The 2007 National Lakes Assessment

Water Quality, Recreational Suitability, and Ecological Integrity of Lakes and Reservoirs

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Wisconsin Lakes Convention
Green Bay, WI
3/31/10

Today's discussion

- Why the National Lakes Assessment?

- What was measured?

- How were the data assessed?

- What did we learn?

- What do we do with the findings?

- How can WI Lake Associations use the information?

- Where can I get the report?

NLA is part of the National Aquatic Resource Survey Initiative

- Why national surveys?

  – CWA Section 305(b) reports do not tell a comprehensive national water quality story

  – States or associations cannot directly compare their assessments to those of partner organizations or in relation to regional conditions

  – Significant findings from consistent assessments promote new policy directions

Supported by:
Gov't Accountability Office
Nat'l Academy of Public Administration
National Research Council
Heinz Center

The National Aquatic Resource Surveys (NARS)

- NARS promote State and Tribal capacity for monitoring and assessment
  - Conducted in partnership with states and tribes -- states and tribes, or contractors, carry out the sampling
  - Offer opportunity for state-scale surveys – about 10 states enhanced their NLA assessments with state-scale surveys
  - Establish new monitoring approaches and assessment tools
  - Promote consistency in cross-jurisdictional assessment of water quality

Purpose of National Aquatic Resource Surveys

- Meet Clean Water Act requirement to report on the condition of waters of the U.S.
  - Unbiased estimate of condition based on randomly selected, representative subset of waters
  - Report on core indicators with regional supplements
  - Standardized or comparable methods
- Provide information on key questions:
  - Extent of waters supporting healthy ecosystems, recreation?
  - Extent of resource affected by key water quality problems/stressors?

Basic Components of Surveys

- Randomized design to report on conditions of each resource at national, regional, and state (optional) scale
  - 1,000 sites for national & regional scale in lower 48 states
- Standard field and lab protocols for core indicators
- National QA program and data management
- Nationally consistent and regionally relevant data interpretation and reports

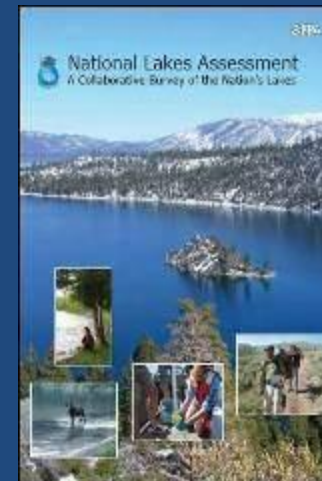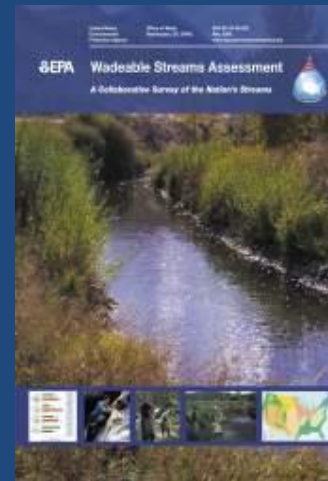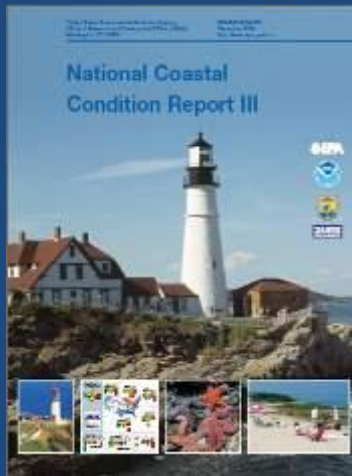# National Aquatic Resource Surveys: A five year recurring cycle

'07 Lakes

→**'08 wadeable streams**

→ **'09 large rivers**

→**'10 coastal estuaries**

→**'11 wetlands**

National Lakes Assessment is the First Comprehensive Survey of the Nation's Lakes

- Lakes, ponds and reservoirs
  - Biological and habitat condition
  - Recreational condition
  - Trophic state

- The 1,028 unique lakes sampled – plus 124 hand-selected reference lakes, and 100 resample visits – describe the condition of about 50,000 lakes nationwide
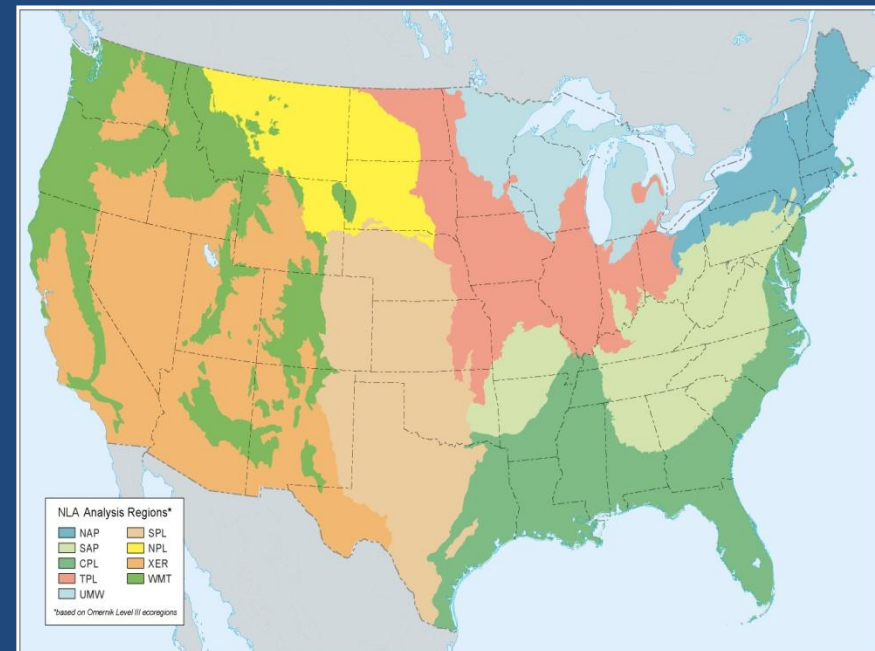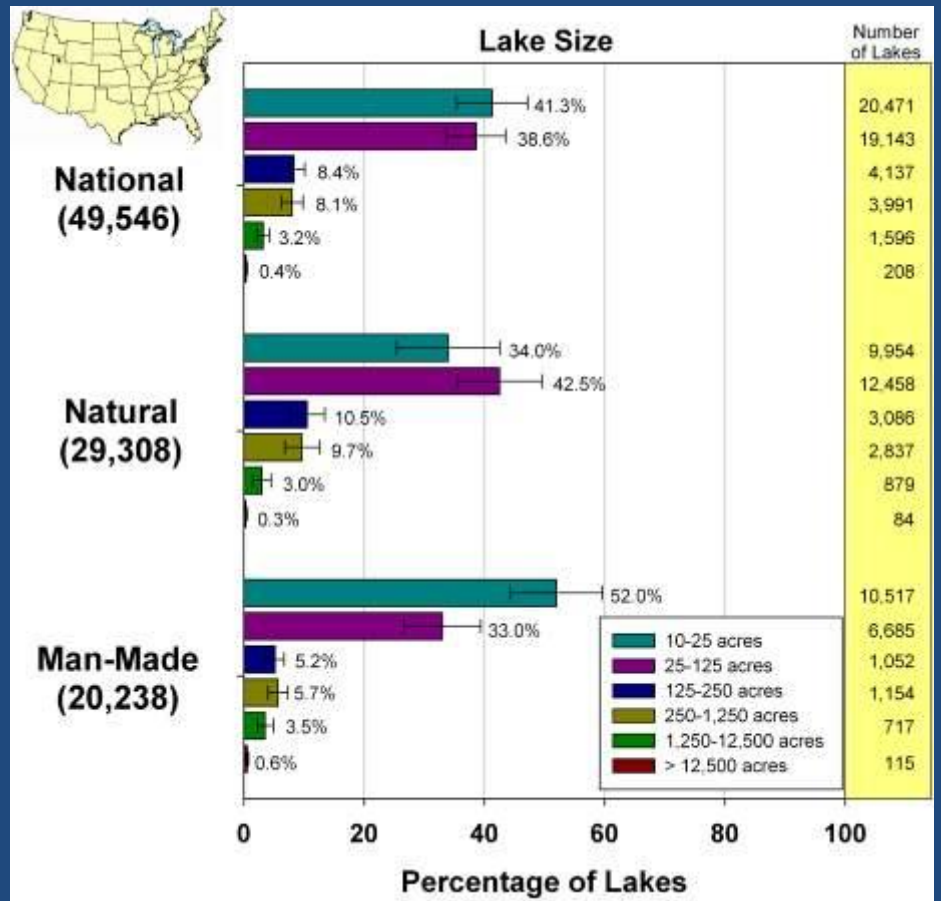
National Lakes Assessment: Design of the Survey

- Lakes selected from National Hydrography Dataset (NHD), leveraging statistical survey methodology

  – Target lakes/reservoirs: >4 ha, >1m deep, non-saline, >0.1 ha open water

  – Permits assessment by size, state, and region

  – 200 National Eutrophication Survey lakes revisited during the NLA sampling year to assess changes between 1972 and 2009

NLA Analysis Regions*

NAP	SPL
SAP	NPL
CPL	XER
TPL	WMT
UMW	

*based on Omernik Level III ecoregions

The NLA represents:

- 49,560 "lakes"
- 59% natural origin
- 41% constructed

NLA Sampled Sites

In the Field…

"At the end of the season, field crews collected 8,536 water and sediment samples; took over 5,800 direct measurements, and recorded in excess of 620,000 observations."

National Lakes Assessment: Assessments of:

- Biology
  - Ecological integrity

- Trophic State
  - Enrichment

- Recreational Use
  - Cyanotoxins

- Habitat Quality
  - Disturbance and integrity

- Chemical stressors
  - Nutrients and chem.

- Change over time
  - Sediments and nutrients

Determining Thresholds: Setting the Bar

For the NLA, two types of thresholds were used to determine condition:

- Nationally-consistent thresholds
  - Fixed values correspond to assessment findings
  - Applied to trophic state and recreational condition

- Regionally reference-based thresholds
  - Fixed percentile of reference lakes defines good/fair and fair/ poor
  - Applied to bioindicators, some habitat indicators and some stressors

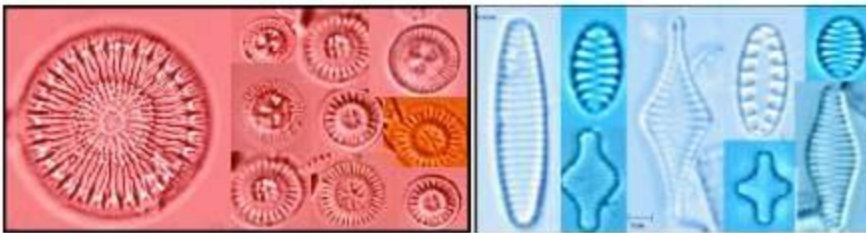- More information about this in tomorrow morning's session

Example IBI

Good

25%

Fair

5%

Poor
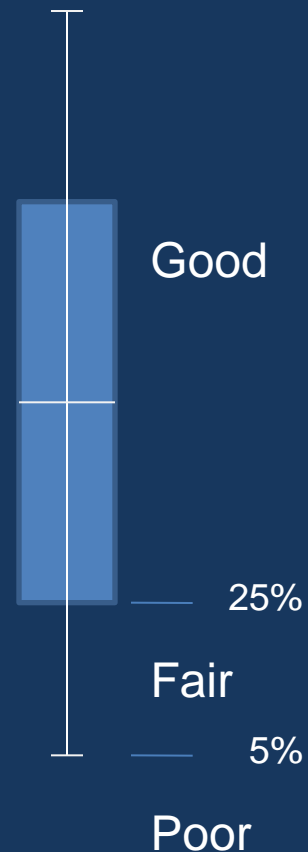
Biological Condition of the Nation's Lakes

- Index of Biotic Integrity – sediment diatoms
- Model of Taxa Loss – open lake (pelagic) plankton*

Centrate (left) and pinnate (right) diatoms. Image courtesy of J. Smol as provided by D. Charles.

* Primary NLA assessment indicator

# Biological Condition of the Nation's Lakes: Planktonic Taxa Loss

- NLA developed a method estimate taxa loss in the zooplankton and phytoplankton communities
  - How?:
    - Look at the species identified in like reference lakes, within regions
    - Compare the species in each assessed lake to the expected taxa from the reference lakes
    - *O*bserved taxa are related to *e*xpectation: the O/E is the taxa loss index.

- The O/E ranges from near 0 (complete loss) to >1.0 (some benign enrichment evident)

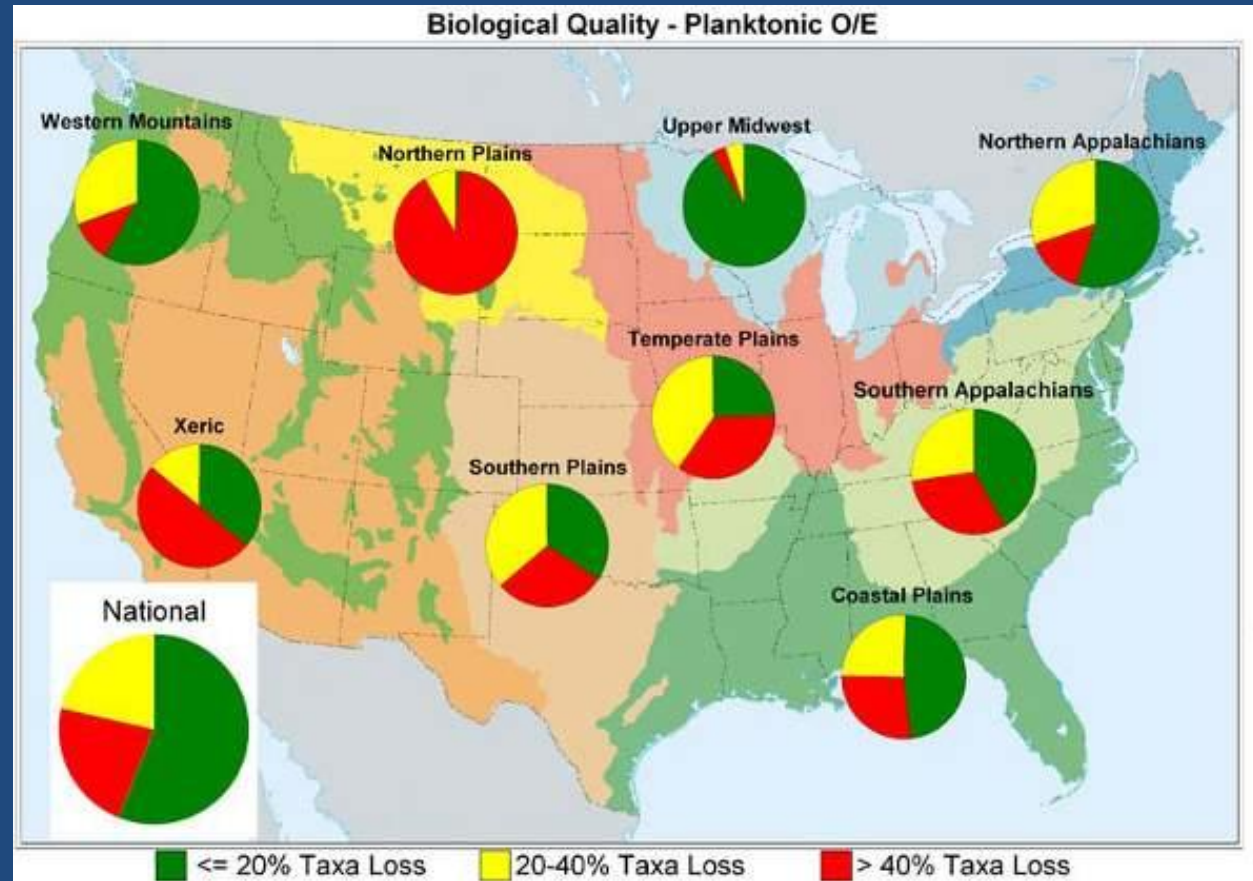# Biological Condition of the Nation's Lakes: Sediment Diatom IBI

- Index of Biological Integrity (IBI) combines measures of community integrity based on sedimented diatoms.
  - Process:
    - Reference lakes are identified within regions
    - A variety of metrics that describe the community are tested
    - Researchers identify those metrics that identify changes from the regional reference lakes that are ecologically relevant
    - IBI is adjusted for natural attributes that affect the community (e.g., depth, lat/long, elevation, pH)
- IBI is scaled to a score of 0-100

Condition of the Nation's Lakes: Biological Condition
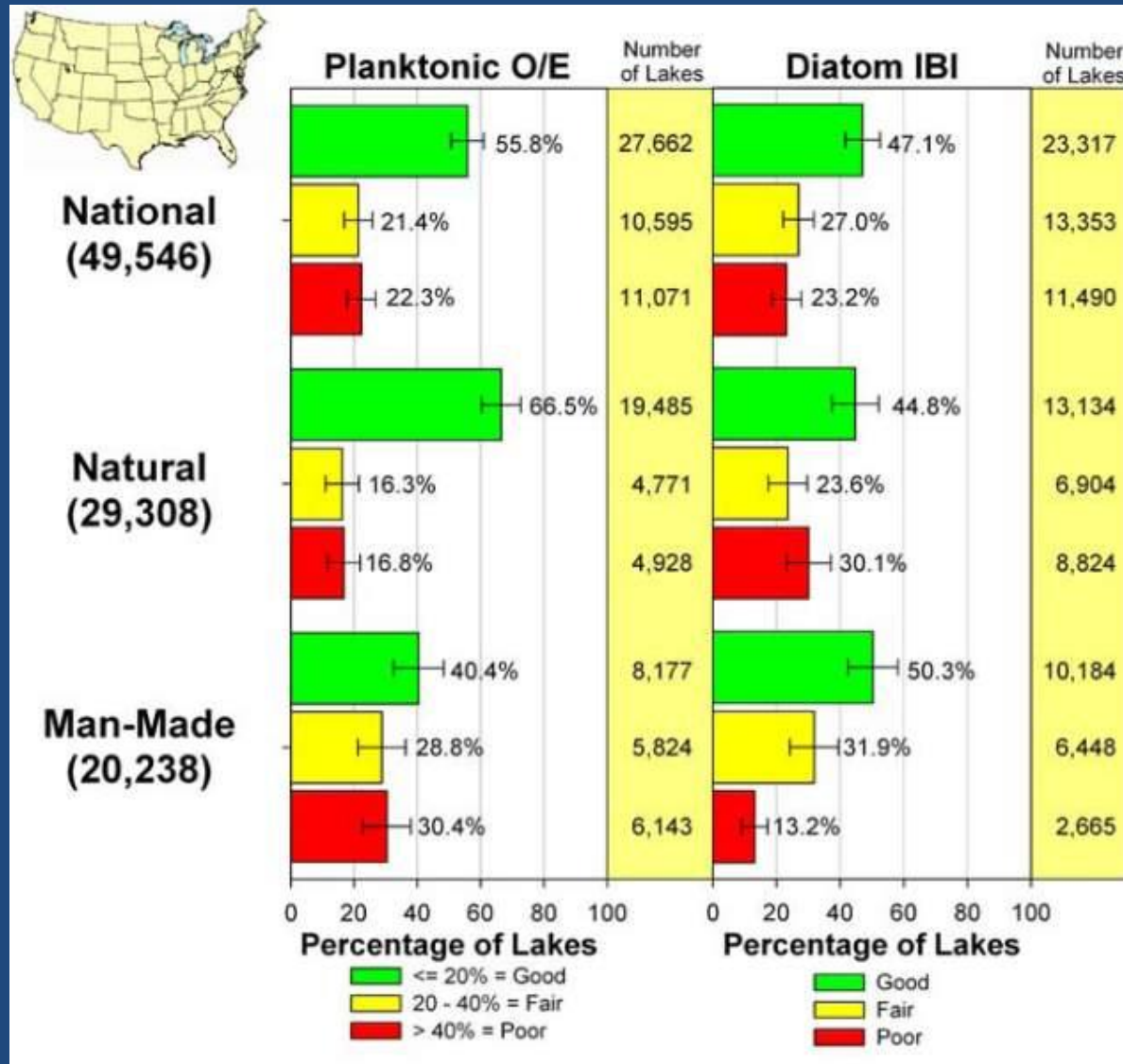
Biological Condition Varies Across the Country

- Xeric and Northern Plains show the greatest proportion of lakes with excessive taxa loss

- Upper Midwest and Western Mountains have the highest proportion of lakes with low taxa loss.

Biological Quality - Planktonic O/E

Western Mountains
Northern Plains
Upper Midwest
Northern Appalachians
Temperate Plains
Xeric
Southern Plains
Southern Appalachians
Coastal Plains
National

■ <= 20% Taxa Loss   ■ 20-40% Taxa Loss   ■ > 40% Taxa Loss
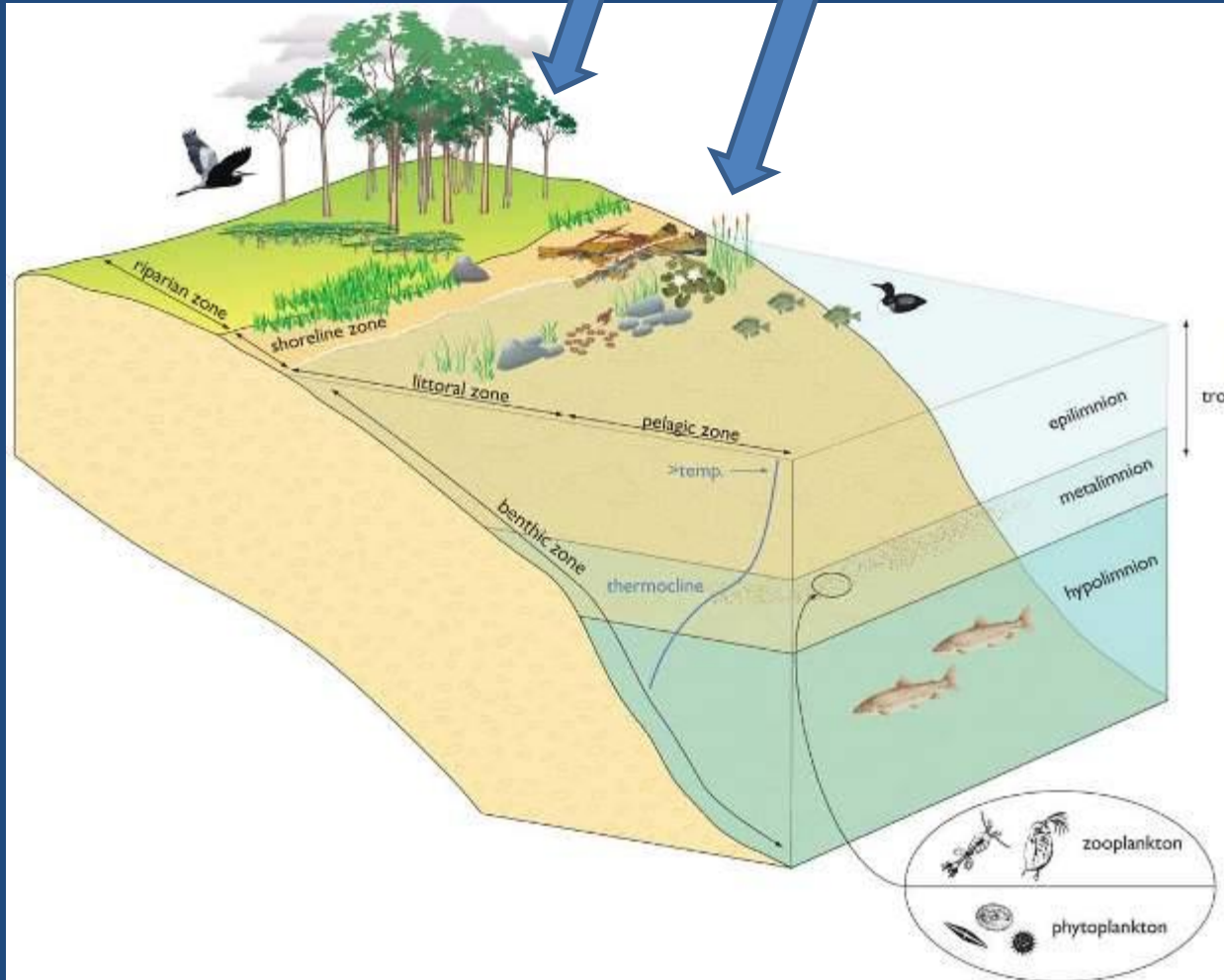
Condition of the Nation's Lakes: Habitat

- 55 individual habitat attributes captured at each site (550/lake).

- Metrics reduced to four indices of habitat quality:
  - Human Disturbance on Lakeshores
  - Riparian Zone Integrity
  - Littoral Zone Integrity
  - Complexity of Riparian/Littoral Interface

- Disturbance index scores assessed against nationally consistent thresholds

- Riparian/littoral indices assessed against regionally-explicit reference conditions (*corrects for expected regional differences*)
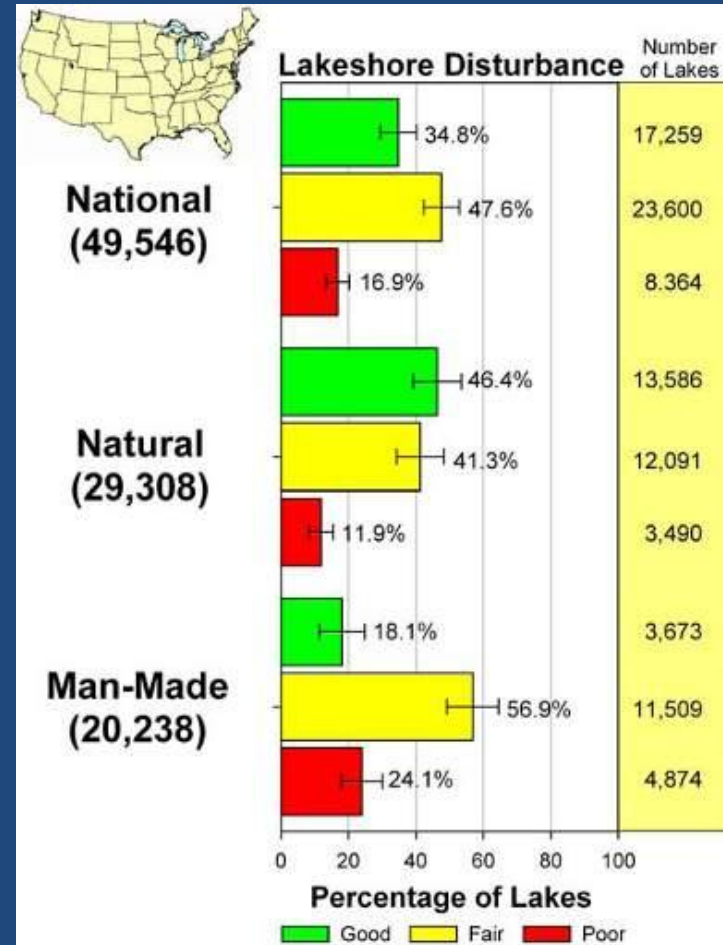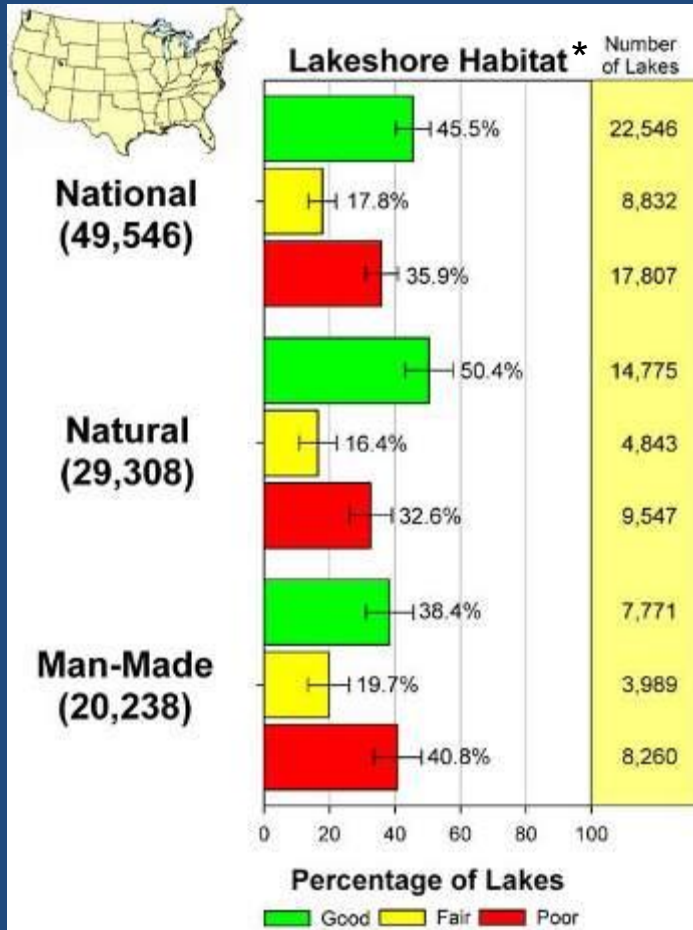
Lakeshore zone   Shallow zone

Complexity:
The degree to which both lakeshore and shallow zones are intact. Complex habitats facilitate movement of food into and out of lakes.

Disturbance:

Condition of the Nation's Lakes: Habitat

*) NLA Primary indicator is Lakeshore Habitat

Chemical Stressors of the Nation's Lakes

- Nutrients and turbidity
- Acidity
- Dissolved Oxygen

Chemical Stressors in the Nation's Lakes: Nutrients and Turbidity

- Lakes were assessed for their nutrient and turbidity levels using regionally-explicit reference thresholds to determine good, fair, and poor condition

Nutrient Ecoregion	# Ref Lakes	TP (ug/L) Good-Fair	TP (ug/L) Fair-Poor	TN (ug/L) Good-Fair	TN (ug/L) Fair-Poor
Coastal Plain	14	26	75	629	2311
II. Western Mts.	23	15	19	278	380
III. Xeric West	14	48	130	514	2286
IV. Grass Plains-Man-made	9	37	56	513	824
IV. Grass Plains-Natural	6	839	1719	8647	9359

Chemical Stressors in the Nation's Lakes: DO, Acidity

- Lake conditions with respect to dissolved oxygen and acidification were assessed using fixed national thresholds

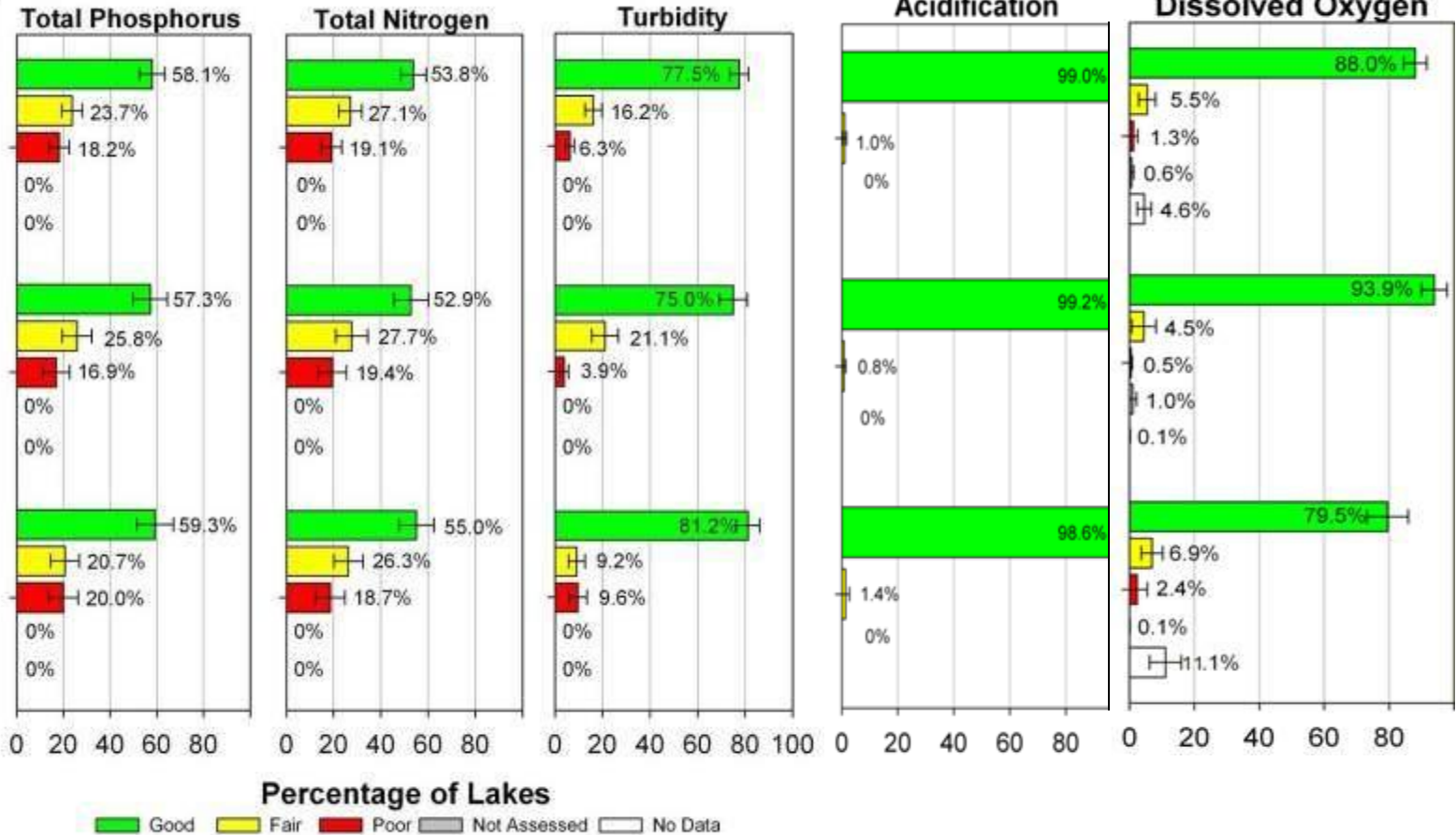| Oxygen (upper 2 m water column)	High	Moderate	Low
	≥ 5ppm	3-5 ppm	<3 ppm
Acidification	Non acidic	Acidic natural	Acidic Anthropogenic
	>50 ueq. ANC	≤50 ueq ANC (DOC ≤5 ppm)	≤0 ueq. ANC (DOC ≤ 5ppm)

# Chemical Stressors in the Nation's Lakes: Nutrients, DO, Acidity

Extent of Stressors and Resulting Risk: What Impacts Biological Condition?

- NLA related chemical stressors and habitat indices to biological condition, to assess which are most consequential.
- Three useful indicators:
  - Relative Extent – What is the proportion of stressors in poor condition?
  - Relative Risk – When stressors indicate poor condition, what is the increased proportion of lakes with poor biological condition?
  - Attributable Risk – What percent of lakes that are in poor biological condition should move to good/fair if this stressor is eliminated?

Stressors to the Nation's Lakes: Extent, Relative Risk, and Attributable Risk
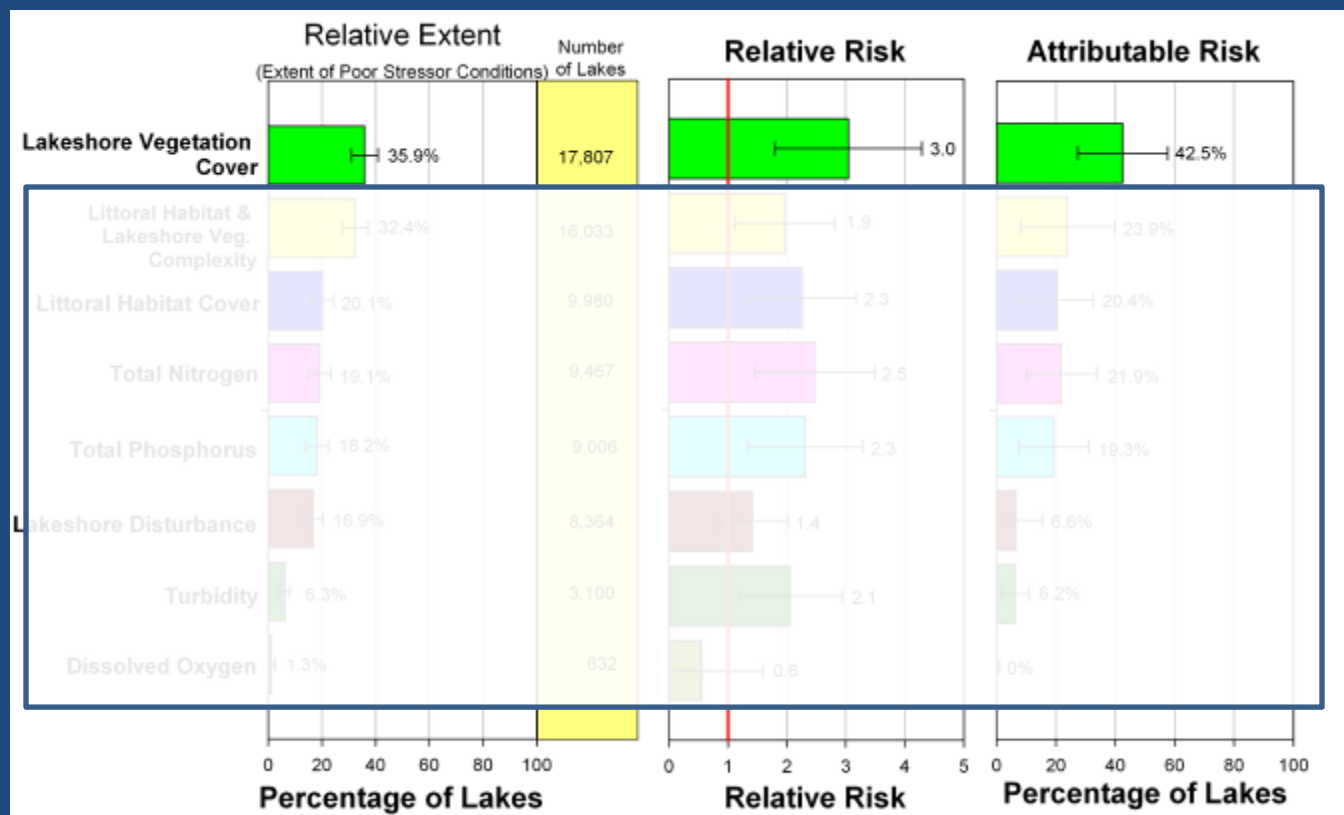

- #1 – Lakeshore vegetation: Poor biology is three times more common when lakeshore vegetation cover is in poor condition. This affects 36% of lakes.

Poor Biology is Three Times More Common when Lakeshore Habitat is Poor
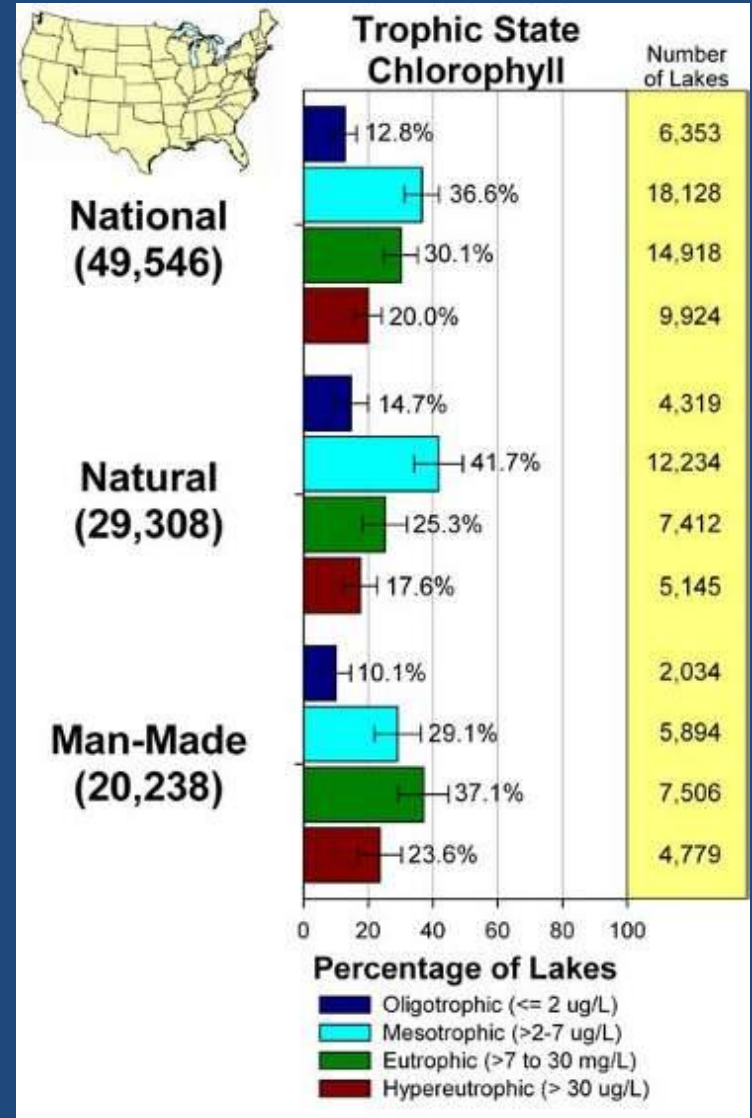
Regional summary:

- Northern Plains, Coastal Plains and Xeric have highest proportion of lakes with poor habitat conditions

- While the Upper Midwest exhibits a high proportion of lakes with high-quality habitat, *> 25% of lakeshores are in poor condition*
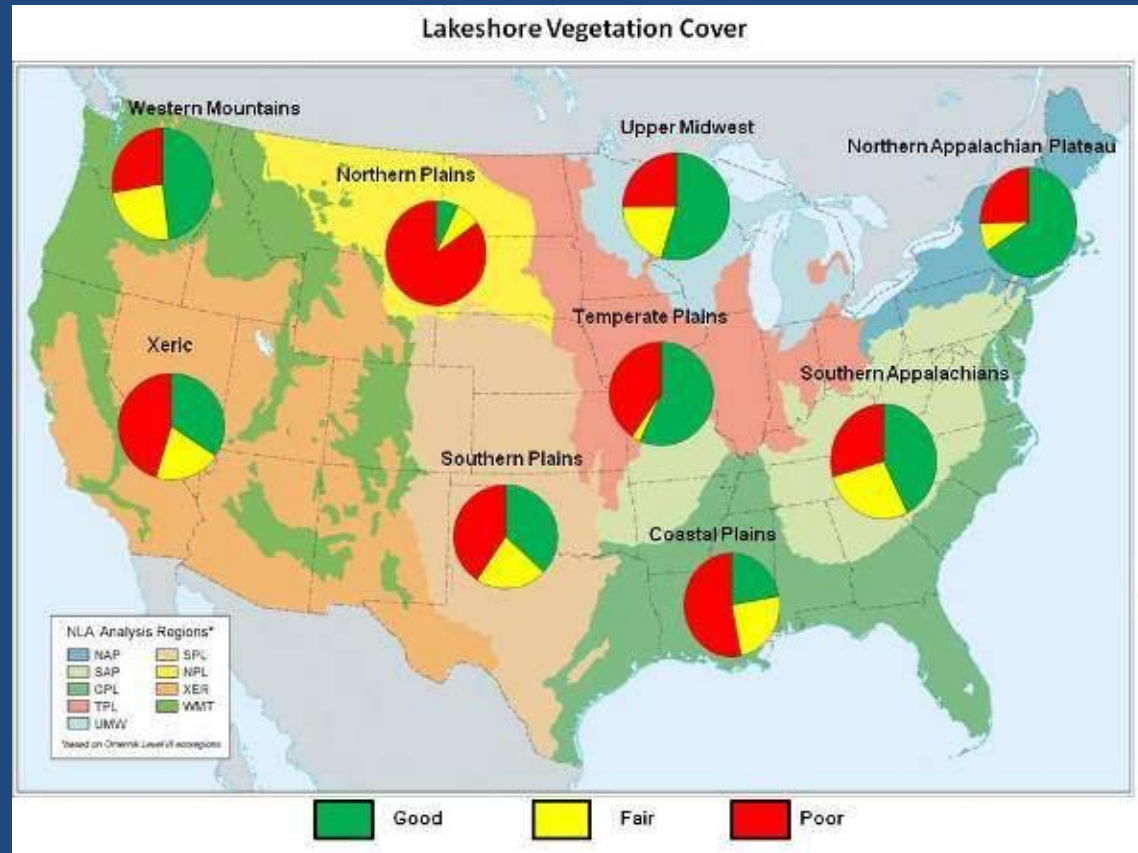
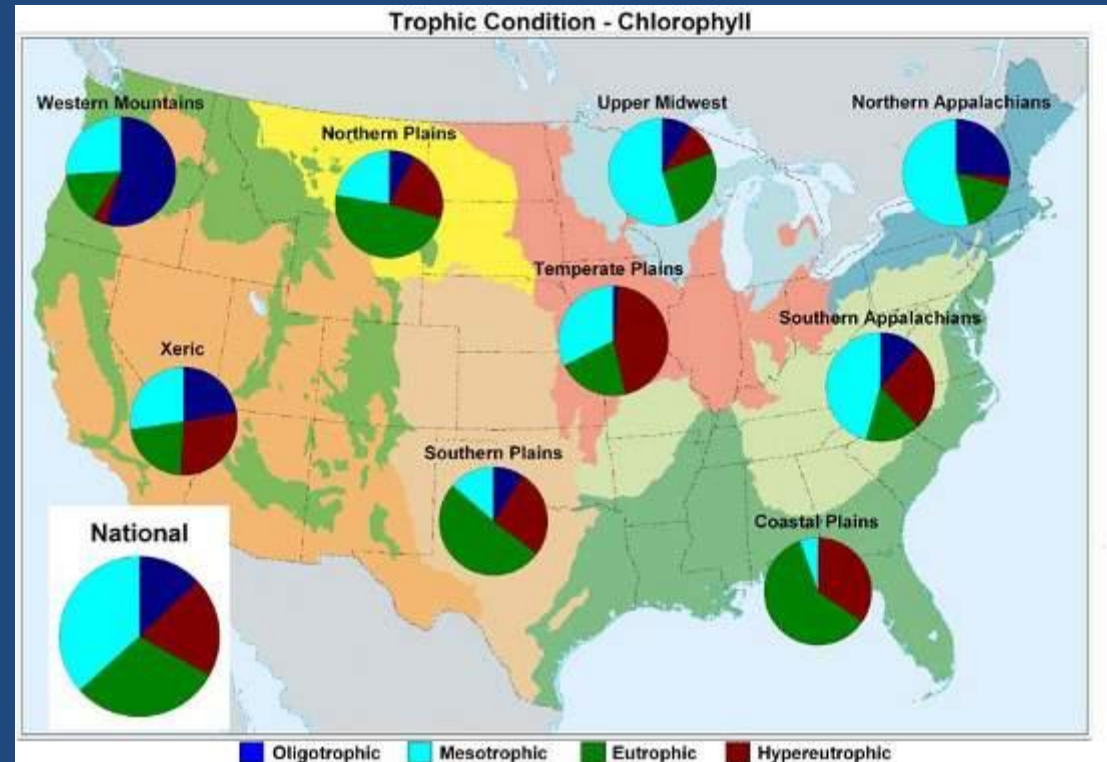We appear to be loving our lakes too much!

Trophic State of the Nation's Lakes

- National Summary:
  - 13% of lakes are oligotrophic
  - 37% are mesotrophic
  - 30% are eutrophic
  - 20% are hypereutrophic.
- Used chlorophyll-a as primary assessment, with "Carlson" thresholds
- Also assessed trophic state independently using total phosphorus, total nitrogen, Secchi.

Trophic State Chlorophyll

		Number of Lakes
National (49,546)	12.8%	6,353
	36.6%	18,128
	30.1%	14,918
	20.0%	9,924
Natural (29,308)	14.7%	4,319
	41.7%	12,234
	25.3%	7,412
	17.6%	5,145
Man-Made (20,238)	10.1%	2,034
	29.1%	5,894
	37.1%	7,506
	23.6%	4,779

Percentage of Lakes

- Oligotrophic (<= 2 ug/L)
- Mesotrophic (>2-7 ug/L)
- Eutrophic (>7 to 30 mg/L)
- Hypereutrophic (> 30 ug/L)

Trophic State – Ecoregional Results

- Western Mountains, Upper Midwest, Northern Appalachians show greatest proportion of oligo/mesotrophic lakes

- Plains show greatest proportion of eutrophic and hypereutrophic lakes

- In some ecoregions (Northern Plains, Xeric) the traditional nutrient : chlorophyll-*a* paradigm does not apply

Trophic Condition - Chlorophyll

Western Mountains · Northern Plains · Upper Midwest · Northern Appalachians · Temperate Plains · Xeric · Southern Appalachians · Southern Plains · Coastal Plains · National

Oligotrophic   Mesotrophic   Eutrophic   Hypereutrophic

Recreational Condition of the Nation's Lakes: Algal Toxin Exposure Risk

- Sampled 4 indicators suitable for assessment of Harmful Algal Bloom (HAB) toxin risk:

  - ***Presence of microcystin*** *(extent)*

  - ***Cyanobacteria cell count*** *(potential risk)*

  - Chlorophyll-*a*

  - Microcystin concentration

- Used World Health Organization thresholds for assessment
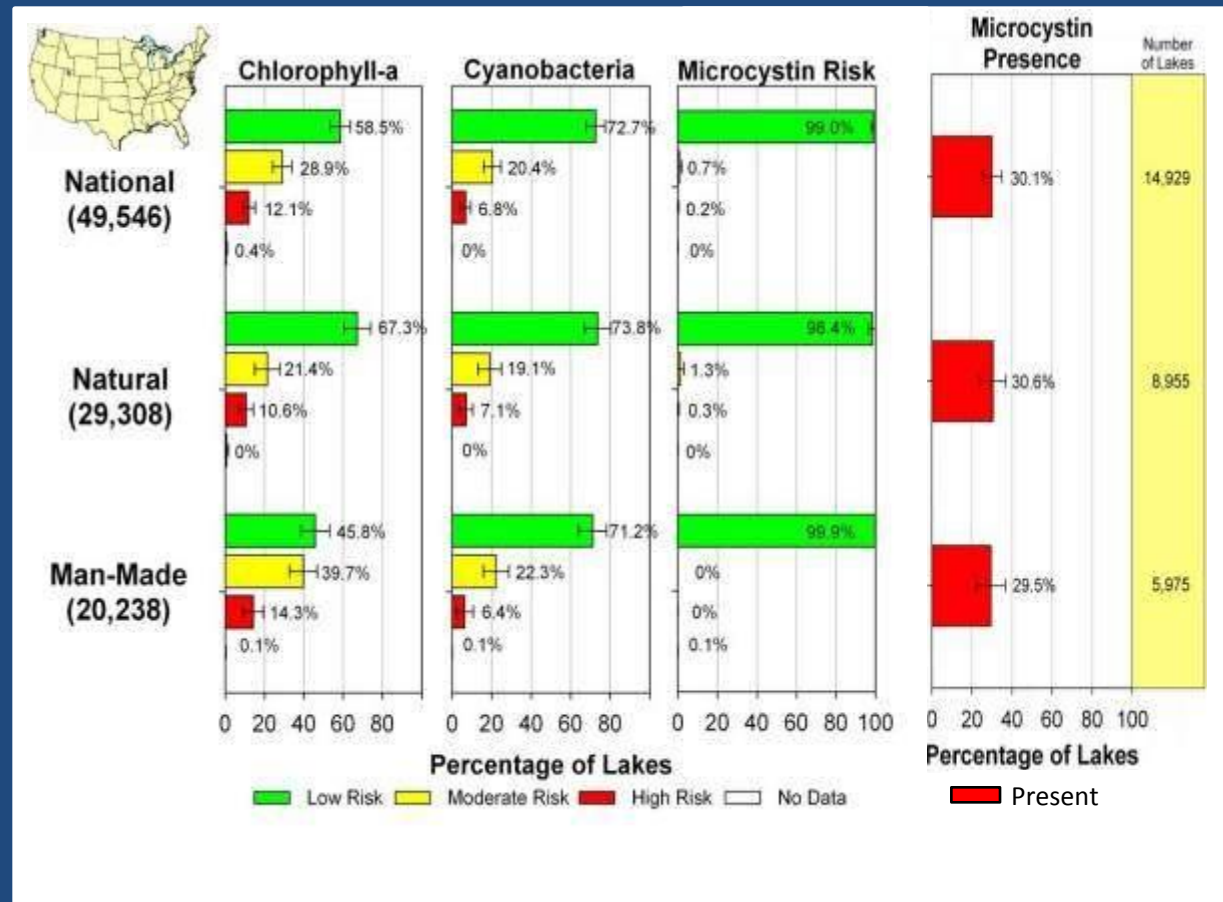
Recreational Condition of the Nation's Lakes: Algal Toxins
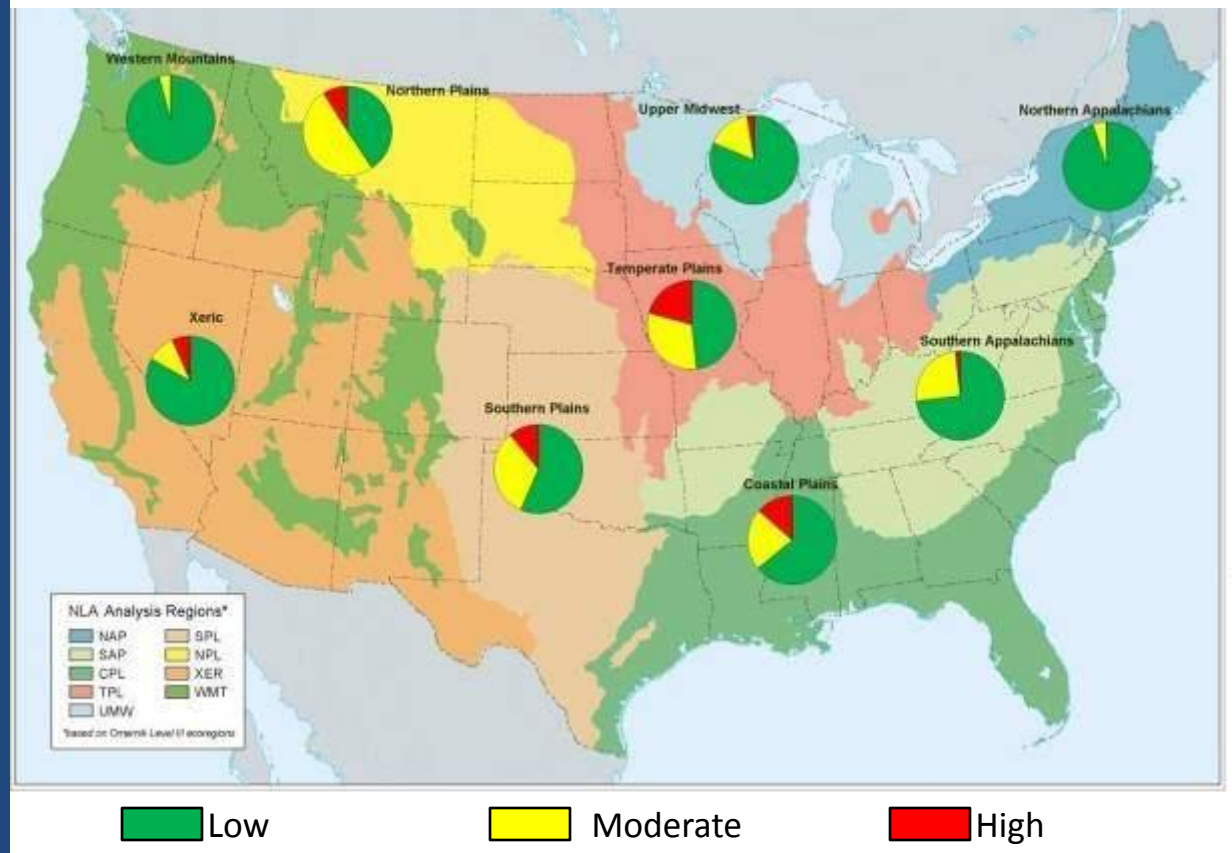
National Summary:

- Microcystin detected in 30% of lakes and at levels of concern in 1%

- Exposure risk based on cyanobacteria:
  - 73% of lakes exhibit low risk
  - 20% moderate risk
  - 7% high risk

- WHO thresholds for cyanobacteria:
  - Low risk (<20K) cells
  - Mod. risk (<100K) cells
  - High risk (>100K cells)

Recreational Condition of the Nation's Lakes: Risk of Cyanotoxin Exposure

- Plains show greatest proportion of high-risk lakes

- Greatest proportion of lakes exhibiting low risk in Western Mountains and Northern Appalachians

Risk of cyanotoxin exposure based on measured cyanobacteria

NLA Analysis Regions*
NAP   SPL
SAP   NPL
CPL   XER
TPL   WMT
UMW

*based on Omernik Level III ecoregions

Low   Moderate   High

Regional Assessments

Northern Appalachians

Southern Appalachians

Upper Midwest

Coastal Plains

Temperate Plains
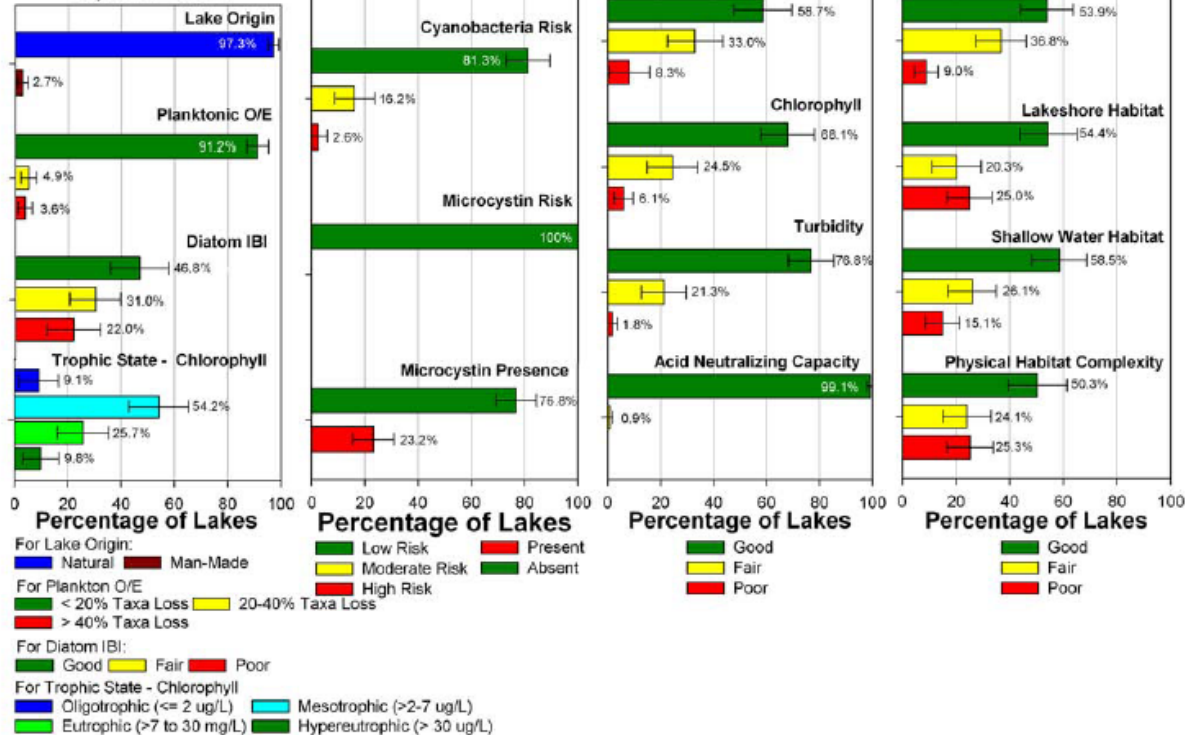
Southern Plains

Northern Plains

Western Mountains

Xeric West

Figure 28. NLA findings for the Upper Midwest ecoregion. Bars show the percentage of lakes within a condition class for a given indicator.

Subset of wastewater-impacted National Eutrophication Survey (NES) lakes (200) were revisited for NLA

Results from these lakes used to project changes in the 800 lakes originally sampled under NES in 1972

Phosphorus trend:

24% of lakes showed no change in phosphorus and 50% of lakes showed decreased phosphorus levels

Change in Phosphorus
NES Lakes 1972 - 2007

Increase 25.9%

Decrease 50.4%
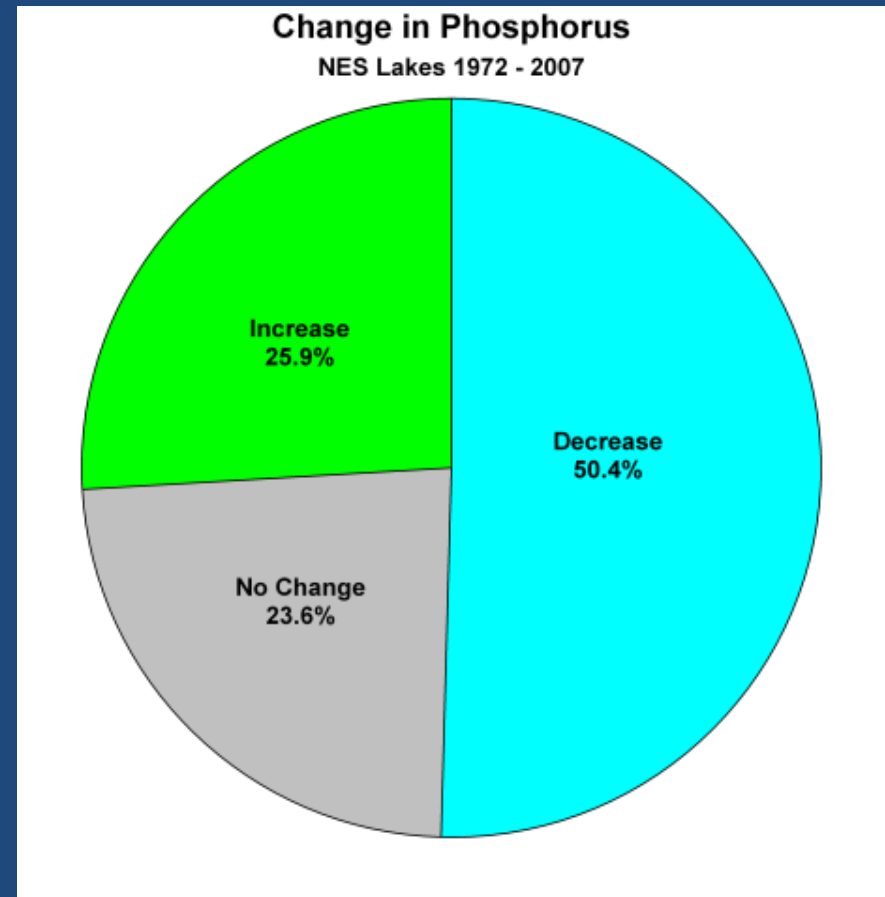
No Change 23.6%

Trends: National Eutrophication Survey and NLA: Looking at Change Between 1972 and 2007

Trophic state trend:

- 26% of NES lakes improved in trophic status
- 51% of NES lakes showed no change in trophic status

Finding that P improved in 50% of lakes and trophic condition improved in 26% of lakes implies success of wastewater treatment plant improvements and other phosphorus control initiatives.

Change in Trophic State (Chlorophyll)

22.6%

26.3%

51.1%

Degraded Unchanged Improved
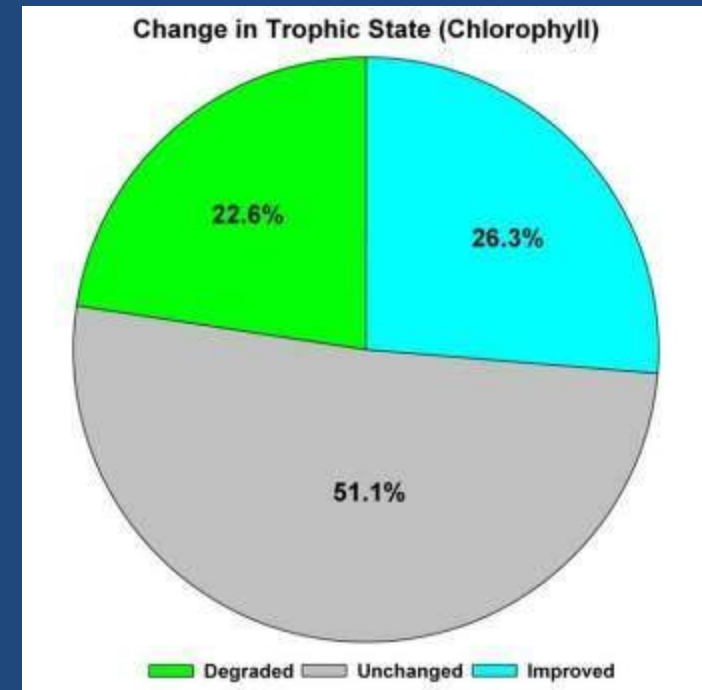
Comparison of change in trophic status of NES lakes

Policy Implications of the NLA Report

- Support for Low Impact Development
  - NLA finding: Habitat alteration is the most important measured stressor in lakes.
  - Supports need to address mitigation of lakeshore habitat impacts.
  - Professional lake community is eager for evidence to support initiatives to protect lakeshores
- Support for trends analysis using statistical survey approach
  - NES→NLA Comparison is just one
  - Options for other similar evaluations
  - Surveys provide a tool to evaluate program effectiveness

Policy Implications of the NLA Report

- Support for water quality criteria development
  - NLA data are useful in the in the development and evaluation of nutrient criteria.
  - Enterococci dataset useful for Critical Path Science Plan
  - Reference distributions of nutrients can support improved criteria guidance
- Support for state lake monitoring/assessment programs
  - Technical tools for computing indicators and other assessments
  - Materials to assist states in transferring results
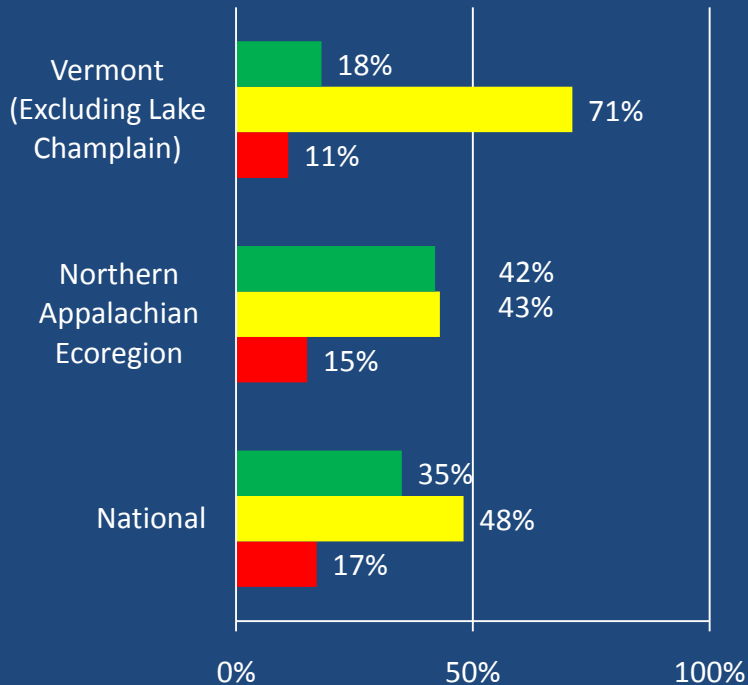
How Can WI use the NLA

- Session Tomorrow morning…
  - WI's participation in NLA,
  - Technical details about the survey and about reference,
  - Comparing lakes to the regional or national condition,
  - How biology was assessed,
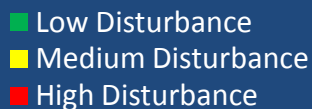 - What is yet to be done.

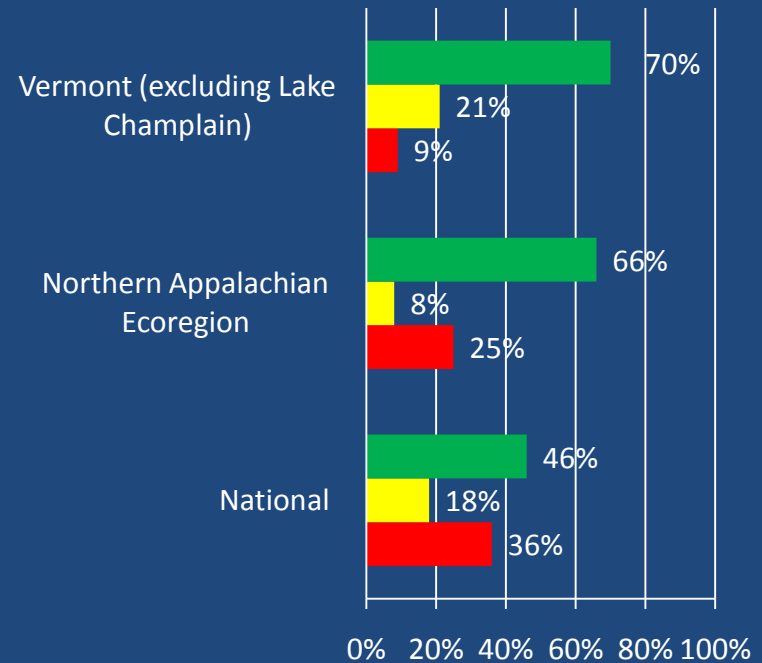# A preview using Vermont data; comparing state lakes to NLA

Lakeshore Disturbance

- Vermont (Excluding Lake Champlain): 18%, 71%, 11%
- Northern Appalachian Ecoregion: 42%, 43%, 15%
- National: 35%, 48%, 17%

Percentage of Lakes

- Low Disturbance
- Medium Disturbance
- High Disturbance

Lakeshore Habitat

- Vermont (excluding Lake Champlain): 70%, 21%, 9%
- Northern Appalachian Ecoregion: 66%, 8%, 25%
- National: 46%, 18%, 36%

Percentage of Lakes

- Good
- Fair
- Poor

Intro and Design

NLA Reference Sites for Biological Condition

Using the NLA

OLIGOTROPHIC (≤ 2 ug/L)   MESOTROPHIC (>2-7 ug/L)
EUTROPHIC (>7 to 30 ug/L)   HYPEREUTROPHIC (> 30 ug/L)

National Findings

Biological Quality - Planktonic O/E
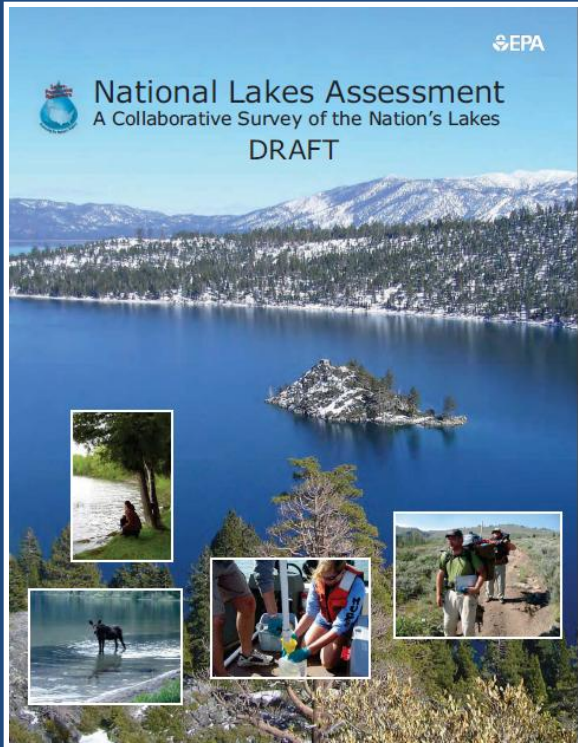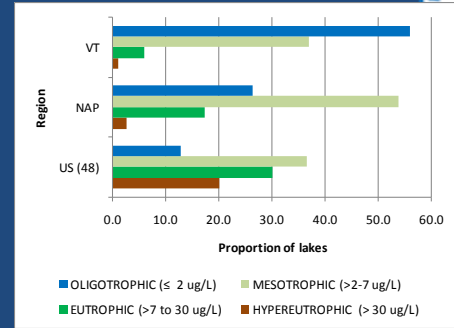
<= 20% Taxa Loss   20-40% Taxa Loss   > 40% Taxa Loss
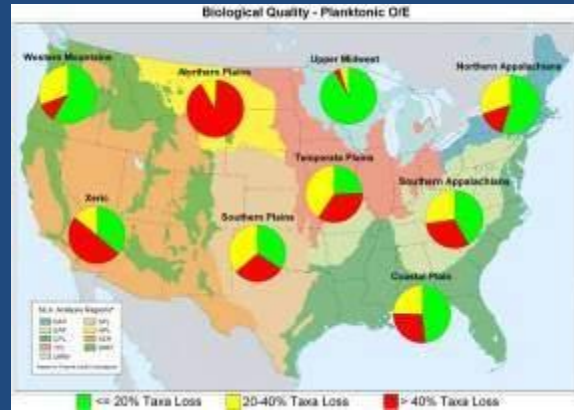
Ecoregional Findings

Change over Time

Change in Phosphorus
NES Lakes 1972 - 2007

Increase 25.9%
Decrease 50.4%
No Change 23.6%
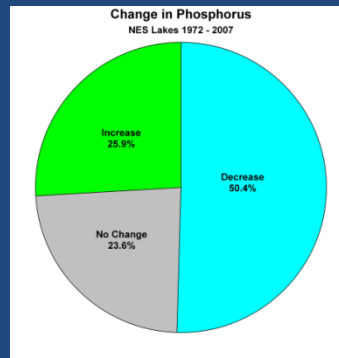
Future Actions – NLA in 2012

National Lakes Assessment
A Collaborative Survey of the Nation's Lakes
DRAFT

National Lakes Assessment Report

- NLA Report available:
  - http://www.epa.gov/lakessurvey

- National Aquatic Resource Surveys:
  - http://www.epa.gov/aquaticsurveys

Questions?