The 2007 National Lakes Assessment

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

Richard Mitchell, United States Environmental Protection Agency
Neil Kamman, Vermont Agency of Natural Resources

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This morning's content

- A few technical details about how the NLA was designed.
- A cautionary word about applicability – a lesson from a small northeastern state.
- The process for reference lake identification and threshold development.
- How biological and habitat indicators were derived
- What remains to do…

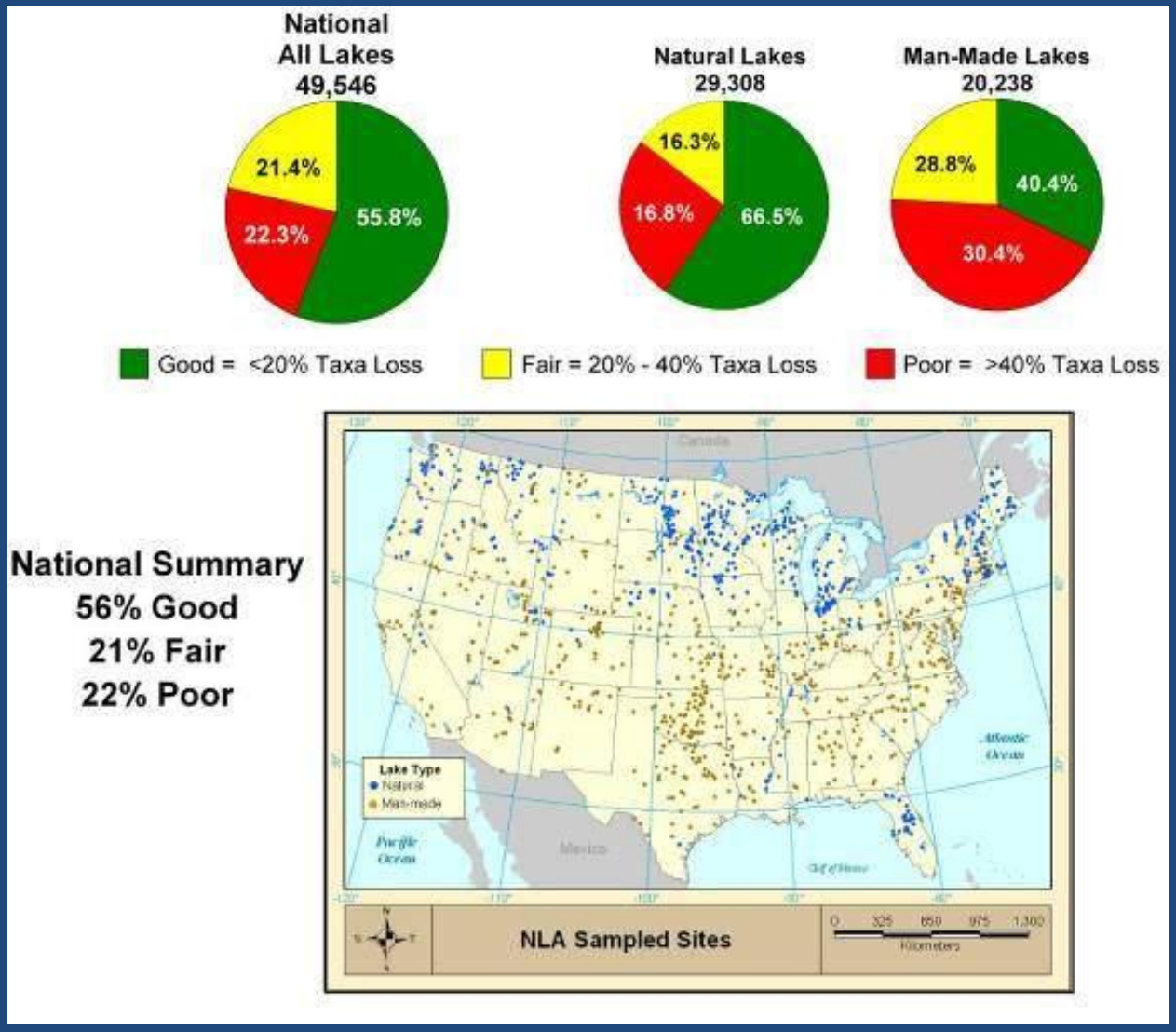
Details about the NLA, and what to watch out for…Kamman

- NLA is scale-dependent
  - What NLA represents and why
  - How the design affects the ability of individuals to use the results.
- NLA findings are a function of reference conditions and assessment thresholds
  - How were reference lakes identified
  - Who picked the thresholds?
- What can we do with NLA data in our own program – VT example.

Details about the NLA, and what to look forward to…Mitchell

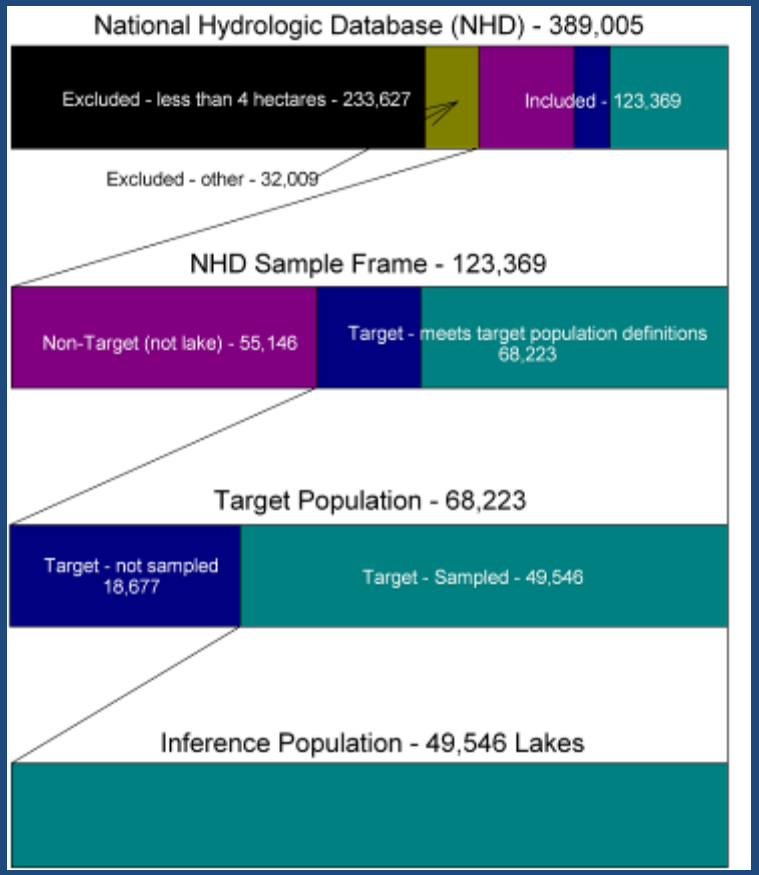
- NLA Biological Assessments are new science
  - Taxa Loss and sediment diatom IBI
  - Habitat indicators
- The NLA did not measure everything, yet.
  - Macroinvertebrates
  - AIS
  - Fish
- This session provides an opportunity to ask questions about any aspect of the survey.

Condition of the Nation's Lakes: Biological Condition Using Taxa Loss Index

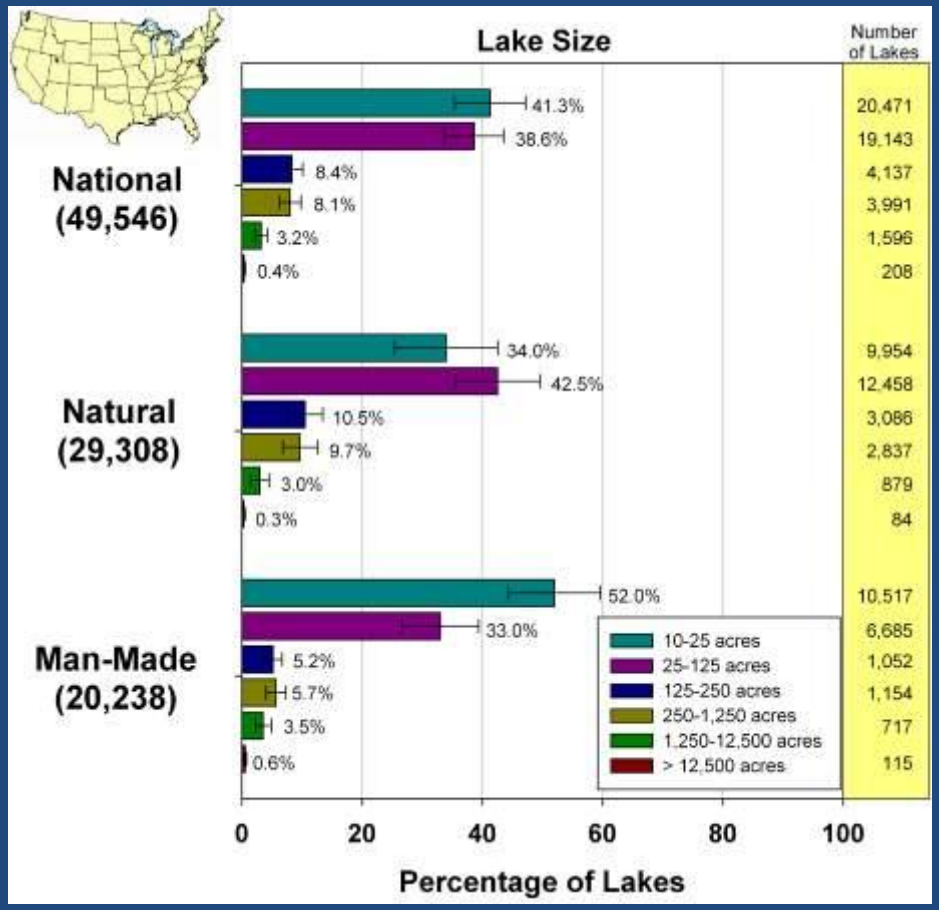


National Lakes Assessment: Design of the Survey

- 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
  - Stratified by size, state, and level-III ecoregion
  - 200 National Eutrophication Survey lakes revisited during the NLA sampling year to assess changes between 1972 and 2009

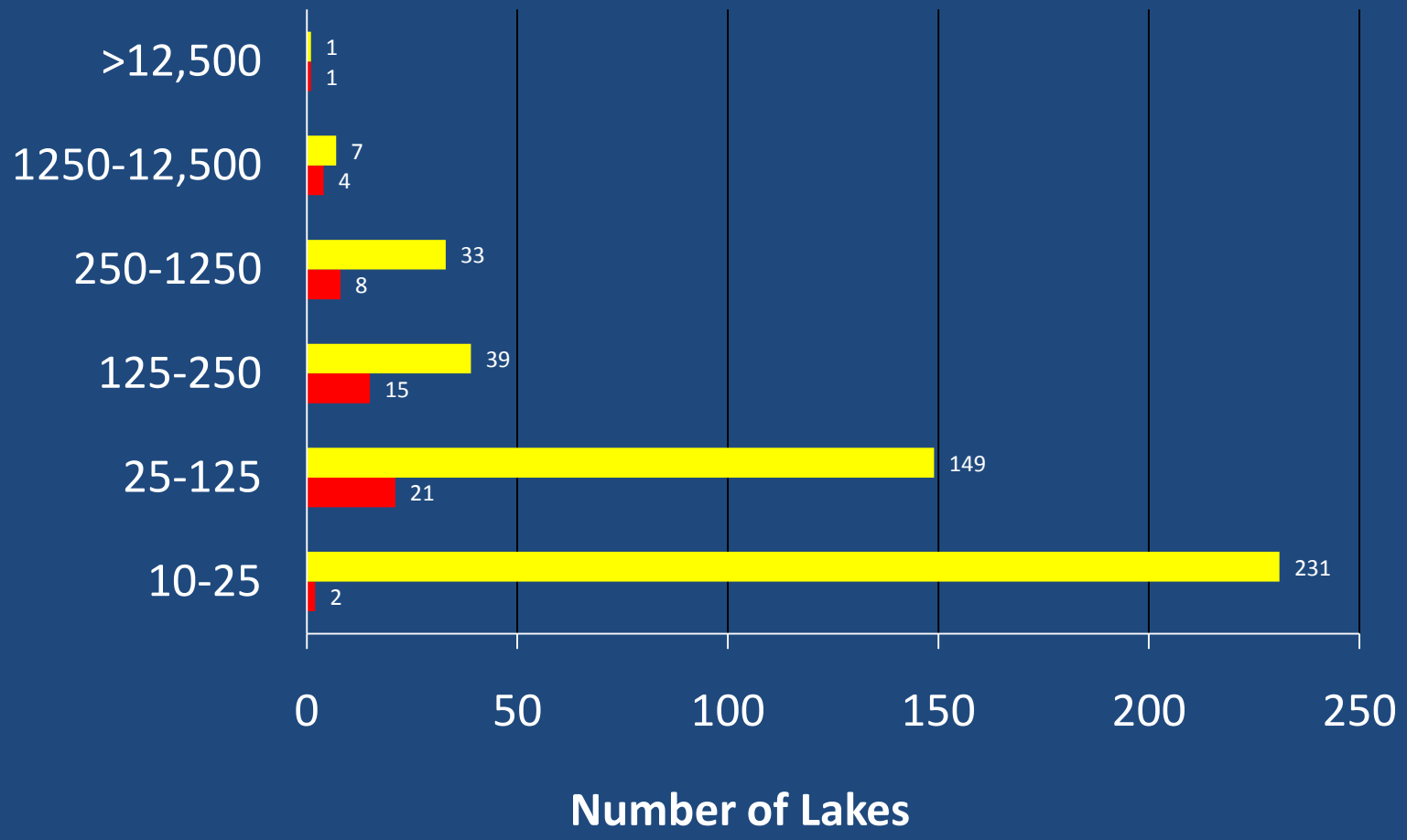


The NLA represents:



- NLA assessed lakes as units, not as areas of water
- Each lake has a "weight"
- 49,560 "lakes"
- 59% natural origin
- 41% constructed

Lakes In Each Size Class
(NLA Sampled & Total # in VT)



Lakes In Each Size Class
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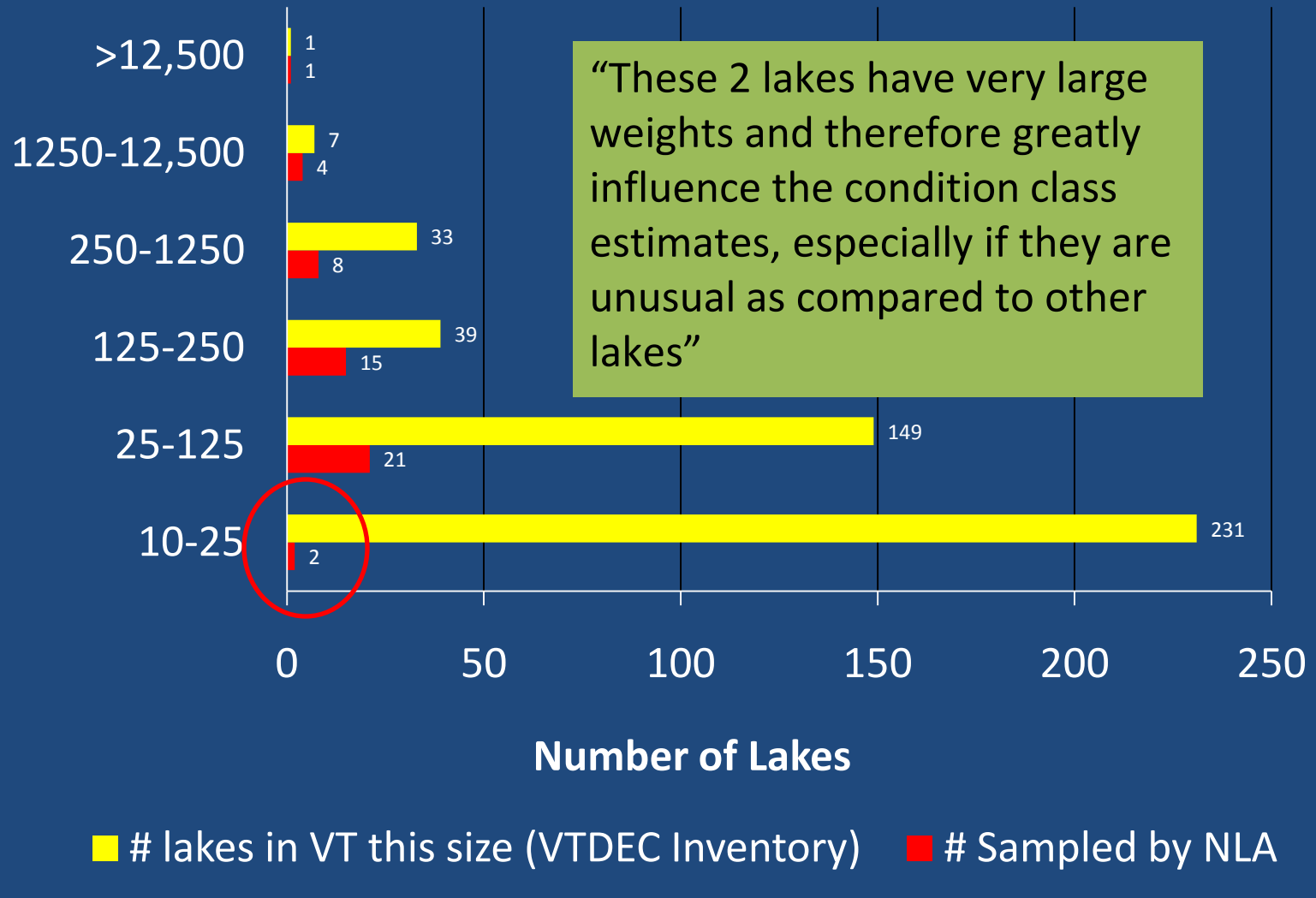
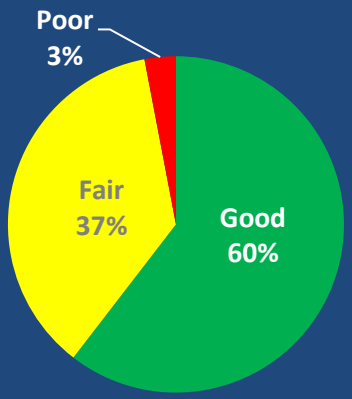


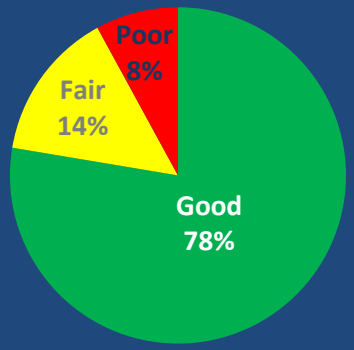
"These 2 lakes have very large weights and therefore greatly influence the condition class estimates, especially if they are unusual as compared to other lakes"

The effect of "high-weight" lakes

Acid Neutralizing Capacity Using VT Thresholds (% of VT lakes >10 acres) Small Ponds Included

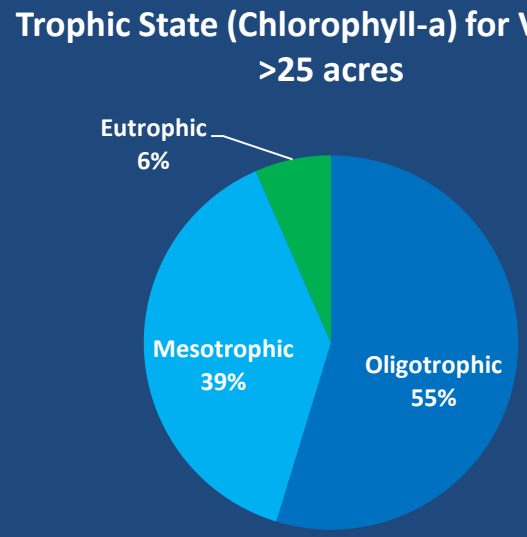


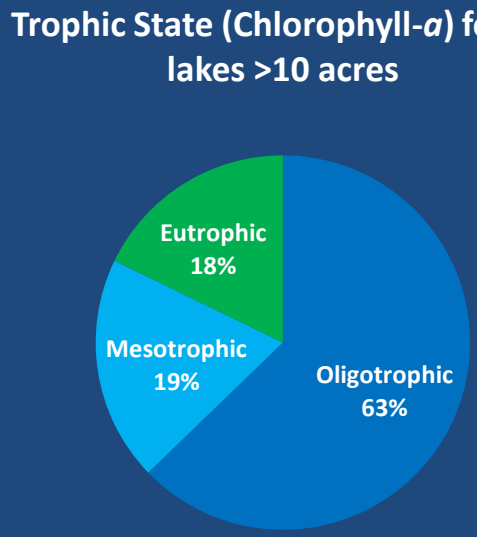
Acid Neutralizing Capacity Using VT Thresholds (% of VT lakes >25 acres) Small Ponds Omitted



- Two lakes with very high weight represents the entire population of 4-10 ha lakes
- If conditions on those lake are atypical, the statewide assessment could be considerably skewed
- In this example, the acid-stressed "Little Rock" Pond exerts tremendous leverage on the statewide assessment

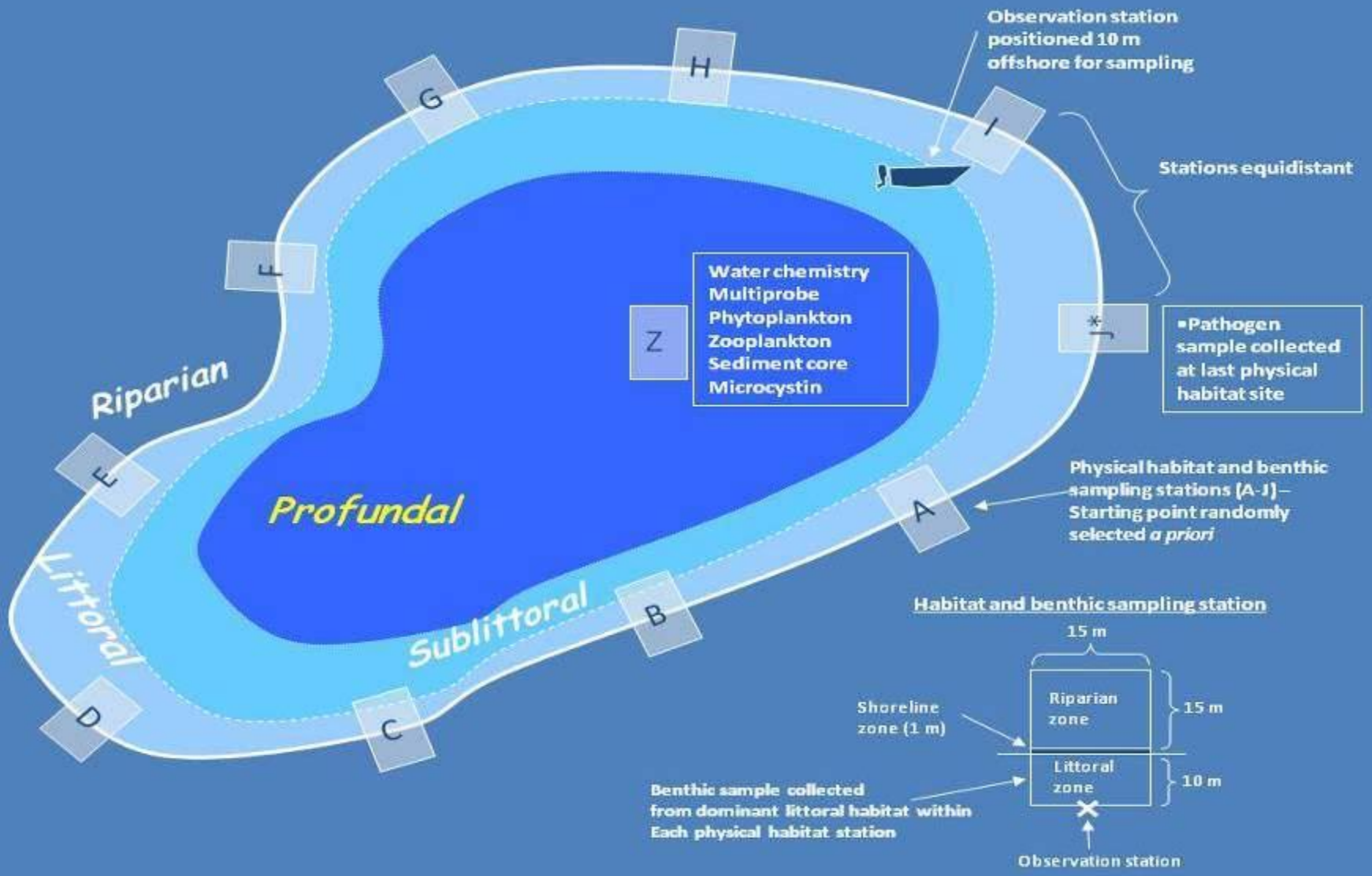
The effect of "high-weight" lakes





- In this example, the eutrophic Lily Pond exerts strong leverage on the statewide assessment as well.
- By omitting the two small lakes, we do not assess 4-10 ha lakes, but we still capture 93% of lake acres statewide.

National Lakes Assessment: Sampling Approach



Determining Thresholds: Setting the Bar

- Two sets of reference lakes:
  - Nutrient
  - Biological

- Reference lakes identified in two steps:
  - Classify into common types
  - Screen using regionally explicit criteria
  - All lakes screened (probability and hand-selected)
  - Lakes that pass criteria comprise the set of reference lakes.

Setting the Bar: Biological Reference Lake Screening Process

Step 1

Cluster analysis:

Elevation
Lat-Long
Precipitation
Mean ann. temp.
Shoreline dev.
Lake size/depth

Step 2

- TP
- TN
- CL
- SO4
- Turb
- ANC (given DOC)
- Euphotic Zone DO
- Shoreline disturbed by Ag
- Shoreline disturbed by non-Ag
- SD – Intensity and extent

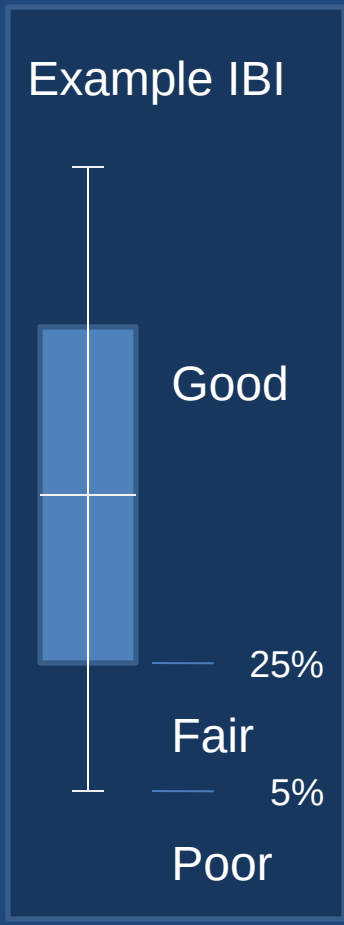
	PTL	NTL	CL
A	12	400	200
B	10	300	250
C [1, 2]	15	500	250

Pass all = ref

Determining Thresholds: Setting the Bar

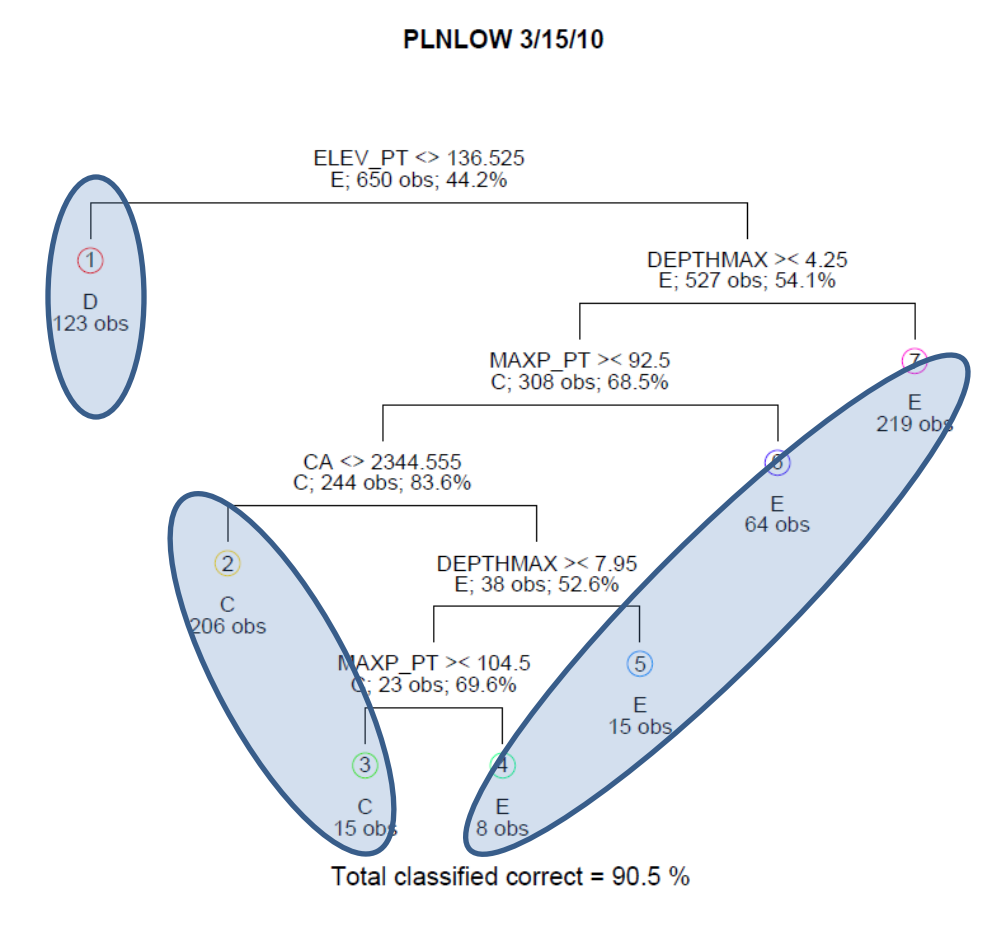
For the NLA, two types of thresholds were used to determine condition:

- Nationally-consistent thresholds
  - Fixed values correspond to assessment findings
  - Applied to trophic state and recreational condition
- Regionally reference-based thresholds
  - Fixed percentile defines good/fair and fair/ poor
  - Applied to bioindicators, some habitat indicators and some stressors



How do I know which reference cluster to use??

- Classification and Regression Tree Analysis
  - Basic attributes used to predict class membership, with a high degree of certainty.



Setting the Bar: Nutrient Reference Lake Screening Process

Step 1

- Begin with nutrient ecoregions
- Pool certain alike regions to obtain sufficient counts of sampled lakes
- Separate reservoirs from natural lakes in one instance

Step 2

- ~~TP~~
- ~~TN~~
- ~~Turb~~
- CL
- SO4
- ANC (given DOC)
- Euphotic Zone DO
- Shoreline disturbed by Ag
- Shoreline disturbed by non-Ag
- SD – Intensity and extent

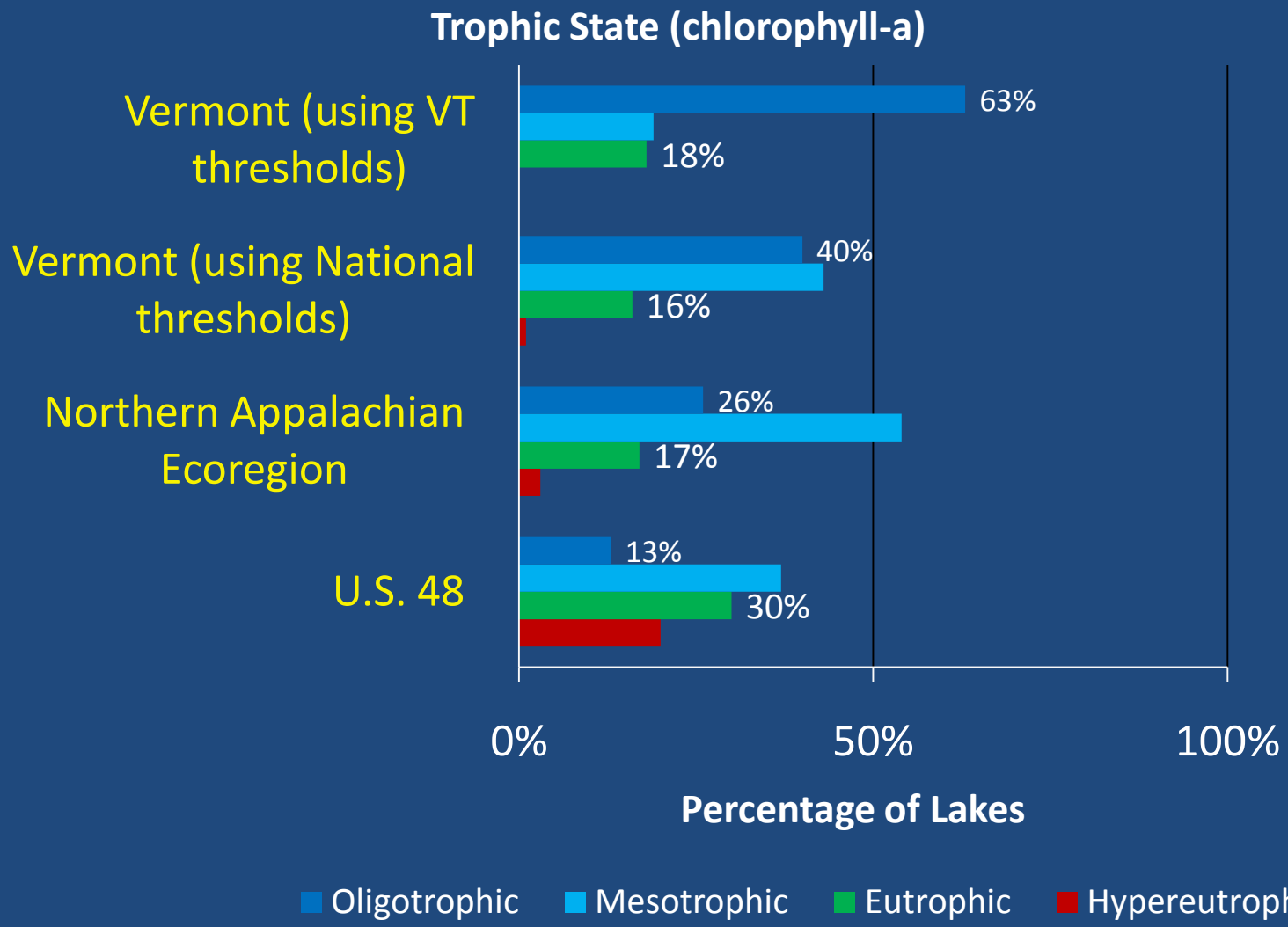
Nutrient Ecoregion	Chloride (ueq/L)	Sulfate (ueq/L)	Habitat ag disturb	Habitat non-ag disturb	Habitat Ex1a disturb	Assess ag	Assess resid	Assess ind
Coastal Plain	>1000	>400	>0	>0.6	>0.6	>4	>9	>4
II. Western Mts.	>20	>50	>0	>0.2	>0.2	>4	>4	>4
III. Xeric West	>500	>10000	>0.1	>0.6	>0.6	>6	>6	>6
IV. Grass Plains-Man-made	>1000	>10000	>0.2	>0.6	>0.6	>9	>9	>9
IV. Grass Plains-Natural	>400	>400	>0	>0.1	>0.1	>5	>5	>5
IX. SE Plains/Piedmont	>200	>400	>0	>0.4	>0.4	>4	>9	>4
V. Cultivated Great Plains	>1000	>10000	>0.2	>0.6	>0.6	>9	>9	>9
VI. Temperate Plains	>1000	>10000	>0	>0.6	>0.6	>9	>9	>9
VII. Southern Glaciated	>400	>400	>0	>0.6	>0.6	>9	>9	>9
VIII. Northern Glaciated	>20	>200	>0	>0	>0	>4	>9	>4
XI. S. Appalachian Mts.	>500	>500	>0.1	>0.5	>0.5	>9	>9	>9

Chemical Stressors in the Nation's Lakes: Nutrients

- 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

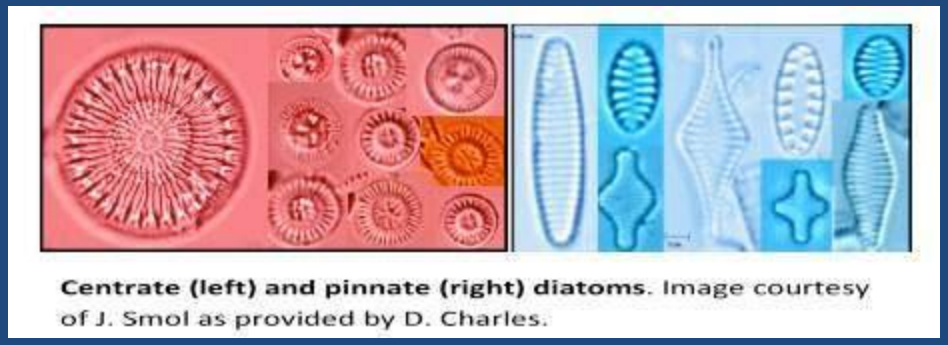
Apples to apples: Comparing Vermont the NLA



Richard Mitchell

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*

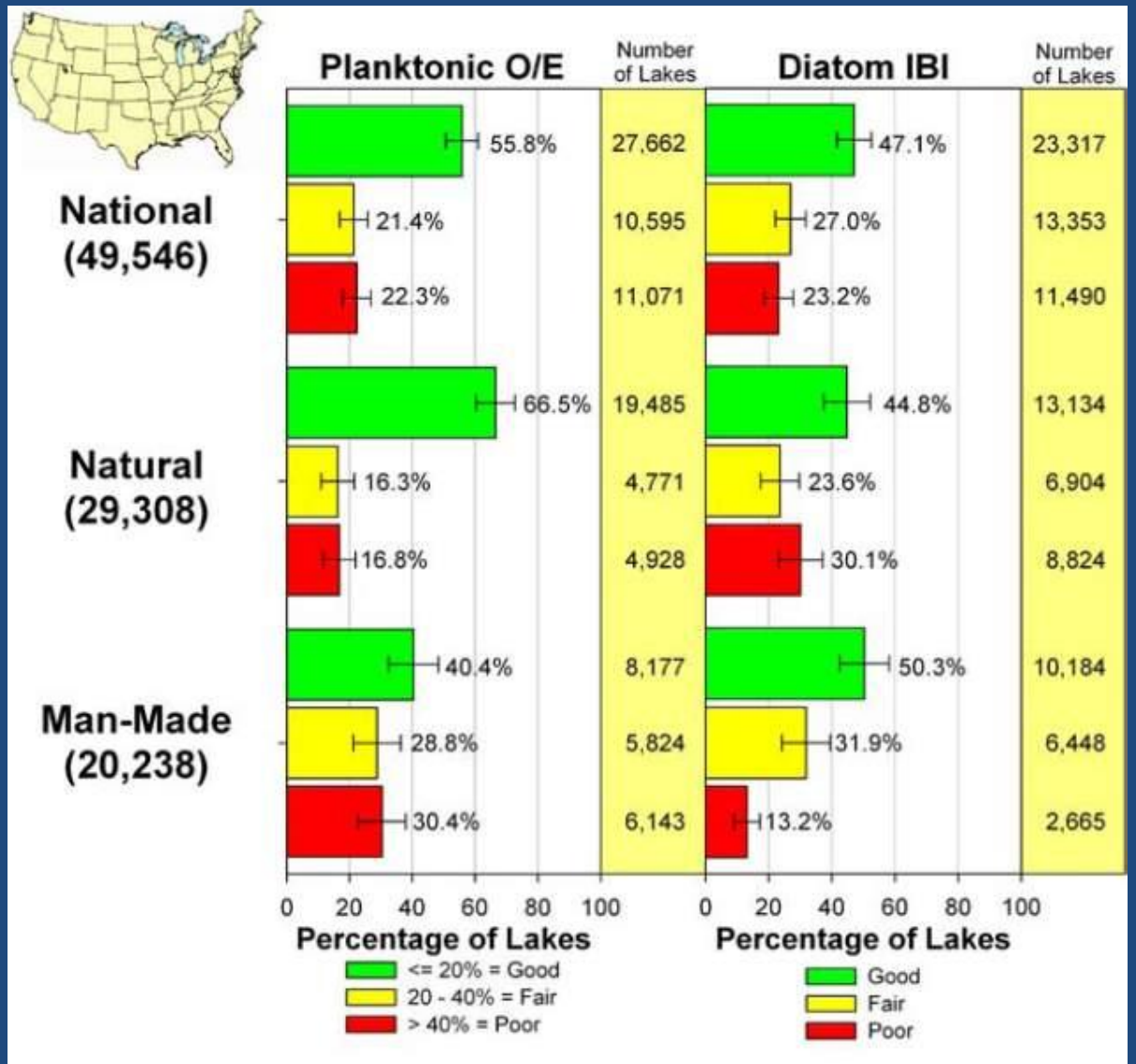
Biological Condition of the Nation's Lakes: Taxa Loss Using an "O/E" Model

- Taxa loss models estimate the taxa Observed at lakes relative to the taxa that are Expected at lakes of a similar type.
  - Process:
    - Reference lakes within regions are classified using physical attributes
    - All lakes are compared to reference classes
    - Expected taxa are determined from the reference lakes, by class
    - Observed taxa are related to expectation
- O/E ranges from near 0 (complete loss) to >1.0 (some benign enrichment evident)

Biological Condition of the Nation's Lakes: Sediment Diatoms

- Index of Biological Integrity (IBI) combines measures of community integrity.
  - Process:
    - Reference lakes are identified within regions
    - A variety of metrics describing the functional and structural attributes of 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

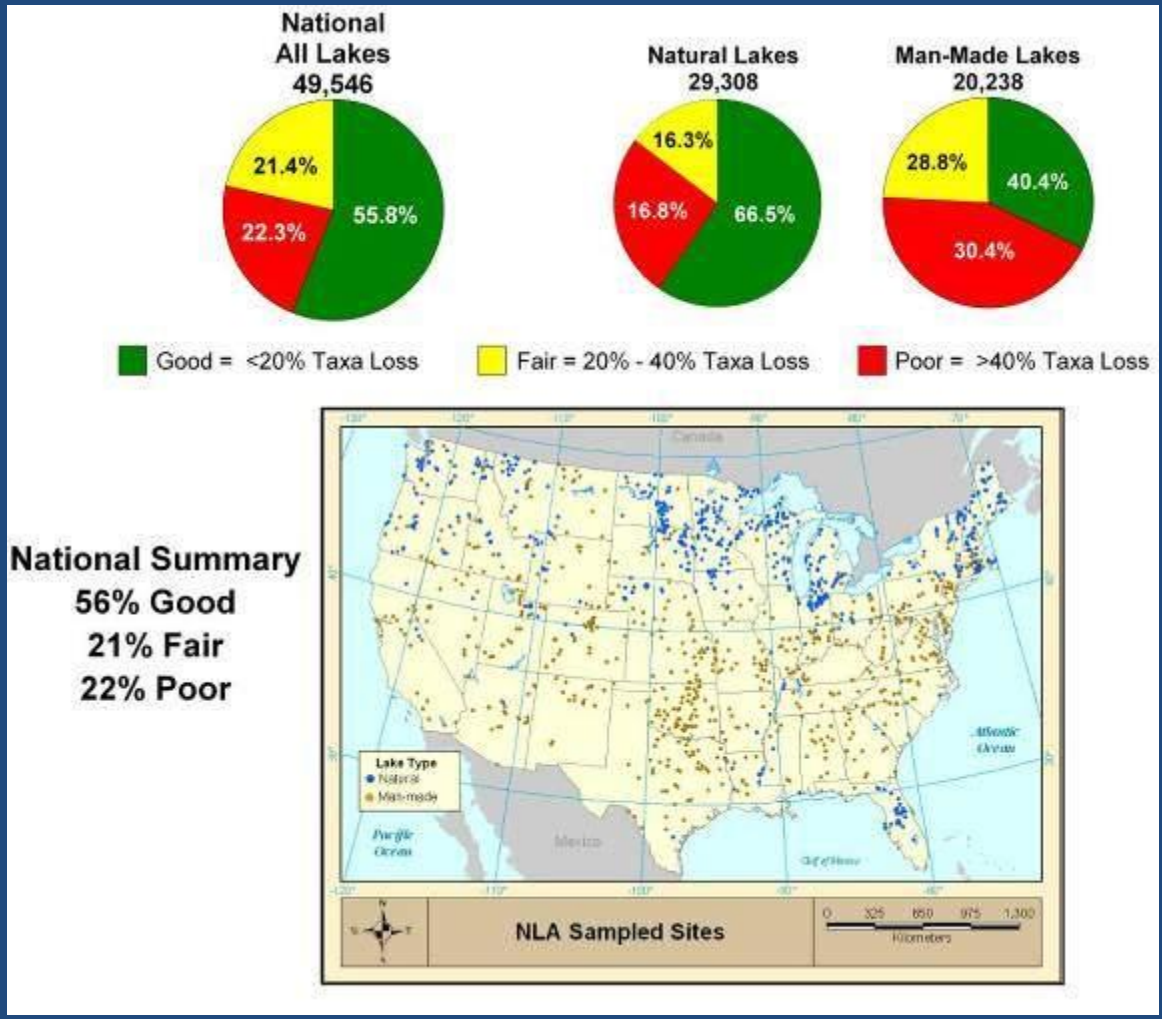
Condition of the Nation's Lakes: Biological Condition



Condition of the Nation's Lakes: Biological Condition Using Taxa Loss Index

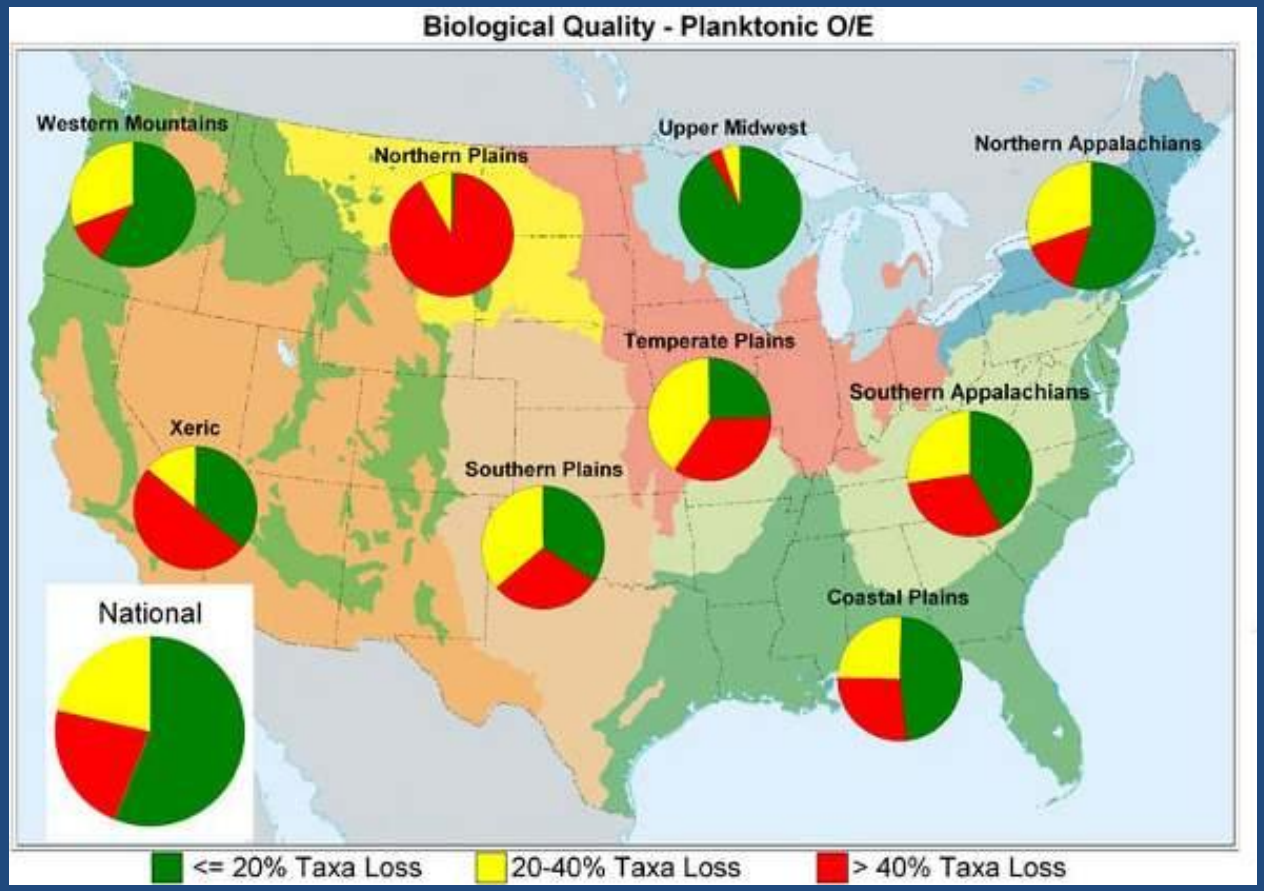
- National Summary:
  - 56% good
  - 21% fair
  - 22% poor

- Consistent national thresholds, but predicated on lake class-specific reference expectations

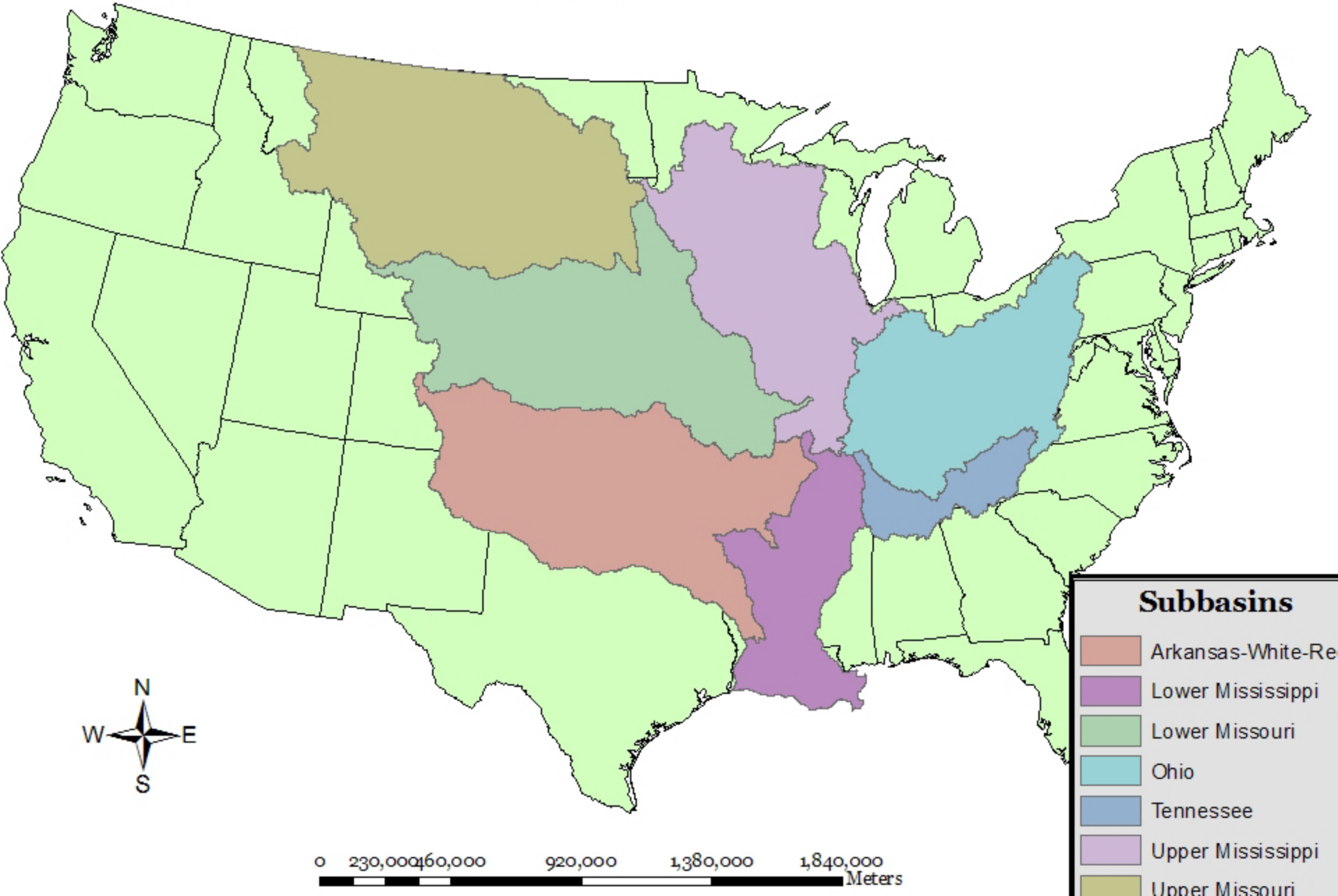


Biological Condition Varies Across the Country

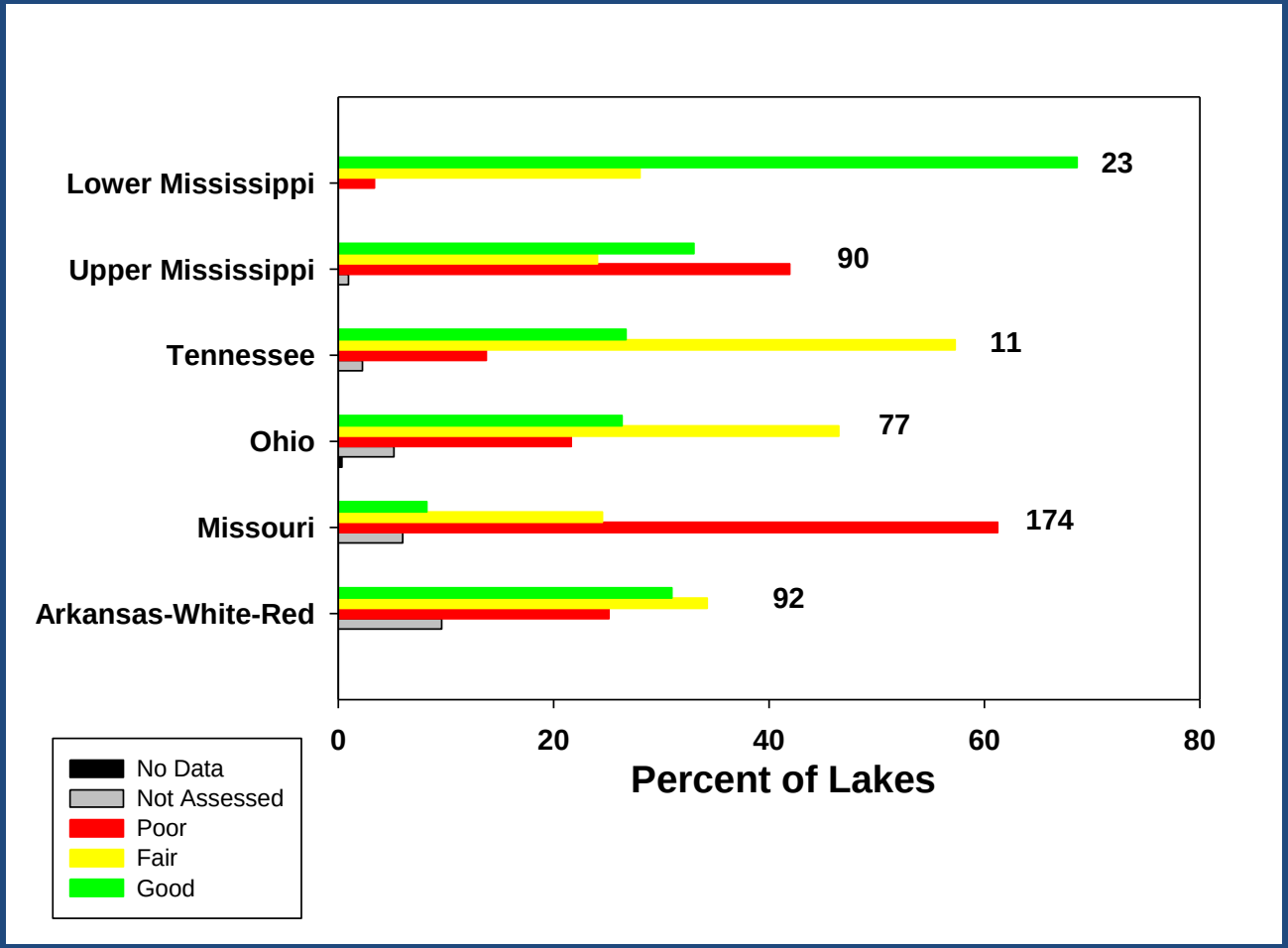
- Xeric and Northern Plains show the greatest proportion of lakes with excessive taxa loss
- Upper Midwest and Western Mountains have the highest proportion of lakes with low taxa loss.



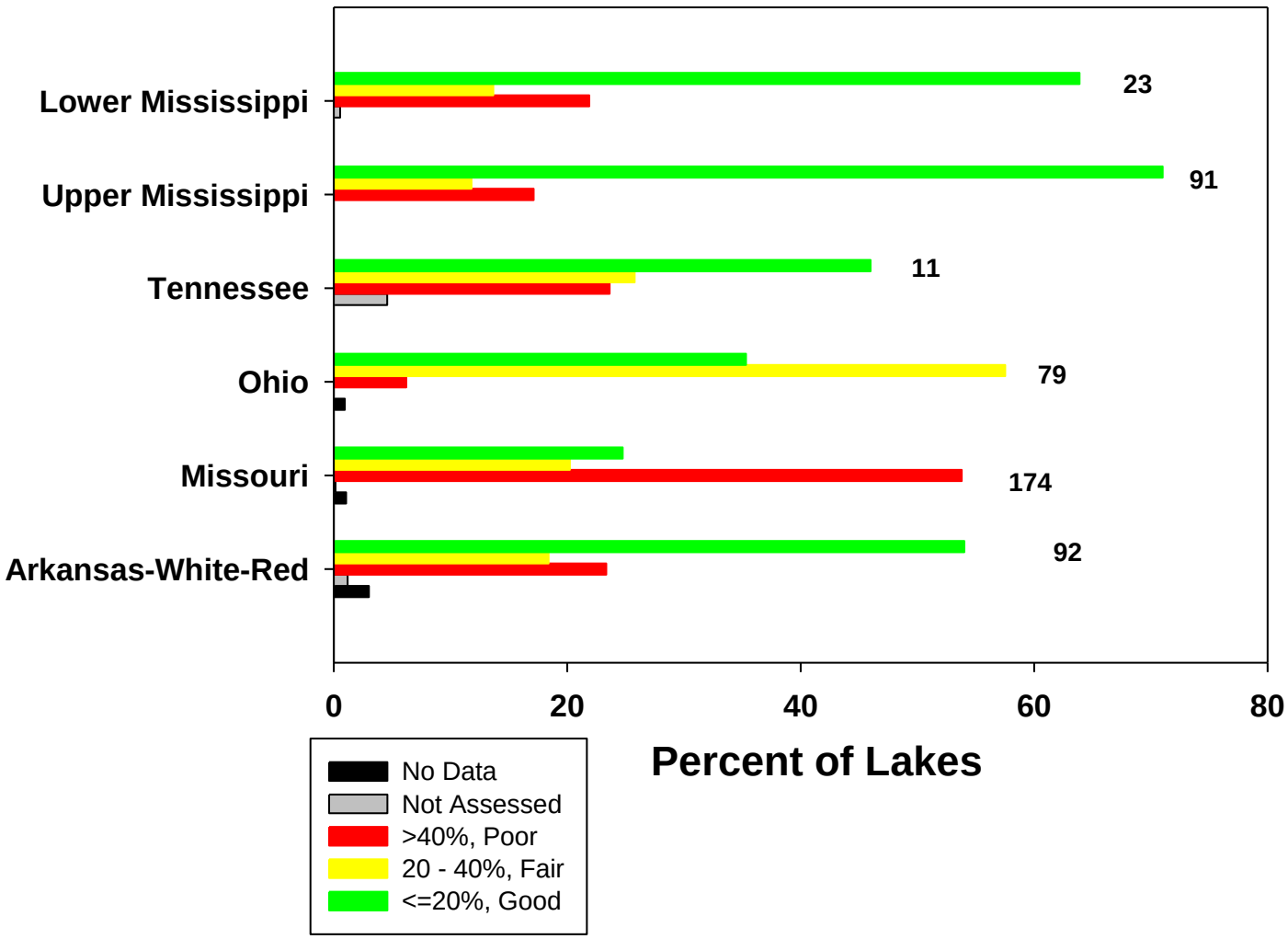
Mississippi Subbasins



Biological Condition of Lakes in the Mississippi Base using Diatom IBI



Biological Condition of Lakes in the Mississippi Base using O/E Model Information

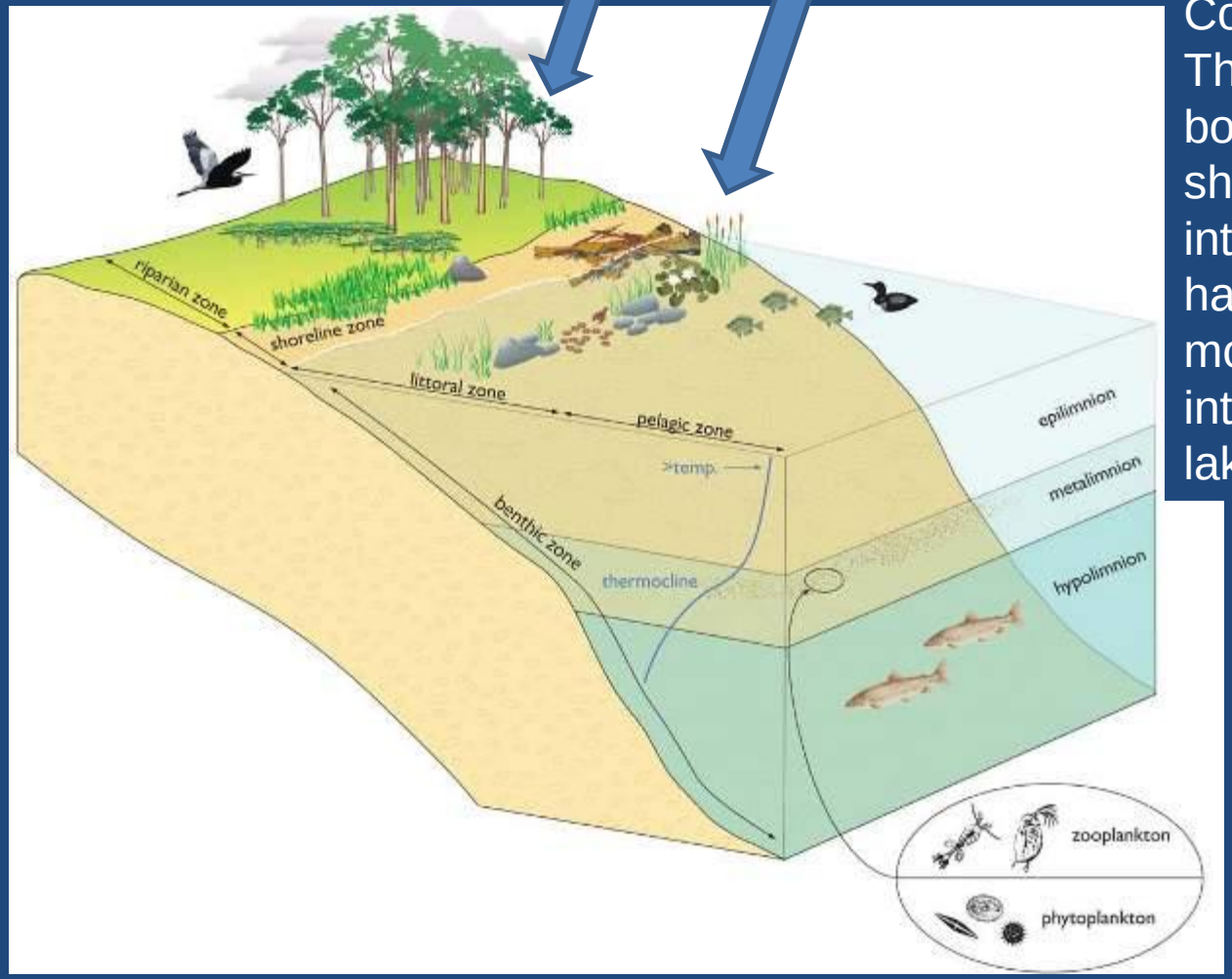


Condition of the Nation's Lakes: Habitat

- 55 individual habitat metrics 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

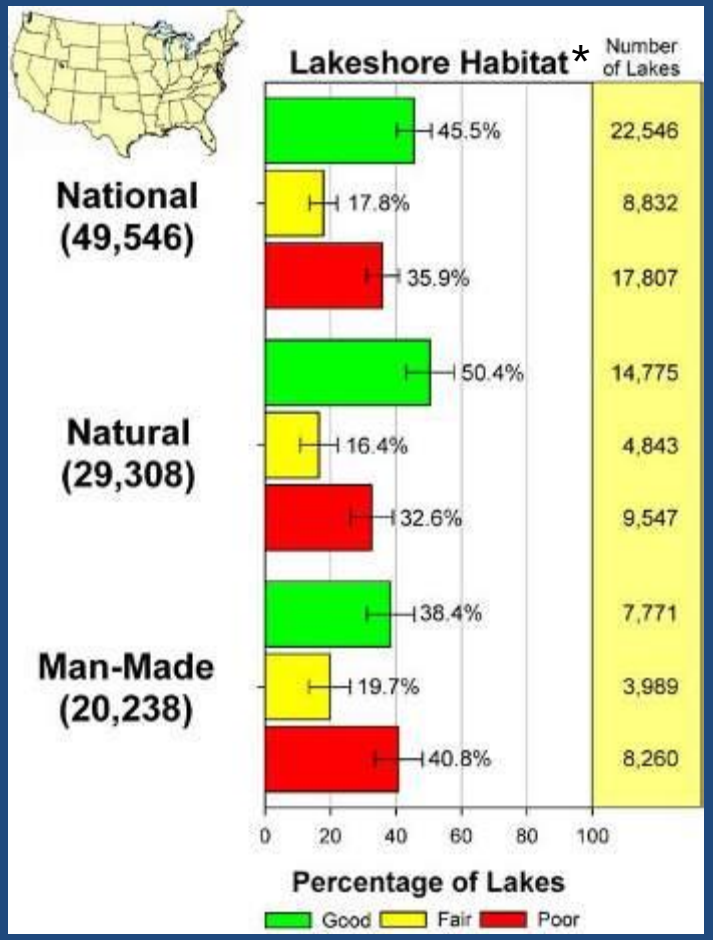
Shallow zone

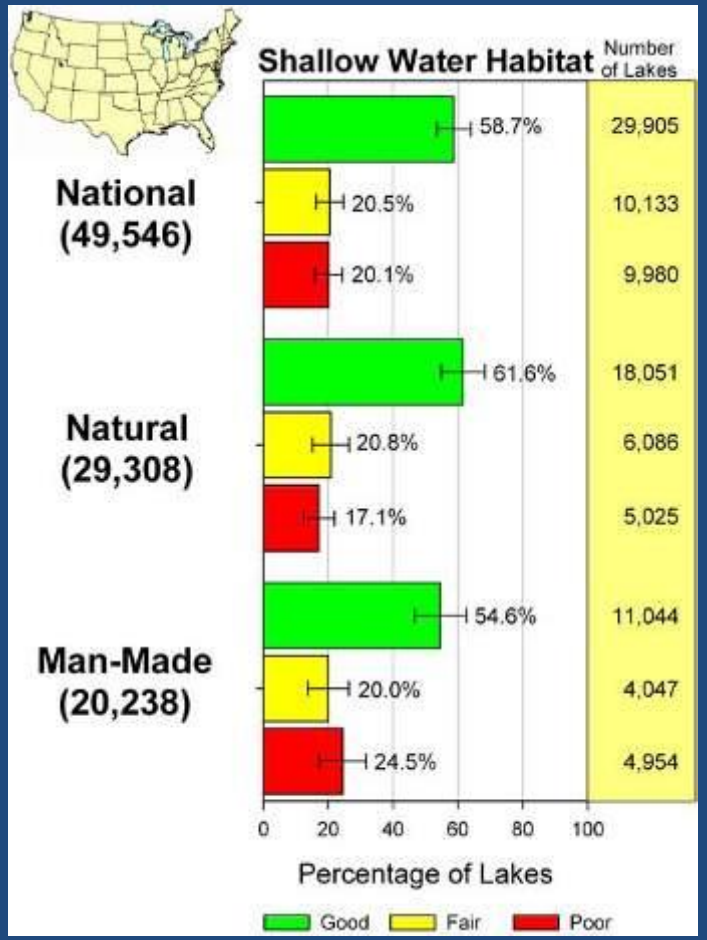


Complexity:
The degree to which both lakeshore and shallow zones are intact. Complex habitats facilitate movement of food into and out of lakes.

Disturbance:

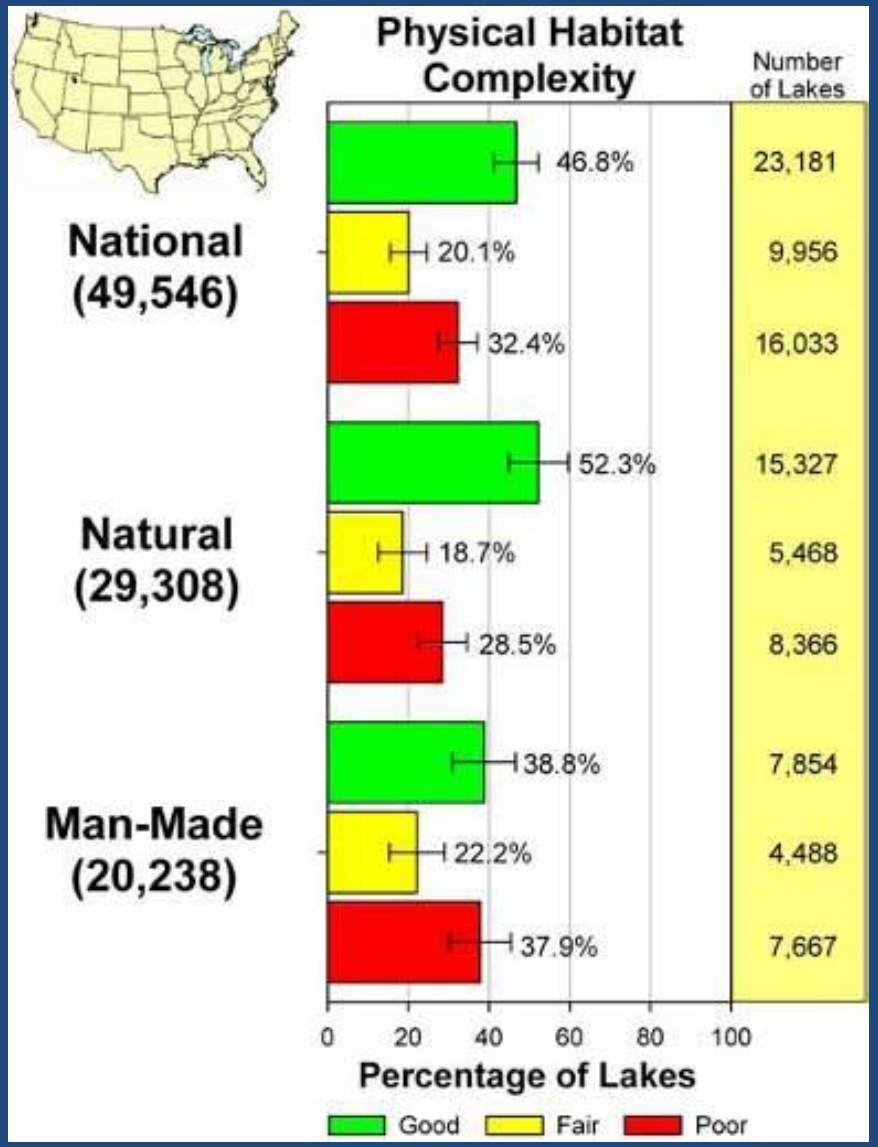
Condition of the Nation's Lakes: Habitat

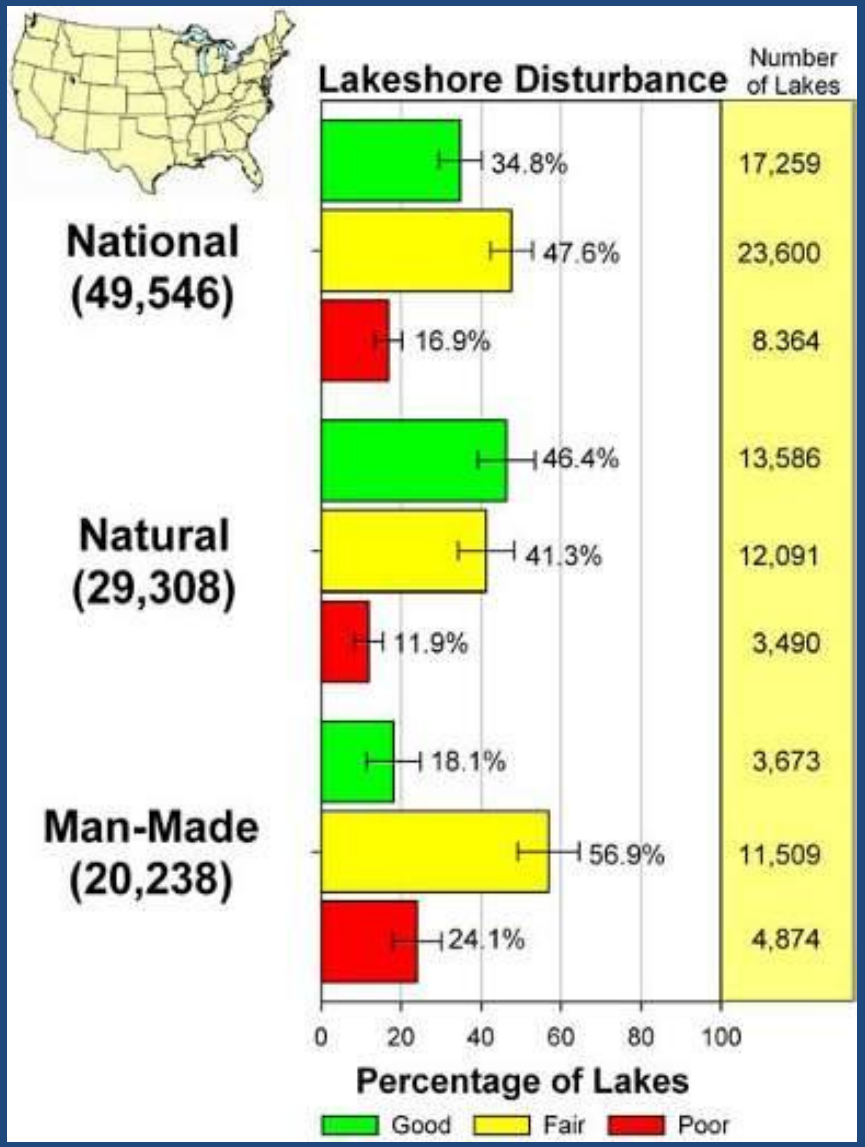




**) NLA Primary indicator is Lakeshore Habitat*

Condition of the Nation's Lakes: Habitat





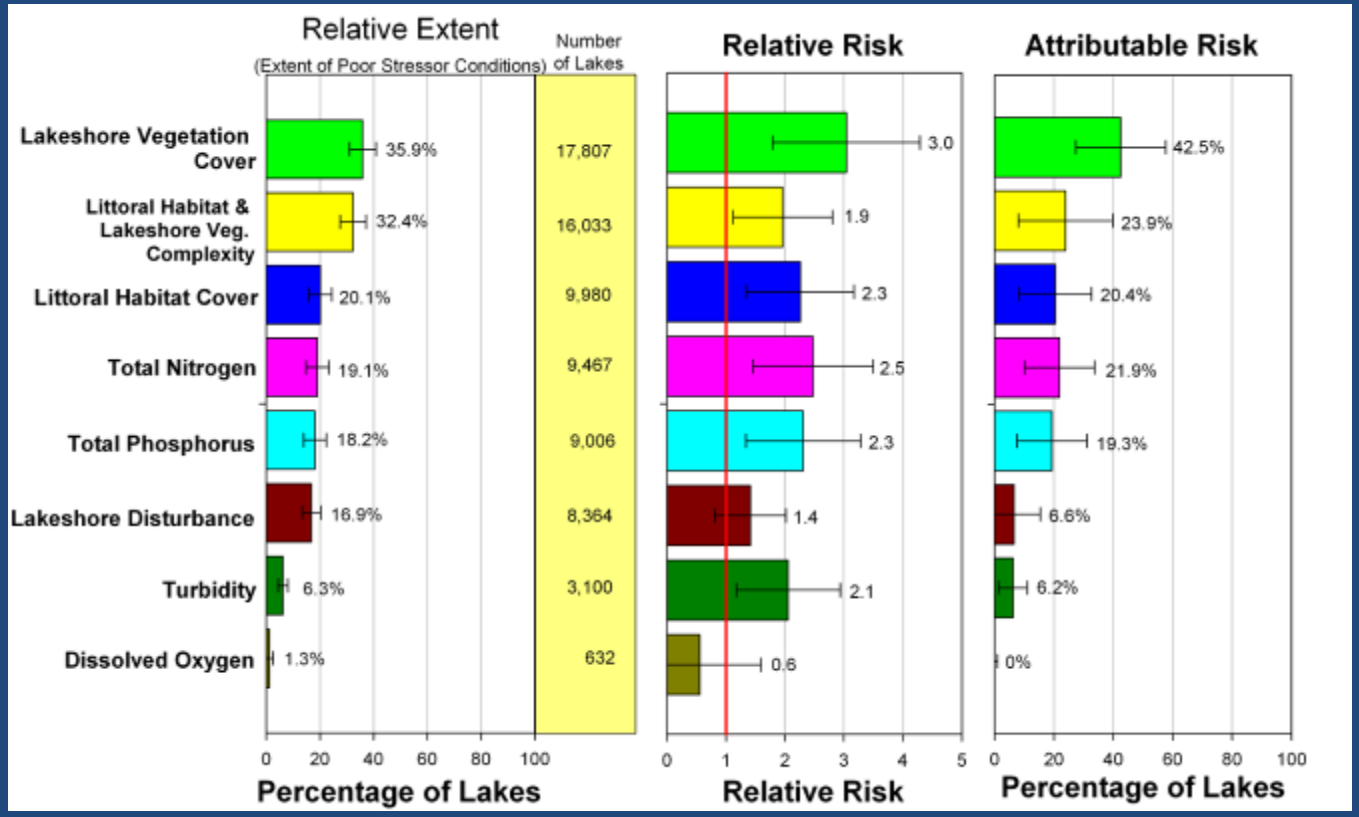
Stressor Extent and Resulting Risk: Relating Stressors to Biological Condition

- NLA evaluated all stressors (chemical and habitat) against biological condition, to assess which are most important.
- Examination of the relationship between three indicators provides:
  - 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?

Relative Risk, Attributable Risk, and Relative Extent

- To estimate RR and AR, condition class estimates (“Good”, “Fair”, “Poor”) for individual lakes were grouped into two categories.
- Categories are “Poor” and “Not-Poor” (“Good” and “Fair” combined)

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.
- #2 – Nutrients: Poor biology is 2.5 times more common when nutrients are high. This affects about 20% 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 Northern Appalachian exhibits the highest proportion of lakes with high-quality habitat, > *25% of lakeshores are in poor condition*