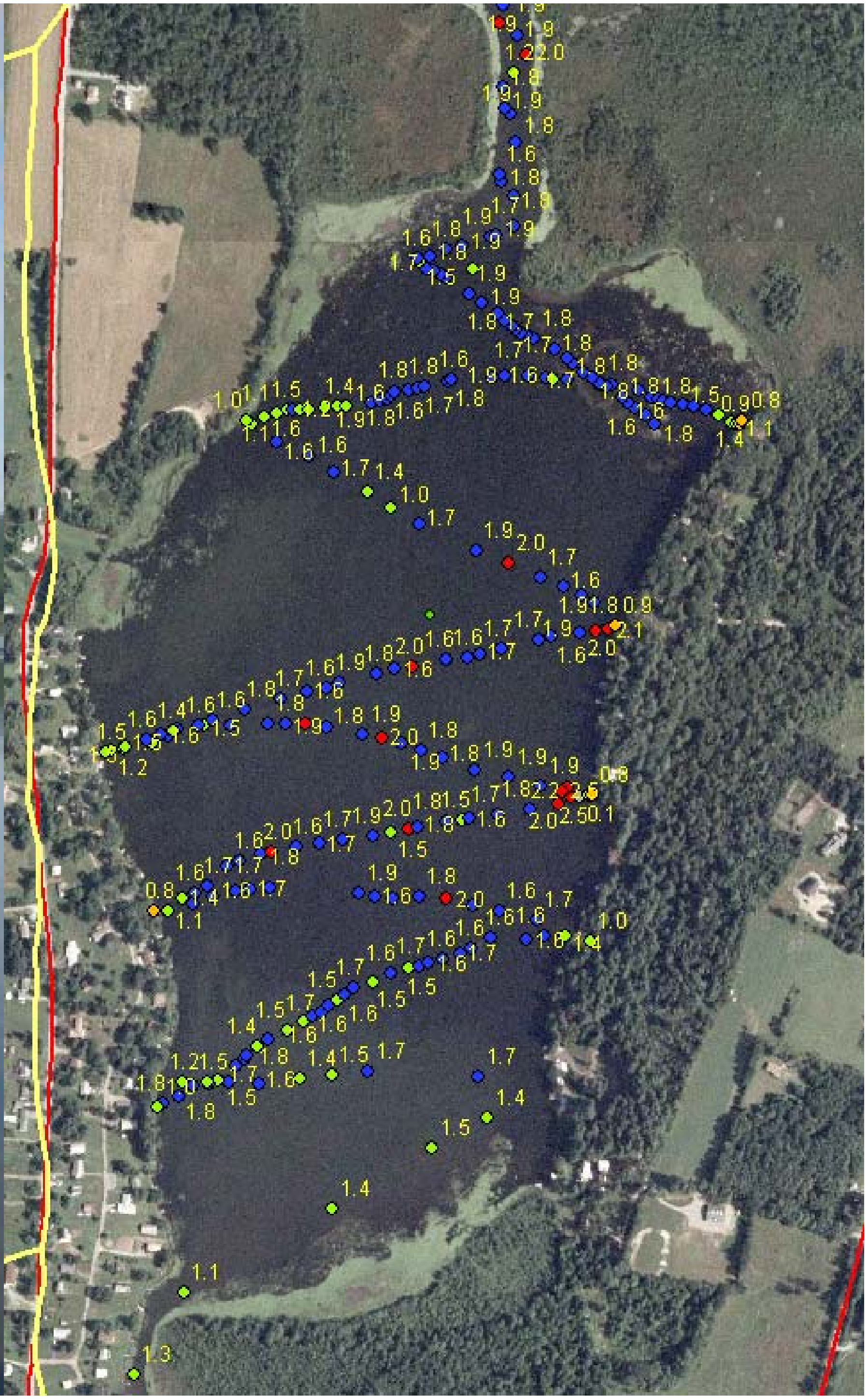
Lake water and sediment depths

Site #	Water Depth	Silt Depth	Total	Weeds
1	4'	0	4'	0
2	5'	0	5'	0
3	5'	2'	7'	some
4	5'	14'	19'	√
5	4'	19'	23'	√
6	4-5'	21'	25-26'	√
7	5'	23'	28'	√
8	5'	25'	30'	√
9	5'	25'	30'	√
10	5'	25'	30'	√
11	5'	25'	30'	√
12	6'	24'	30'	√
13	4'	26'	30'	√
14	4'	26'	30'	√
15	3-4'	11'	14-15'	√
16	2-3'	11'	13-14'	√
17	1-2'	5'	6-7'	√



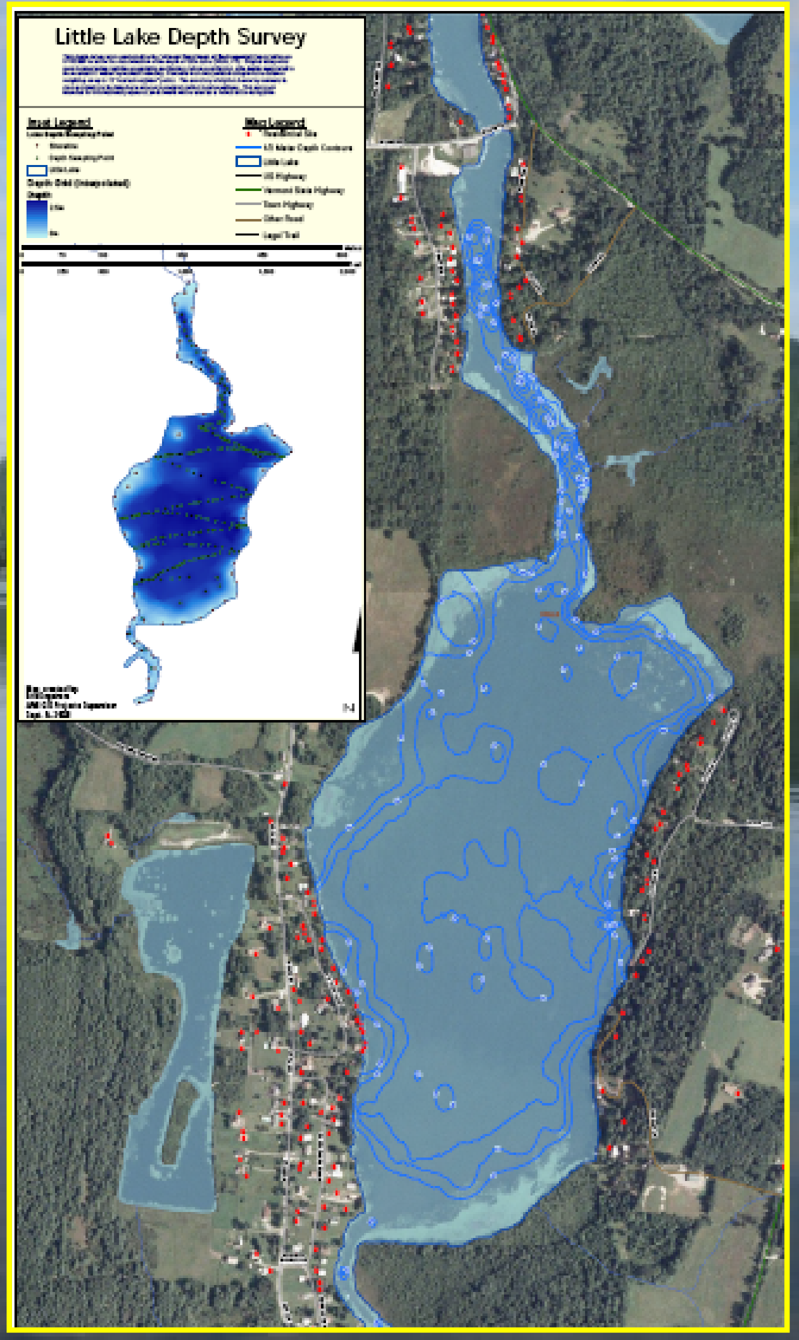
How deep is Little Lake?

- On 8/18/08 DEC field technicians performed a depth survey of Little Lake
- Used automated means to capture the survey
- Depths tested using hand-sounding to avoid inaccurate sonar readings



Depth map of Little Lake

- VTDEC Dam inventory indicates dam initially impounded ***7 feet*** of water.
- Depths of 5-6.5 feet are common throughout the openwater.



Little Lake is in a clearwater, plant-dominated phase

- VTANR believes this is preferable to a turbid-water, algae-dominated phase.
- The question then becomes how do we maintain a clearwater Little Lake while minimizing plant growth?
- What about the mud itself?

And if the sediment is the expectation in this lake, what can we do?

- Eurasian milfoil is a fierce competitor for sediments.
- Control of milfoil means other native species will return.
- Yet, many native plants preferentially colonize “fresh” sediments.
- Therefore, controlling sediment accumulation from watershed sources is a one strategy to control plant growth – particularly in nearshore areas.

Sediment delivery to Little Lake comes from the direct watershed

- Typically, there is 80% loss of sediment and P from upstream to downstream lakes
- Therefore, treating sediment sources in Little Lake should focus on the direct watershed and nearshore areas.

Maintaining a lake's natural line of defense

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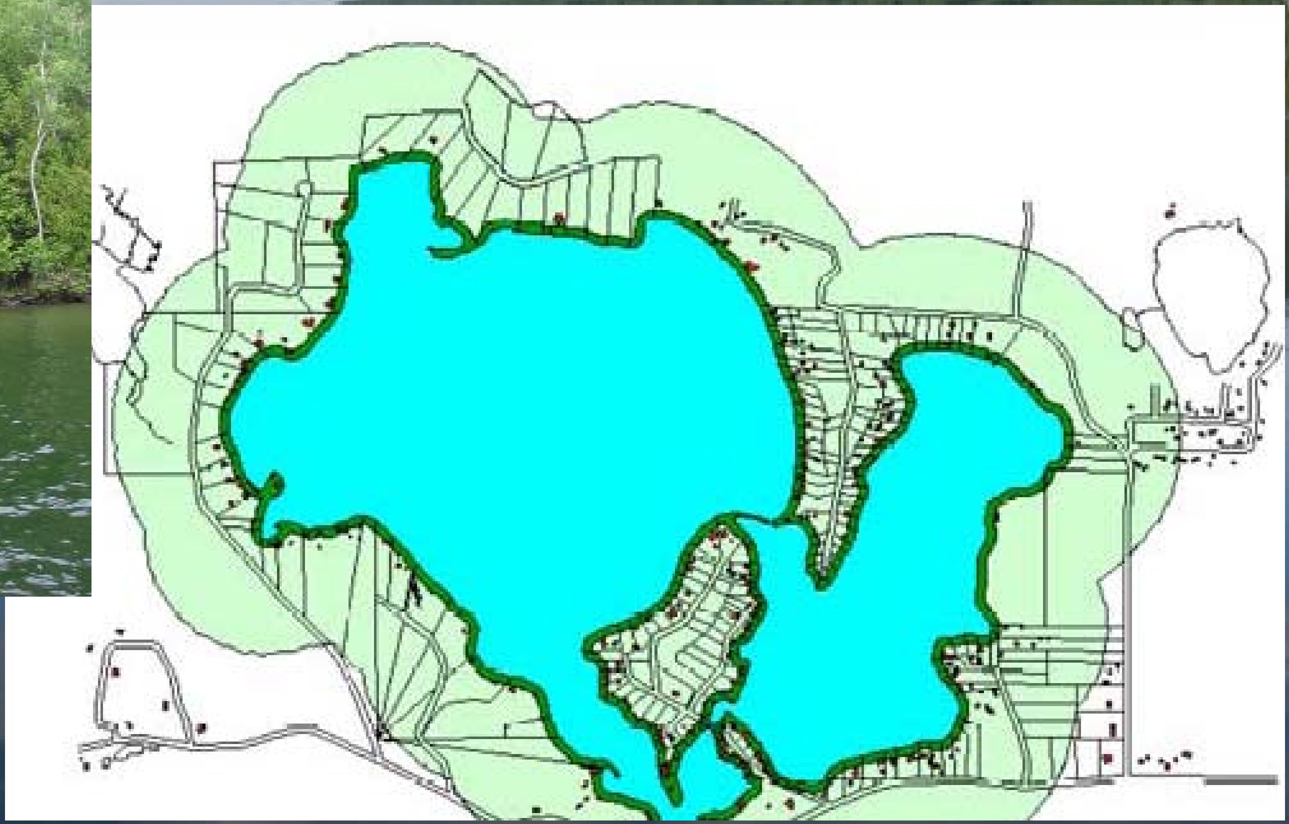
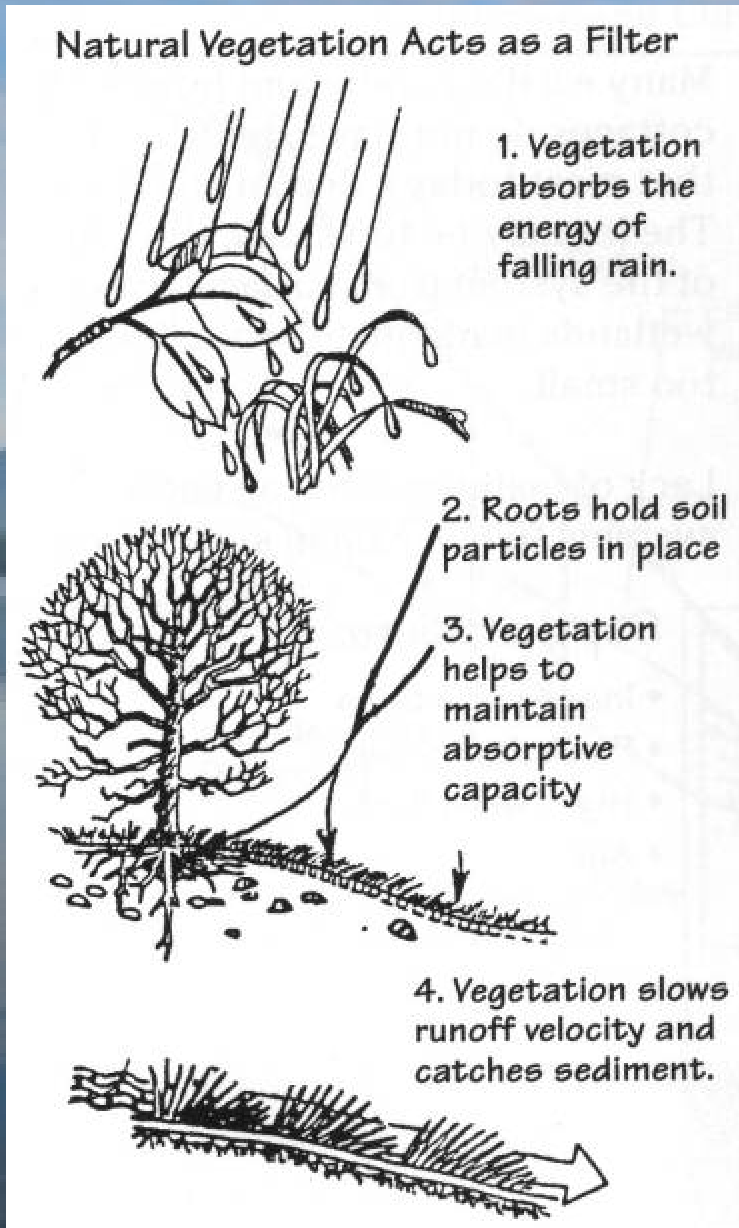
Control of sediment

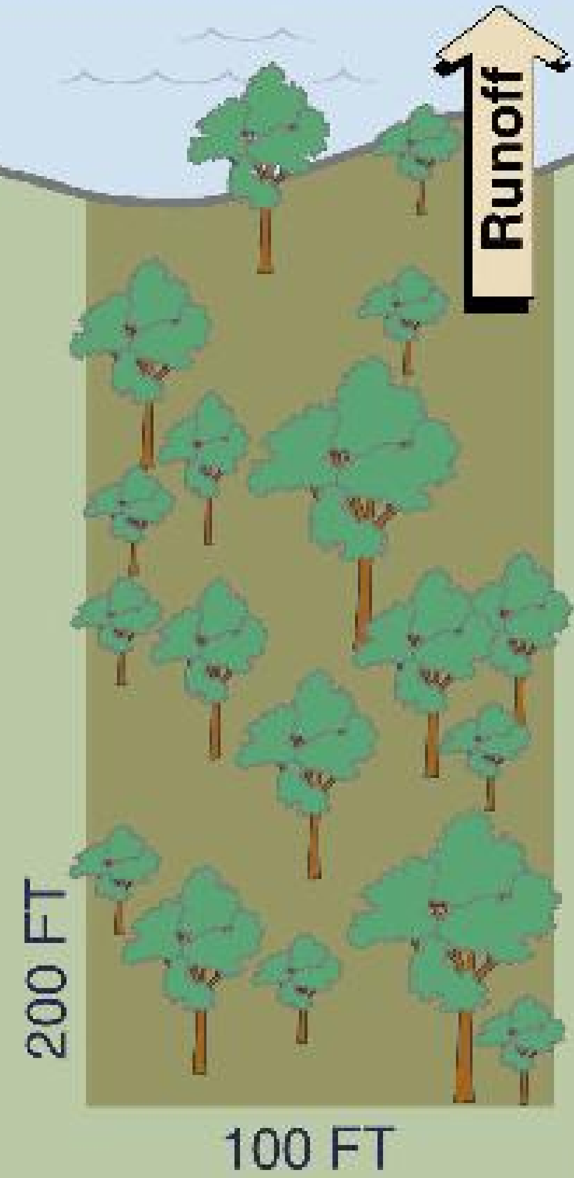



Natural Vegetation Acts as a Filter
1. Vegetation absorbs the energy of falling rain.
2. Roots hold soil particles in place
3. Vegetation helps to maintain absorptive capacity
4. Vegetation slows runoff velocity and catches sediment.

Materials like cement, asphalt, roofing, and compacted soil that prevent percolation of runoff into the ground.

Undeveloped – Apr.-Oct. phosphorus/sediment runoff model

- maple-beech forest
- 6% slope to lake
- sandy loam soil



IMPACT
ON LAKE
(April - Oct.)

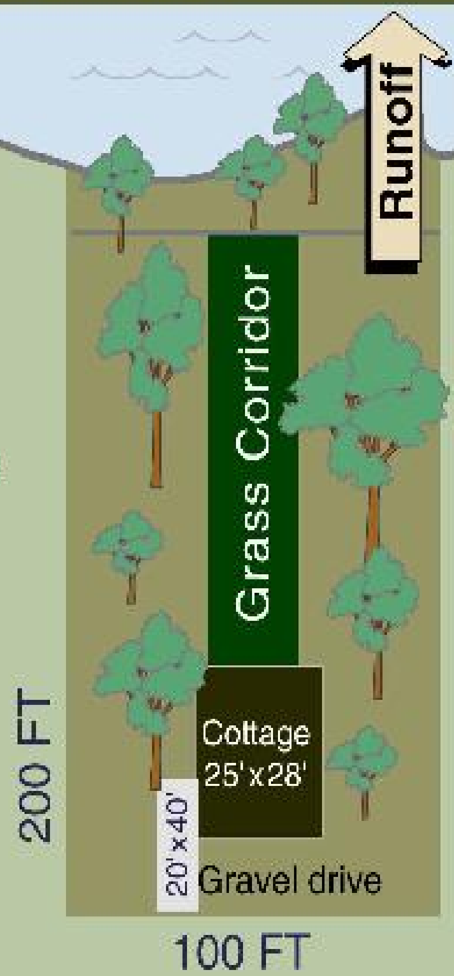
- 1,000 ft^3 runoff to lake
- 0.03 lbs. phos. to lake
- 5 lbs. sediment to lake

Source: Wisconsin Dept. of Natural Resources

The Wisconsin Lakes Partnership

1940s development – Apr.-Oct. phosphorus/sediment runoff model

- maple-beech forest
- 6% slope to lake
- grass corridor 20'-wide
- cottage 700 ft² perimeter
- gravel drive 800 ft²
- 35'-wide buffer strip



IMPACT ON LAKE (April - Oct.)

- 1,000 ft³ runoff to lake
- 0.03 lbs. phos. to lake
- 20 lbs. sediment to lake

4 Xs the sediment

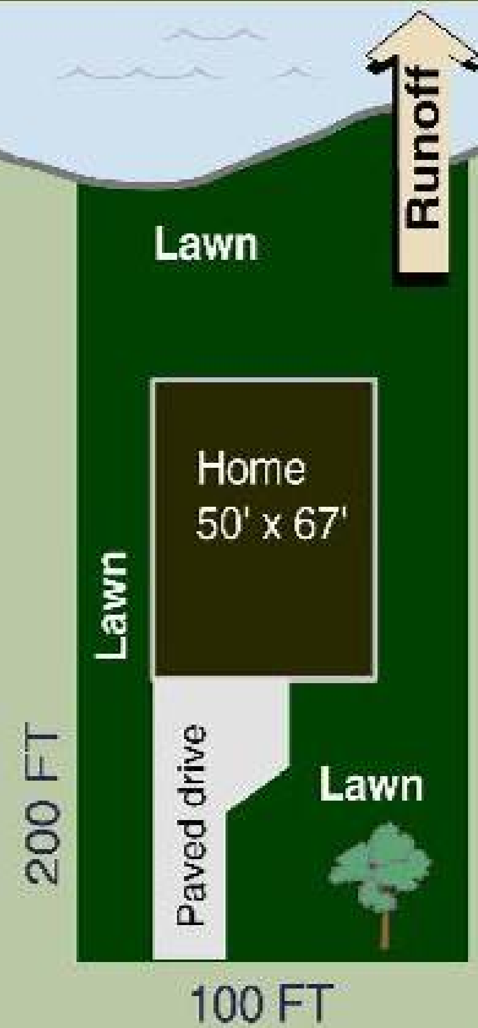
Source: Wisconsin Dept. of Natural Resources

The Wisconsin Lakes Partnership

Small camp development, with a 35’ natural buffer contributes more sediment than a forested site

1990s development – Apr.-Oct. phosphorus/sediment runoff model

- maintained lawn, soil graded
- 6% slope to lake
- home 3,350 ft² perimeter
- paved drive 770 ft²



IMPACT ON LAKE
(April - Oct.)

- 5,000 ft³ runoff to lake
- 0.20 lbs. phos. to lake
- 90 lbs. sediment to lake

5 Xs the runoff

7 Xs the phosphorus

18 Xs the sediment

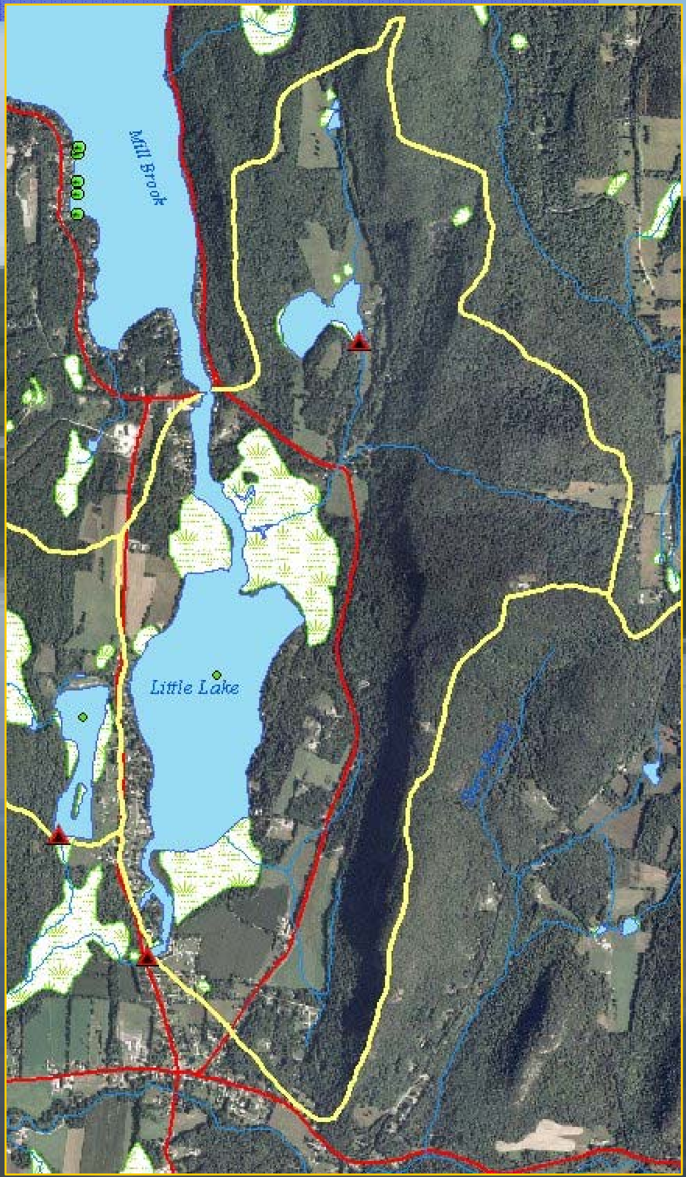
Source: Wisconsin Dept. of Natural Resources

The Wisconsin Lakes Partnership

Modern development contributes more phosphorus and sediment than a forested site

Cumulative development and Little Lake

- The observed changes in Little Lake are as much a function of watershed and lakeshore development as any other cause.
- VTANR suggests an aggressive look at mitigating sediment delivery from tributaries and shorelines.



What are the next steps - survey activities

- Watershed survey – inventory nutrient and sediment sources
- Consider geomorphic assessment of streams in direct watershed
- Shoreline survey – inventory nutrient and sediment sources
- Identify opportunities for rebuffering of the lakeshore
- Inventory lakeside roads for erosion sources

What are the next steps - monitoring activities

- Enter into Lay Monitoring Program. There are 23 years of weekly summer monitoring data for St. Catherine.
  - This type of record would be critical to understanding observed changes in Little Lake, but we do not have the data.
- Initiate a watershed stream monitoring program under the LaRosa Partnership Program.

VTANR’s involvement

- Provide coordination, training, and support for survey and monitoring.
- Leverage existing partnerships with PMNRCD and others
- Provide opportunities or pathways for funding outside of the ANC program.
- Provide guidance for organizational development and support.

We all live in a watershed. What you do matters.

For more information:

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