

New England's Lakes:

Early Results from the Regional and
National Lake Assessments

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How do people affect lakes?

Indicators / Metrics:

- Water chemistry, trophic status
- Sediment chemistry
- Submerged aquatic plants
- Fish habitat quality
- Contaminants in fish tissue
- Sediment cores (paleo studies)
- Recreation
- Aesthetics
- Freshwater
 - Consumption
 - Agriculture & Industry
 - Hydropower
- Human Health
- Fisheries
- Wildlife Habitat

How are lakes used?

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Major lake surveys in New England

- Survey of Problem Lakes in the US (pre-1970)
- National Eutrophication Survey (NES) 1970's)
- Northeast Lake Acidification Survey / PIRLA (early '80's)
[Paleoecological Investigations of Recent Lake Acidification](#)

[Clean Air Act: 1990 amendment](#)

- EMAP Northeast Lakes ('91-'03)
- REMAP Survey of Hg in Fishes of Maine Lakes ('92-'94)
- REMAP Survey of Hg in VT and NH Lakes* ('98-'00)
- National Fish Tissue Study (2000-'04)
- REMAP New England Lakes and Ponds ('05-'11)
- National Lakes Survey ('07)

www.epa.gov/owow/lakes/lakessurvey/nov05workshop/NALMS05_Kamman.ppt

Findings from the early probability surveys

- EMAP (probability survey)
 - 1) Acidification
 - 2) Assessment of trophic state, and of trophic change using paleolimnology
 - 3) Initial highlight on fish contaminants
 - Assessment of zooplankton community responses to disturbance
 - Dataset provided “jump-off” point for many research-based projects with wide and varied applicability

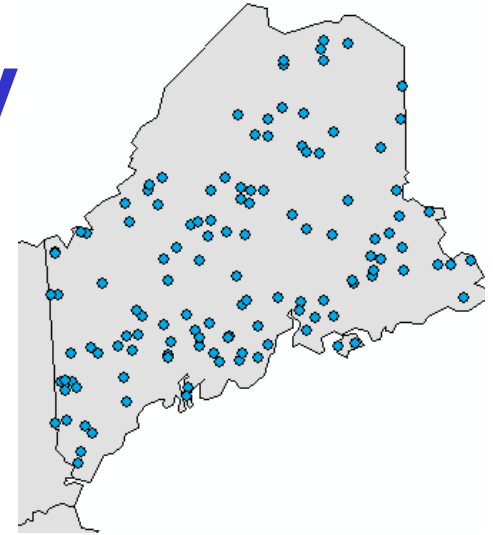


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Findings from the probability surveys



- Maine REMAP ('92 – '94)
 - First random-probability lake survey undertaken by a northeast State.
 - Project focused specifically at fish mercury
 - Exposed the fish-mercury problem to all of the Northeast.
 - Provided data for New England's first mercury-specific fish consumption advisory.
 - Spawned numerous other research projects

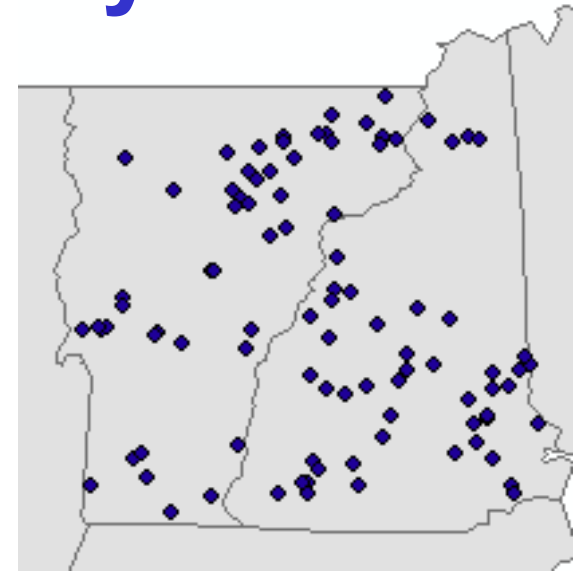
www.epa.gov/owow/lakes/lakessurvey/nov05workshop/NALMS05_Kamman.ppt

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Findings from the probability surveys

- VT-NH REMAP ('98 – '00)
 - First large-scale random probability survey to look at mercury across the food web as well as water and sediment
 - Verified the mercury bloom dilution hypothesis



More algae means $<$ Hg cell;

$<$ Hg per cell means $<$ Hg per bite of algae for zooplankton

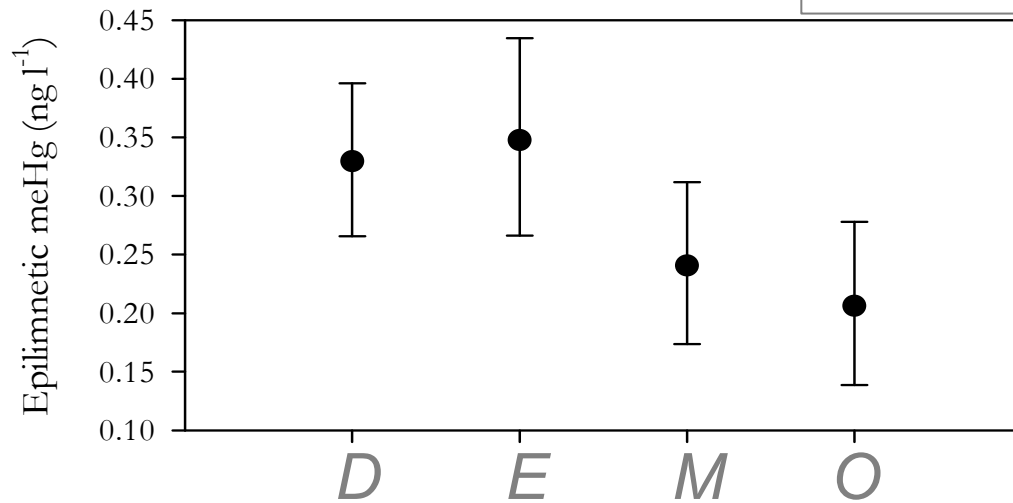
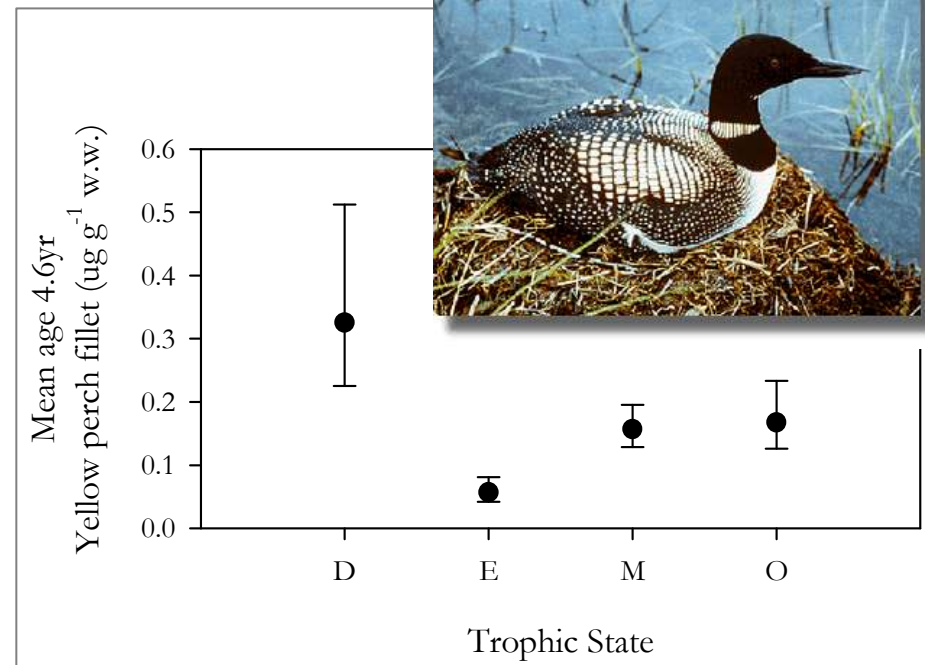
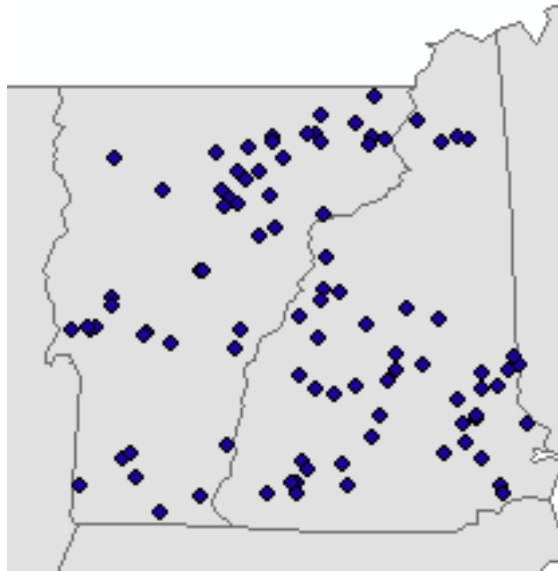
$<$ Hg per bite of zoop. means less efficient bioaccumulation to fish

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Effect of bloom dilution



D – Dystrophic
(tea colored lakes)
E - Eutrophic
M - Mesotrophic
O - Oligotrophic

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New England Lakes and Ponds (NELP) 2005 - 11

Project Modules:

- **Water chemistry** / multiprobe profile
 - standard limnological parameters + ICPMS metals
 - chl-a by membrane and SCUFA™
- **Sediment**
 - bulk chemistry
 - “before and after” paleo (sediment diatom model)
- **Macrophyte transects** (by underwater video)
- **Crayfish** (native vs. non, contaminants, stresses on fish populations)

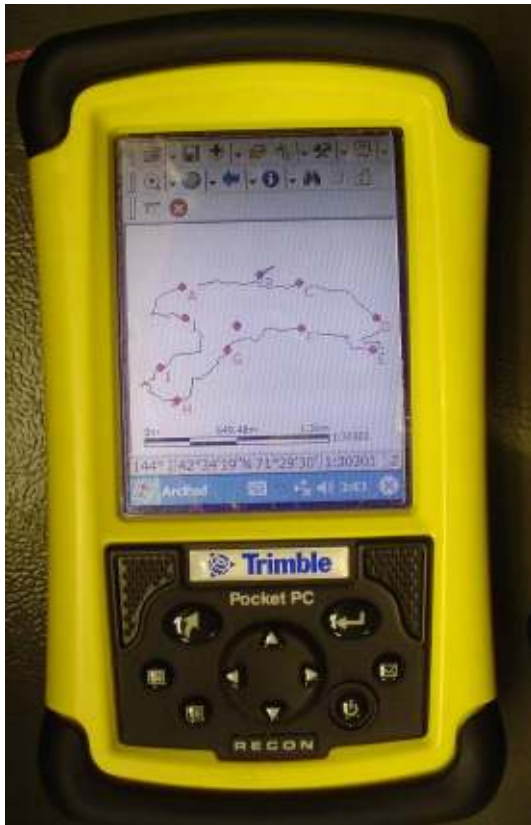
www.epa.gov/owow/lakes/lakessurvey/nov05workshop/NALMS05_Kamman.ppt

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Module: Habitat Assessment

- 10 pre-selected random locations around the lake.



www.epa.gov/owow/lakes/lakessurvey/nov05workshop/NALMS05_Kamman.ppt

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Module: **In-situ hyperspectral imaging**

- Experimental module
- Relate aspects of lake productivity to watershed and chemical attributes
- A hybrid of traditional chemical sampling and remote sensing

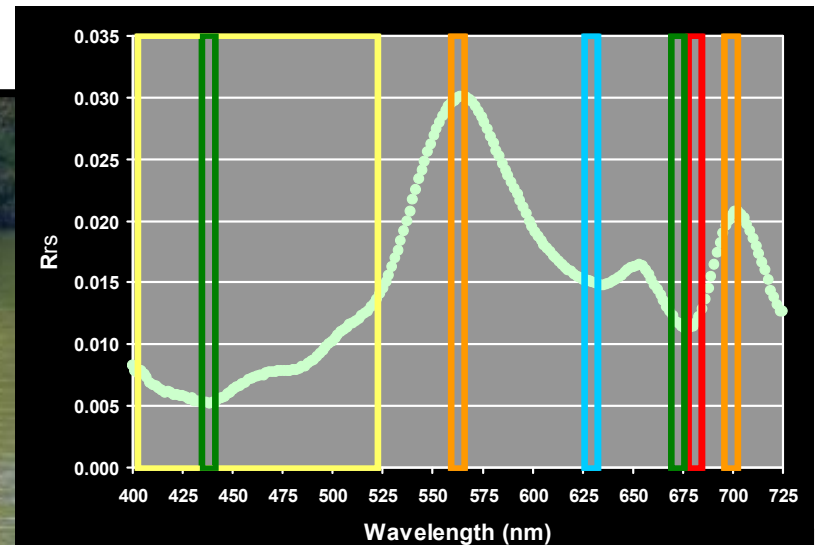
Lake Color (Shane Bradt, UNH)

Phycocyanin found in blue-green algae: produce toxins affect zooplankton, wildlife, livestock, people

Chl *a* = 61.9 $\mu\text{g l}^{-1}$

SDD = 0.6 m

CDOM = 28.4 CPU



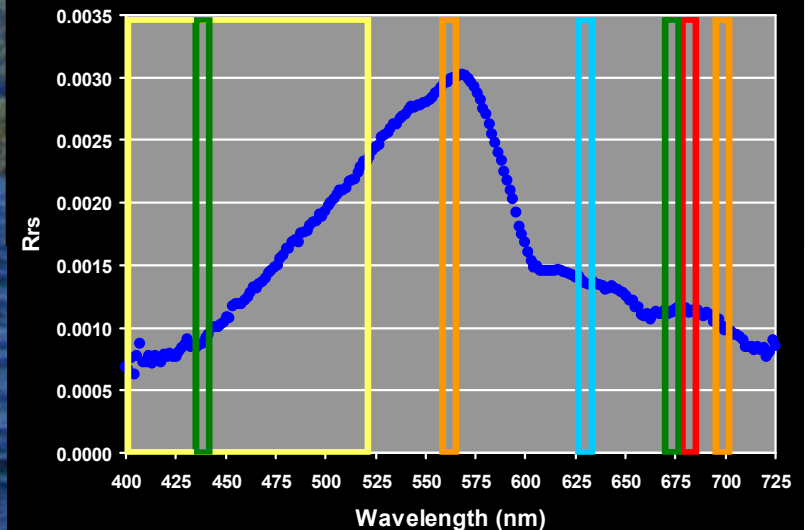
Chlorophyll *a* **Scattering** **Phycocyanin**
CDOM **Fluorescence**

Chl *a* = 1.4 $\mu\text{g l}^{-1}$

SDD = 6.4 m

CDOM = 7.4 CPU

http://extension.unh.edu/staffbios//index.cfm?function=display.detail&employee_id=249



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Module:

Zooplankton by flow-through cytometer; the FLOW CAM

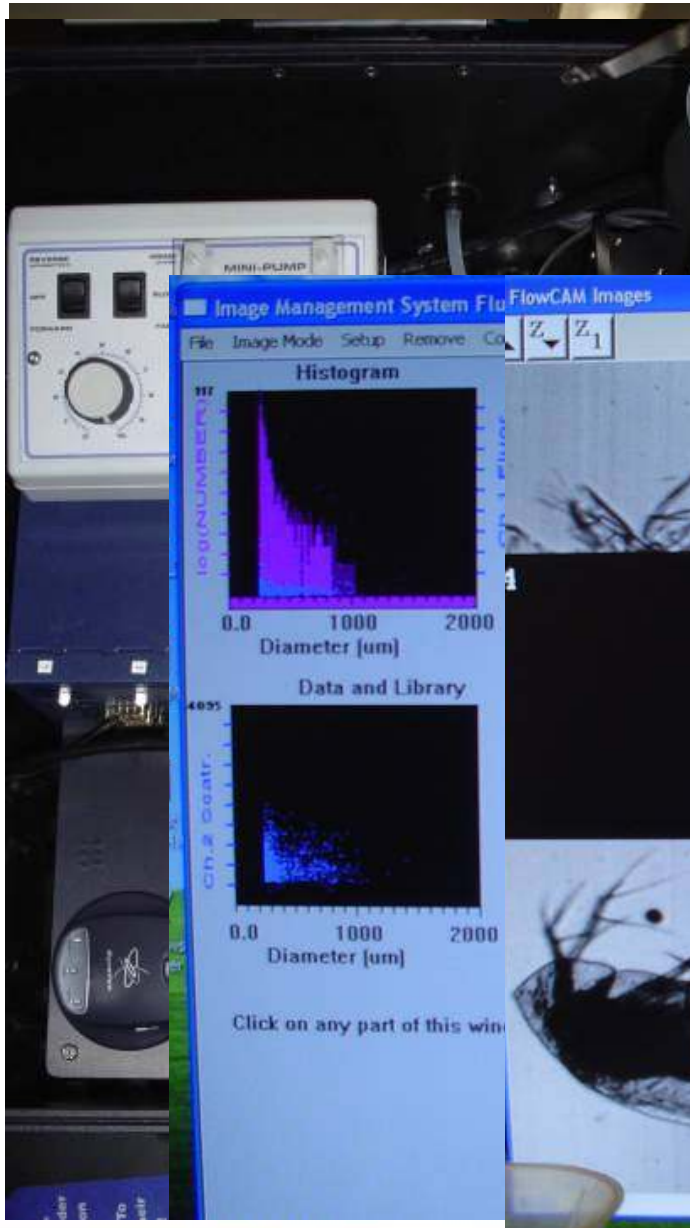
- Count & Identify zooplankton
- Identify size/length distributions of samples
- Images individual zoop's, and sorts/groups images by length, aspect ratio, and diameter

www.epa.gov/owow/lakes/lakessurvey/nov05workshop/NALMS05_Kamman.ppt

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Zooplankton by flow-through cytometer; the FLOW CAM

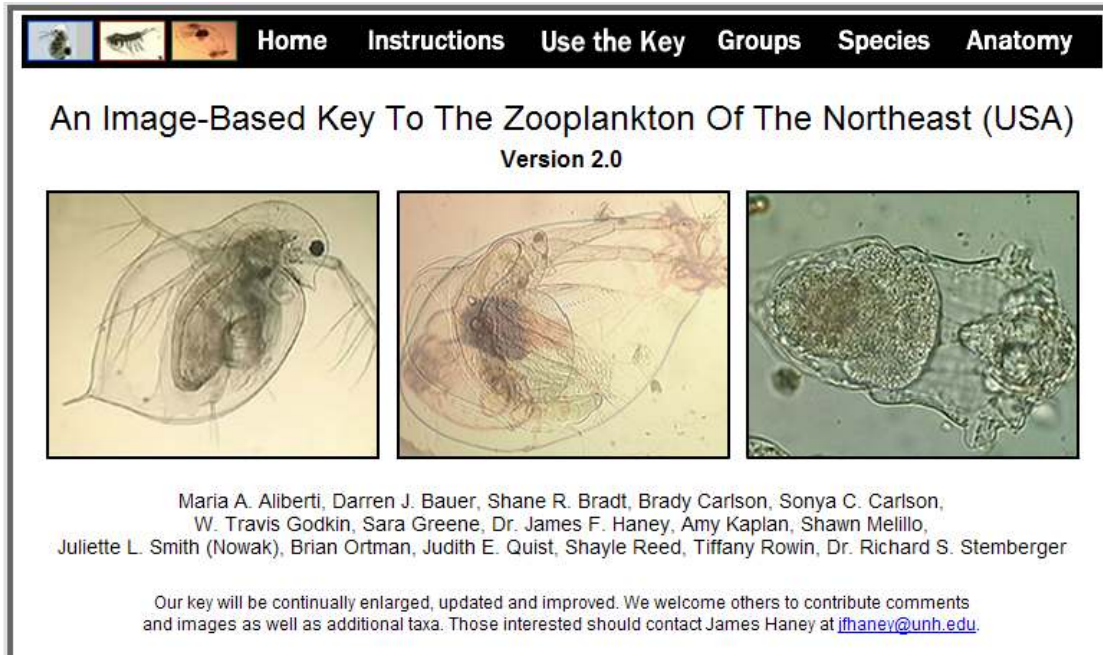


<http://www.fluidimaging.com/default.aspx>

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Zooplankton Taxonomy, UNH



Home Instructions Use the Key Groups Species Anatomy

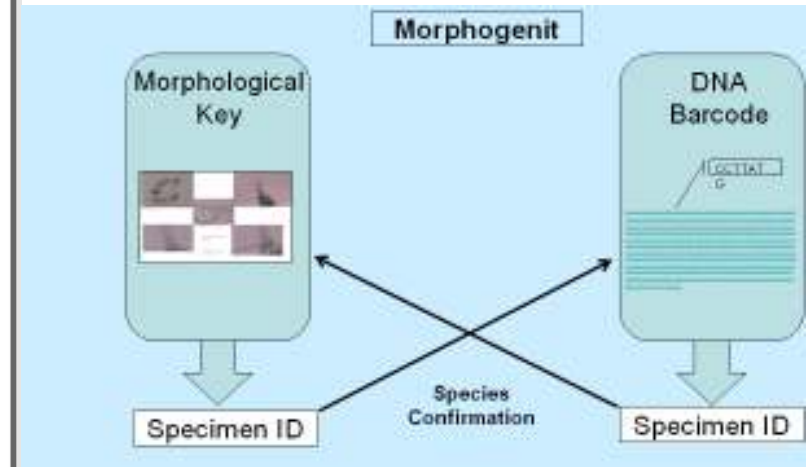
An Image-Based Key To The Zooplankton Of The Northeast (USA)
Version 2.0

Maria A. Aliberti, Darren J. Bauer, Shane R. Bradt, Brady Carlson, Sonya C. Carlson,
W. Travis Godkin, Sara Greene, Dr. James F. Haney, Amy Kaplan, Shawn Melillo,
Juliette L. Smith (Nowak), Brian Ortman, Judith E. Quist, Shayle Reed, Tiffany Rowin, Dr. Richard S. Stemberger

Our key will be continually enlarged, updated and improved. We welcome others to contribute comments and images as well as additional taxa. Those interested should contact James Haney at jfhaney@unh.edu.

Research on Genetic Bar-coding

Elisha Allan, Marian Litvaitis & James Haney, Univ NH



<http://cfb.unh.edu/CFBkey/index.html>

<http://zoology.unh.edu/faculty/haney/haney.html>

One gene from ribosome

- 9 species tested
- 194 sequences out of 199 were correctly grouped with their morphological species

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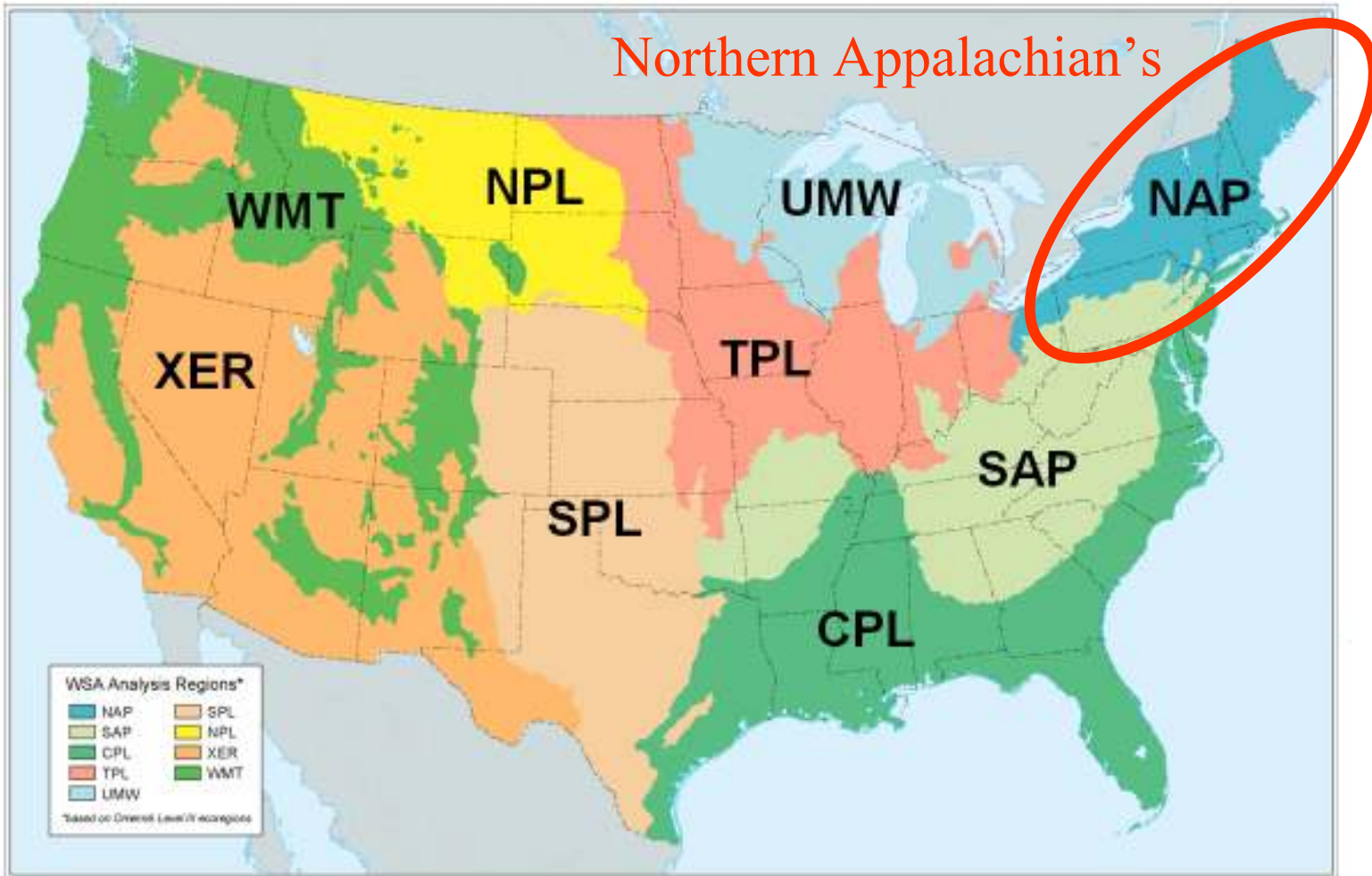
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Goals of National Lake Assessment

- **Report on the condition of the Nation's Lakes**
 - Statistically-valid design so dataset represents the condition of all lakes in regions that share similar ecological characteristics
 - Provide regional and national estimates of the condition of lakes, with option for State-scale estimates
 - Use consistent sampling and analysis procedures to ensure the results can be compared across the country
- **Promote collaboration across jurisdictional boundaries in the assessment of water quality**
- **Help build State and Tribal capacity for monitoring and assessment**
- **In 2007, NLS & NELP projects sampled the same lakes**

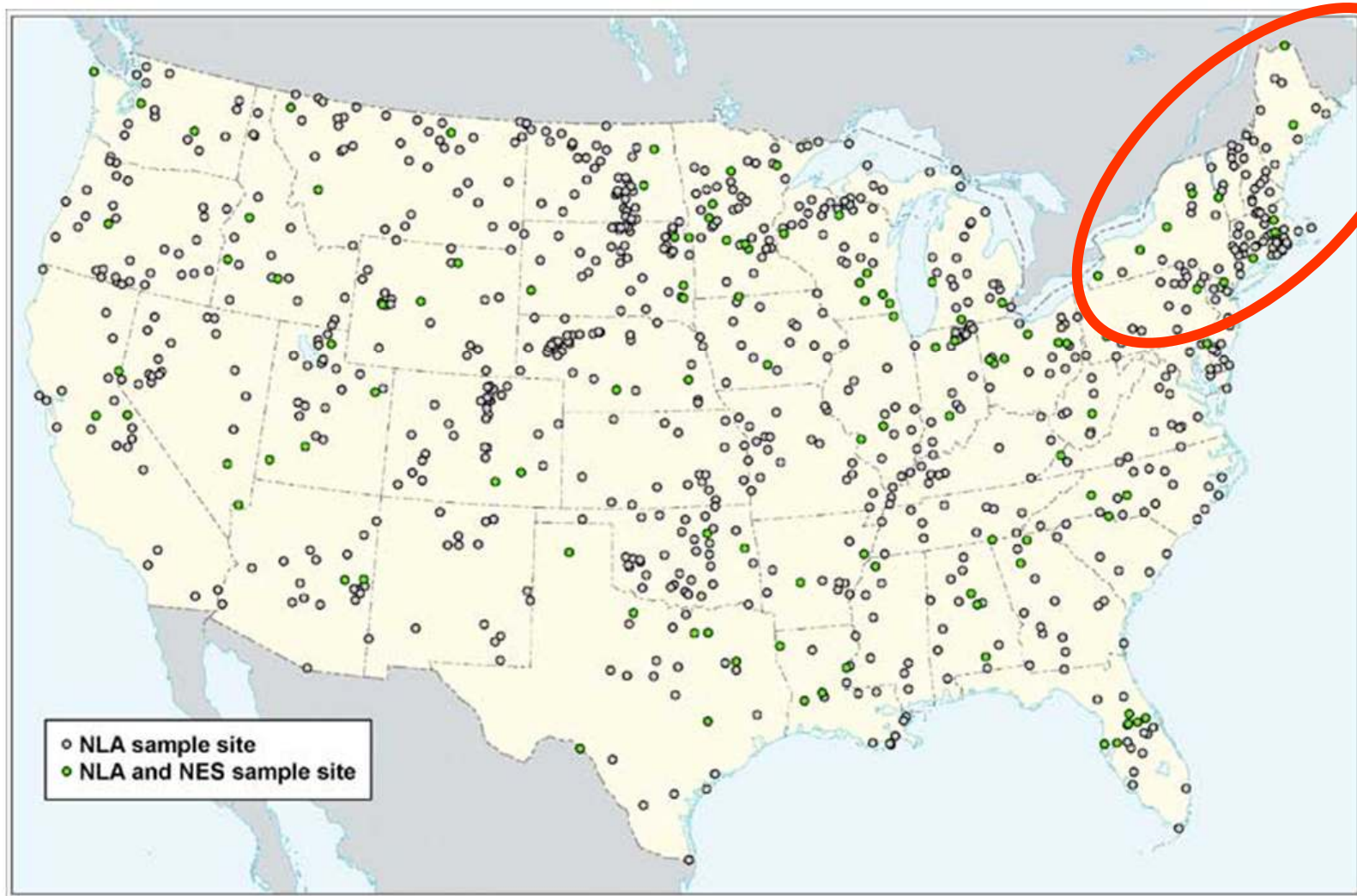
Aggregated Ecoregions

Ecoregions used in EPA Wadeable Streams Assessment



More detailed ecoregions coverages <http://www.epa.gov/wed/pages/ecoregions.htm>

NLA Sample Lakes: Planned



Acid Rain: Status of New Hampshire Lakes

Acidity can adversely affect zooplankton, macroinvertebrates, fish, and enhance methylation of mercury and transport thru the food chain

Sensitivity Category	Alkalinity (mg/L CaCO ₃)	Percent of Lakes
Acidified	0	3 %
Critical	>0-2	18 %
Endangered	>2-5	32 %
Highly Sensitive	>5-10	32 %
Sensitive	>10-20	12 %
Not Sensitive	>20	3 %

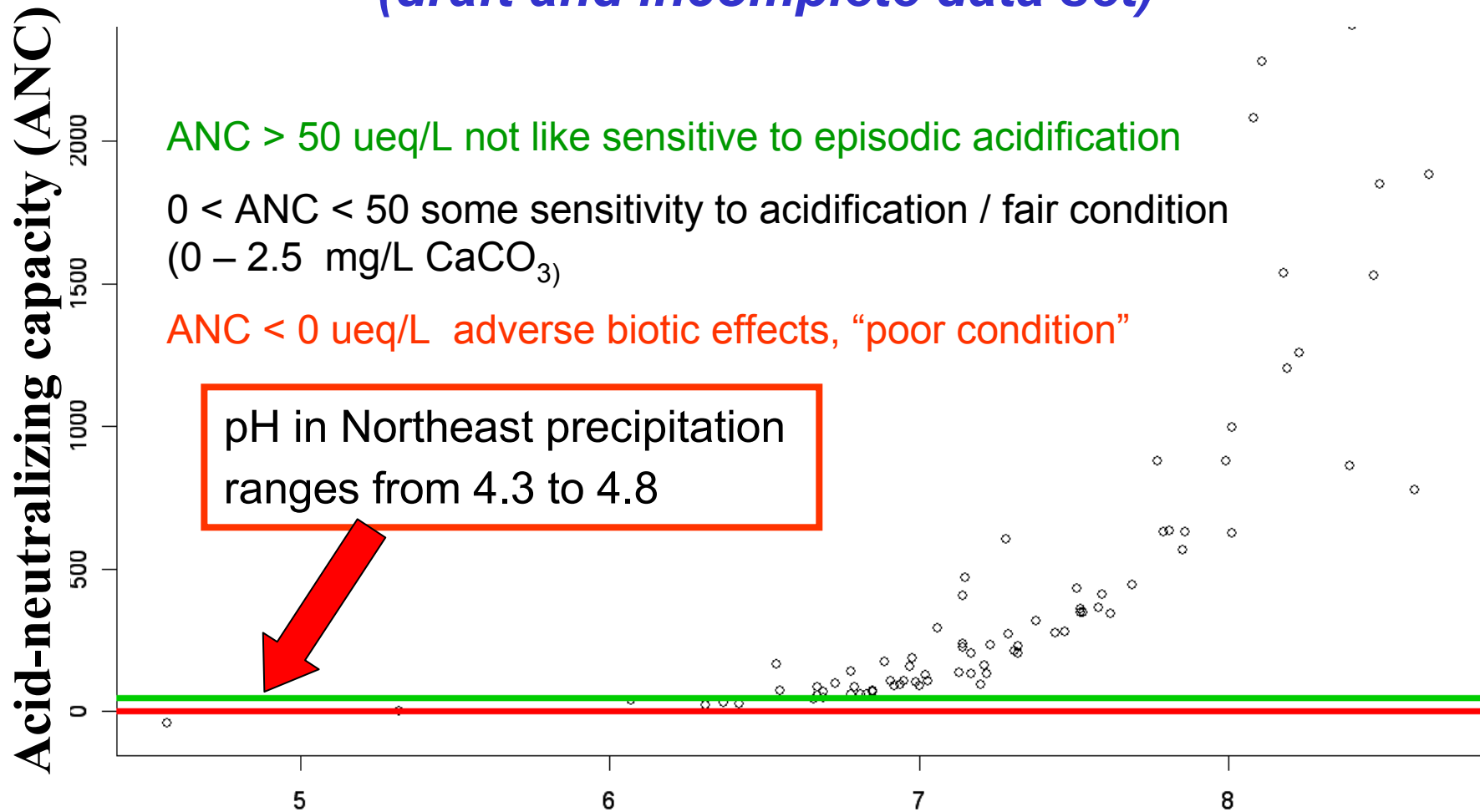
<http://www.des.state.nh.us/factsheets/bb/bb-16.htm>

http://www.des.state.nh.us/wmb/tmdl/documents/20040920_Final_NH_Acid_Pond_TMDL.pdf

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Early results from National Lakes Survey (draft and incomplete data set)



pH in some New England Lakes (NH data from 2007 not included)

Hubbard Brook Forest Studies:

One continuing problem is acid rain leaches calcium from soil resulting in loss of soil buffering capacity. →
Acidified soils.

Acidified lakes in the northeastern United States will not fully recover by 2050, even under the most aggressive proposals for acid rain legislation.

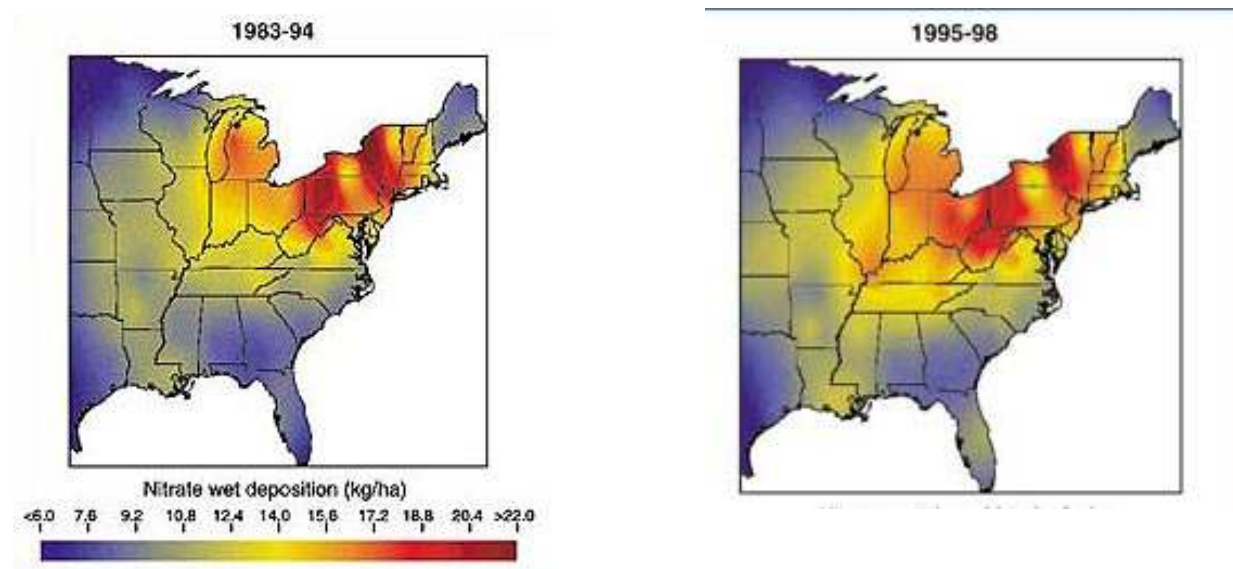
Environmental Science and Technology Online Science News -
March 30, 2001

http://pubs.acs.org/subscribe/journals/esthag-w/2001/mar/science/JP_acidlakes.html

Good News: Clean Air Act → 24% drop in SO₂ emissions
Bad News: Northeastern Acid Lakes Remain Impaired

http://pubs.acs.org/subscribe/journals/esthag-w/2001/mar/science/JP_acidlakes.html

Deposition of acid-forming nitrogen in the eastern United States remained virtually unchanged from 1989 through 1998

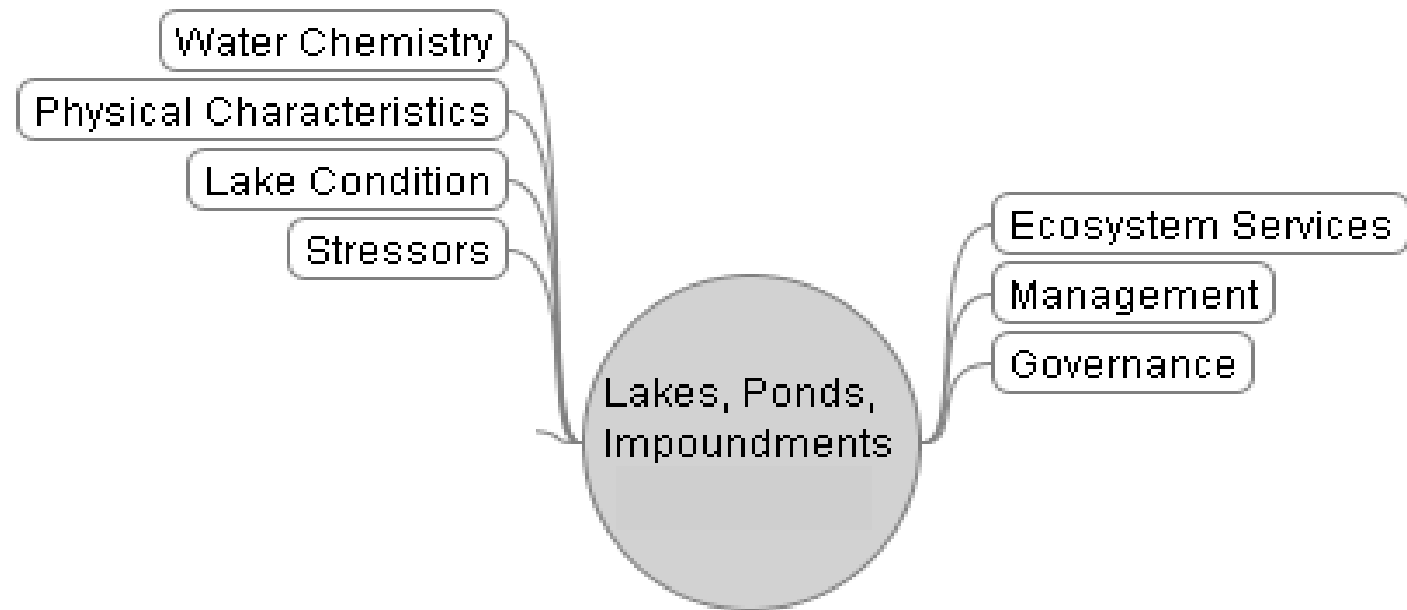


Environ. Sci. Technol. 2000, 34 (11), 248A

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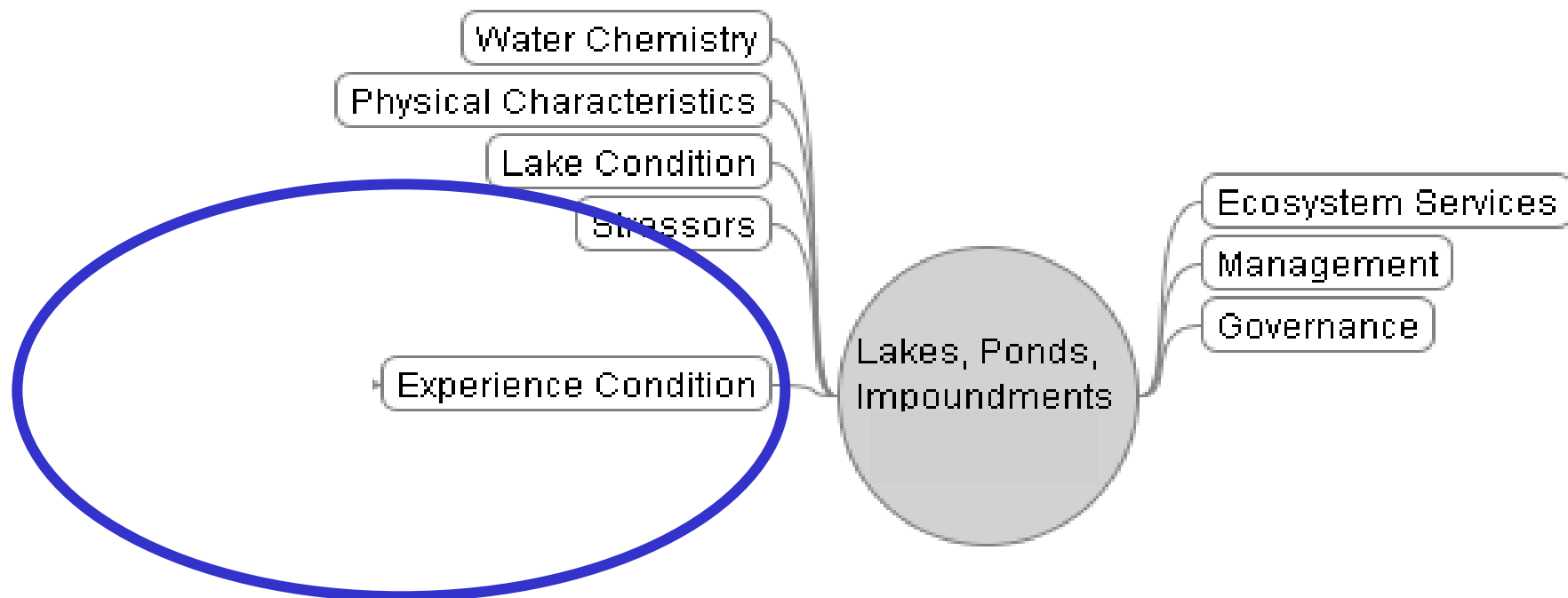
Our past research focus has been on how human activities affect ecosystem conditions: acid deposition, pollutants (e.g. acid rain, Hg)



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Some future research will focus on how impacts on ecosystems affect human well being.



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Field Notes from 2007 Lakes Survey in New England

NICE LAKE, SURROUNDED BY
FORESTS AND MOUNTIANS.
CAN HEAR TRAFFIC FROM
ROAD AT TIMES.

'BEAUTIFUL LAKE.
ONLY A FEW HOUSES
ON SHORE. OSPREY
FLEW OVERHEAD AND
DOVE FOR FISH.

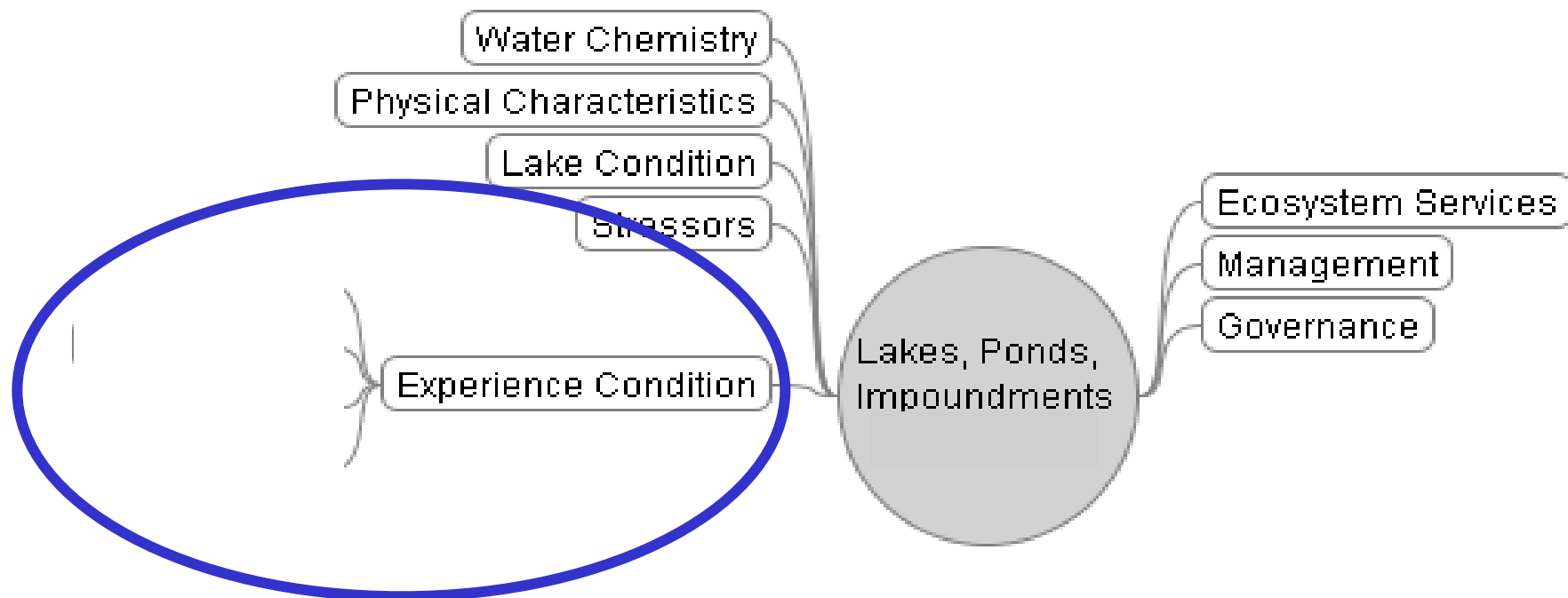
PRISTINE OLIGOTROPHIC LAKE.
EXCELLENT FISH HABITAT.
LOONS PRESENT ON LAKE

Experience Condition

Lakes, Ponds,
Impoundments

'RIVERINE HYDROPOWER IMPOUNDMENT;
SINUOUS LAKE ABOUT 10 MILES LONG

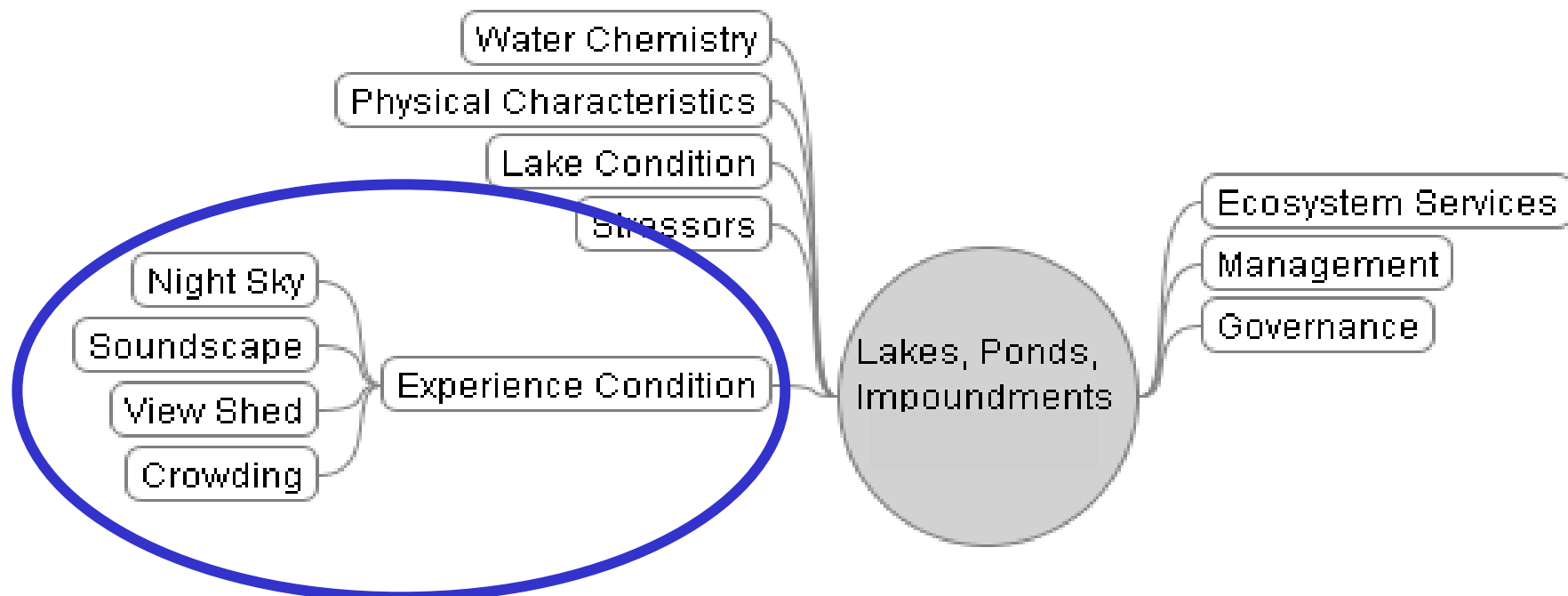
Can we develop other indicators of lake condition relate to our human experience ?



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Can we develop other indicators of lake condition relate to our human experience ?



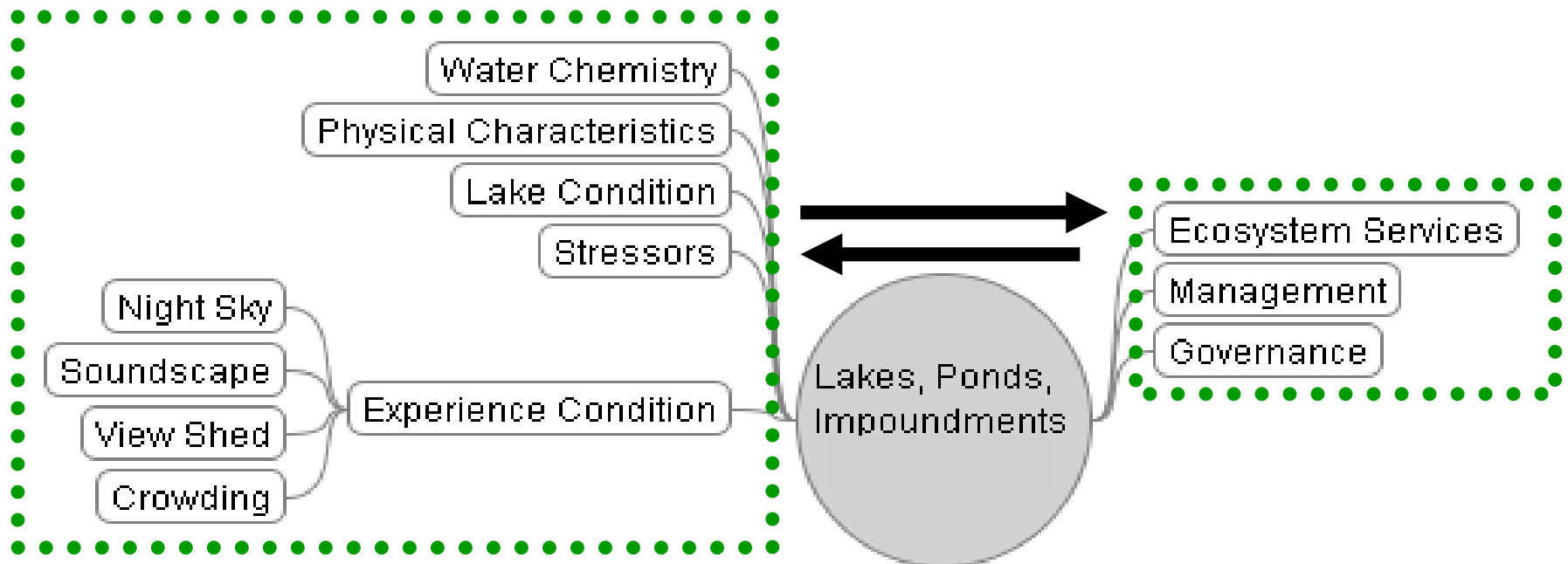
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EPA research:

1) How human activity affects lake condition

2) How impacts on ecosystems affect human well being.

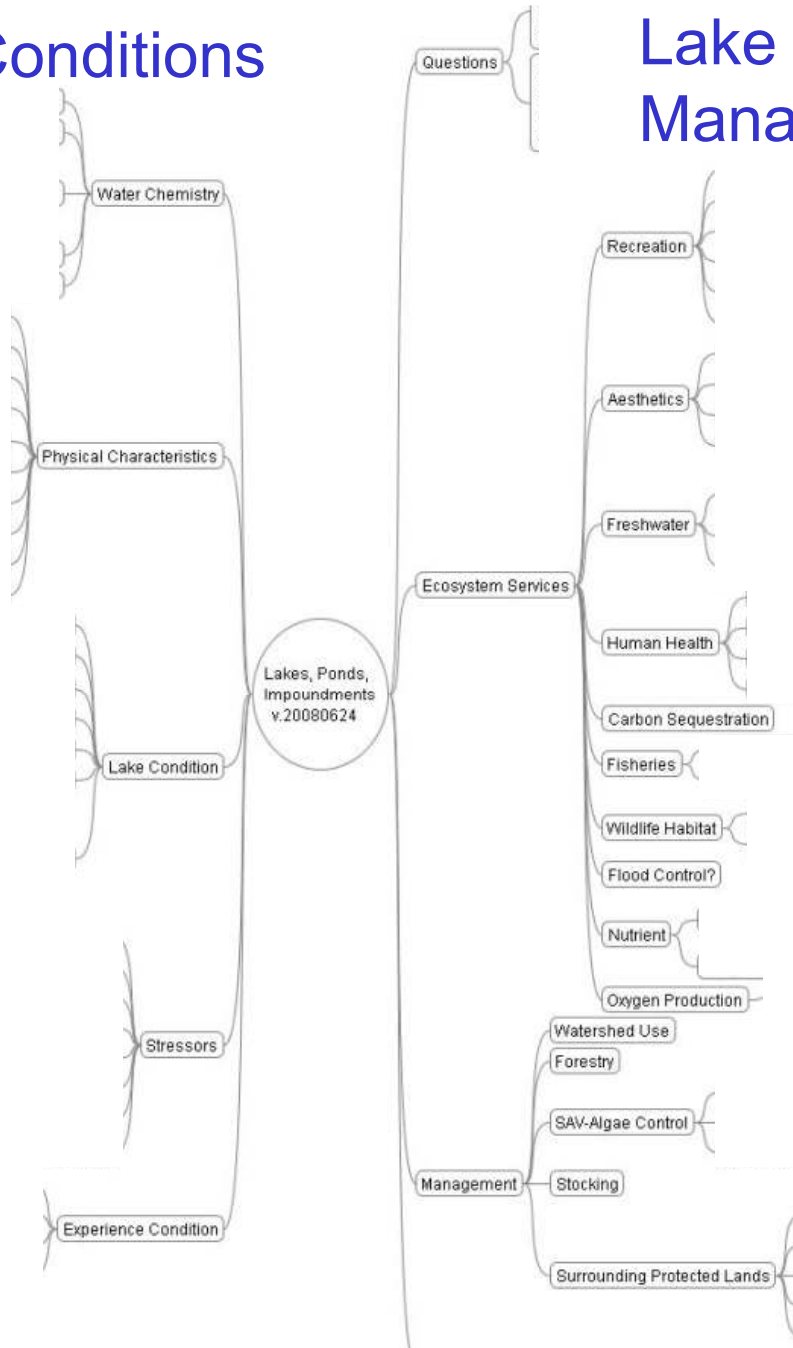


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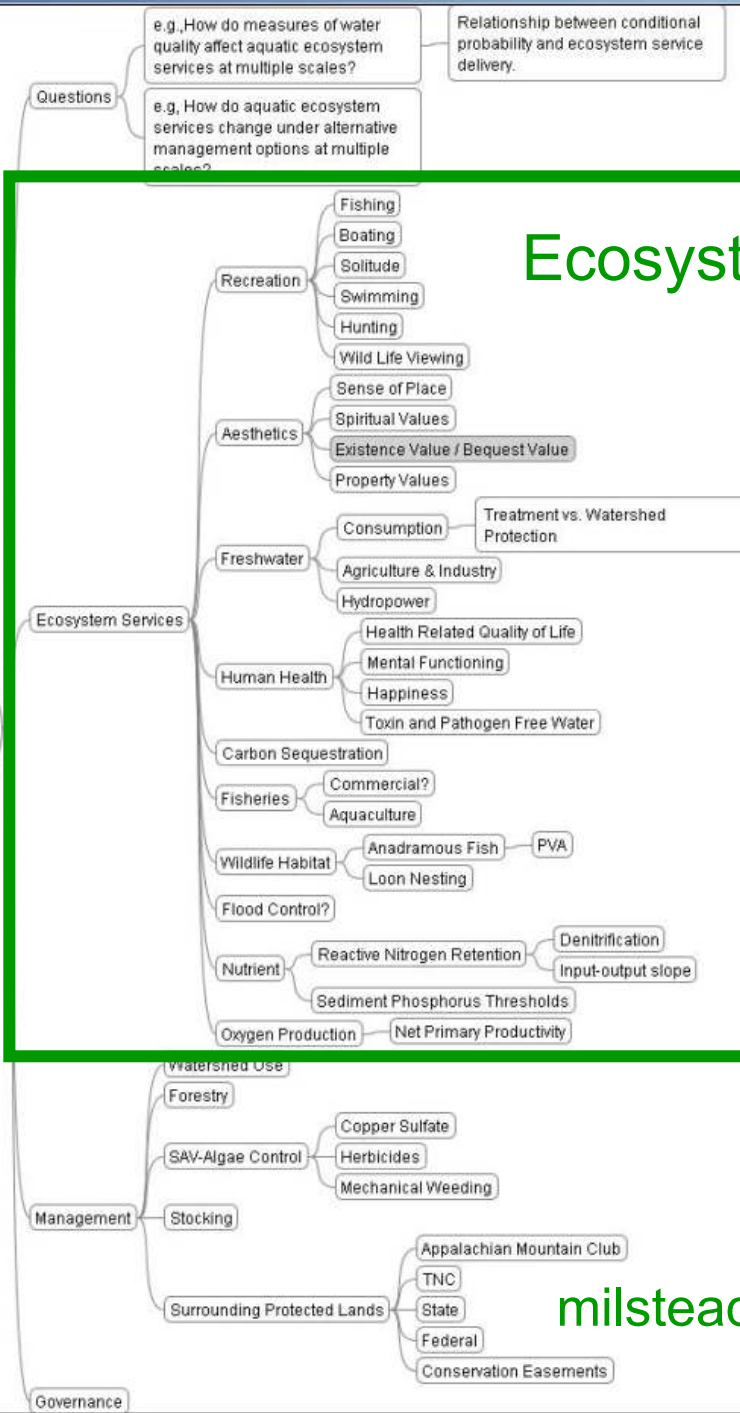
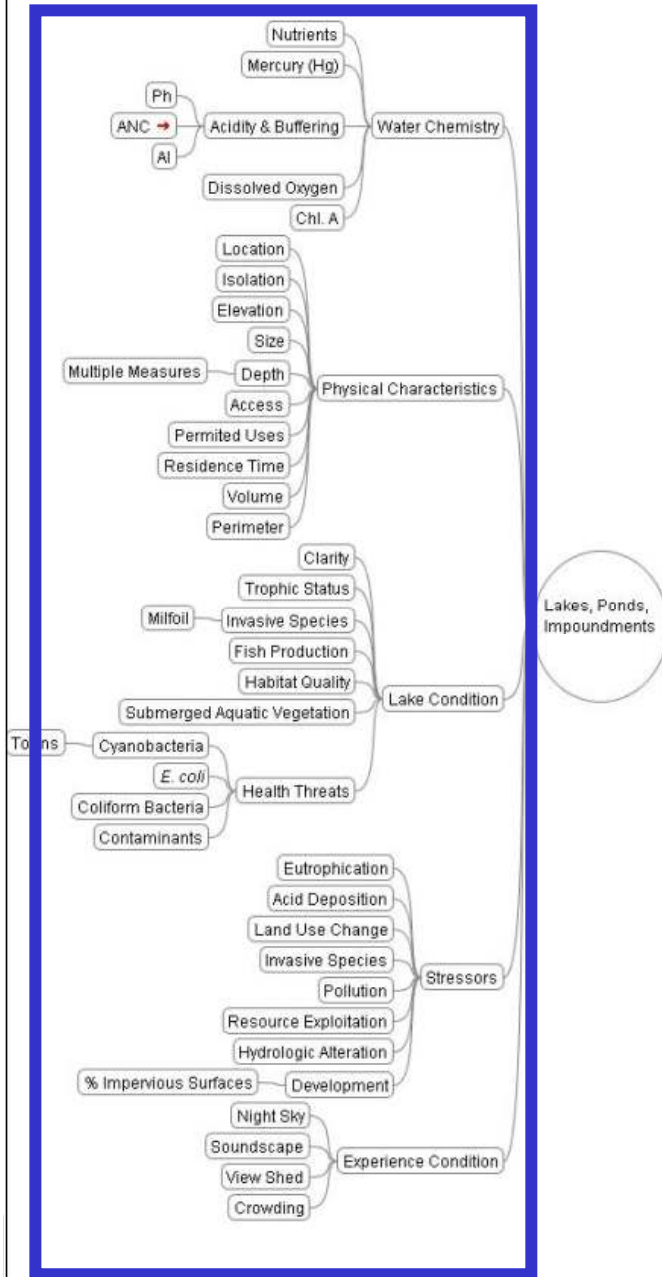
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Lake Conditions

Lake Uses & Management



Indicators of Condition



Ecosystems Services

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How do people affect lakes?

How do ecosystems serve & affect people?



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