

An aerial photograph showing a stream flowing through a lush, green landscape. The stream is a prominent dark blue line winding through the terrain. The surrounding area is covered in dense vegetation, with some lighter green patches indicating different types of plants or possibly agricultural fields. The overall scene is a natural, outdoor setting.

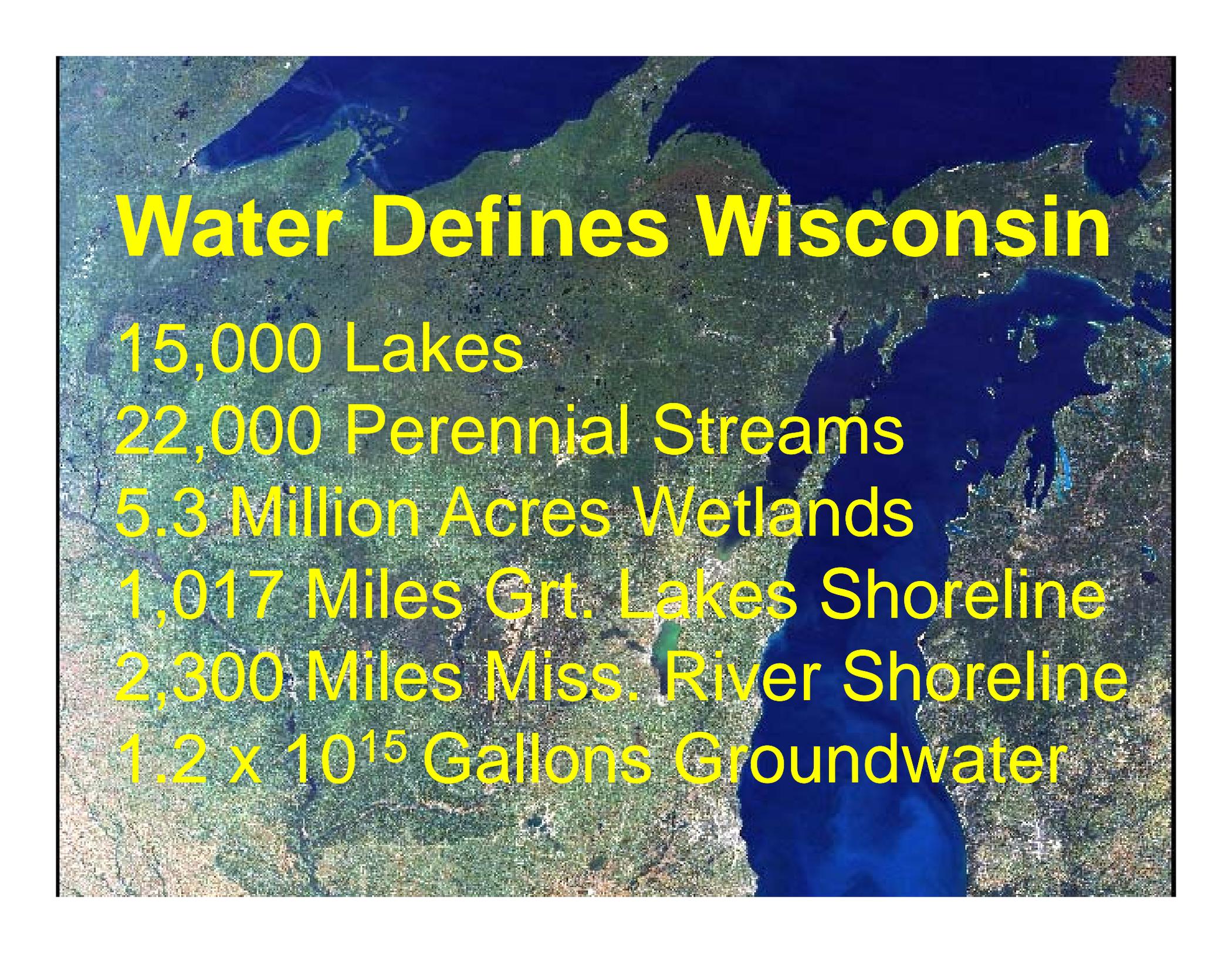
Assessment Results from Probabilistic Sampling of Wisconsin's Streams

Michael A. Miller

Wisconsin Department of Natural Resources
Madison, WI

Presentation Outline:

- Water Resources and Human Influence
- Stream Assessment Study Objectives and Sampling Design
- Findings:
 - Wisconsin Stream Conditions
 - Threats to Their Biological Integrity



Water Defines Wisconsin

15,000 Lakes

22,000 Perennial Streams

5.3 Million Acres Wetlands

1,017 Miles Grt. Lakes Shoreline

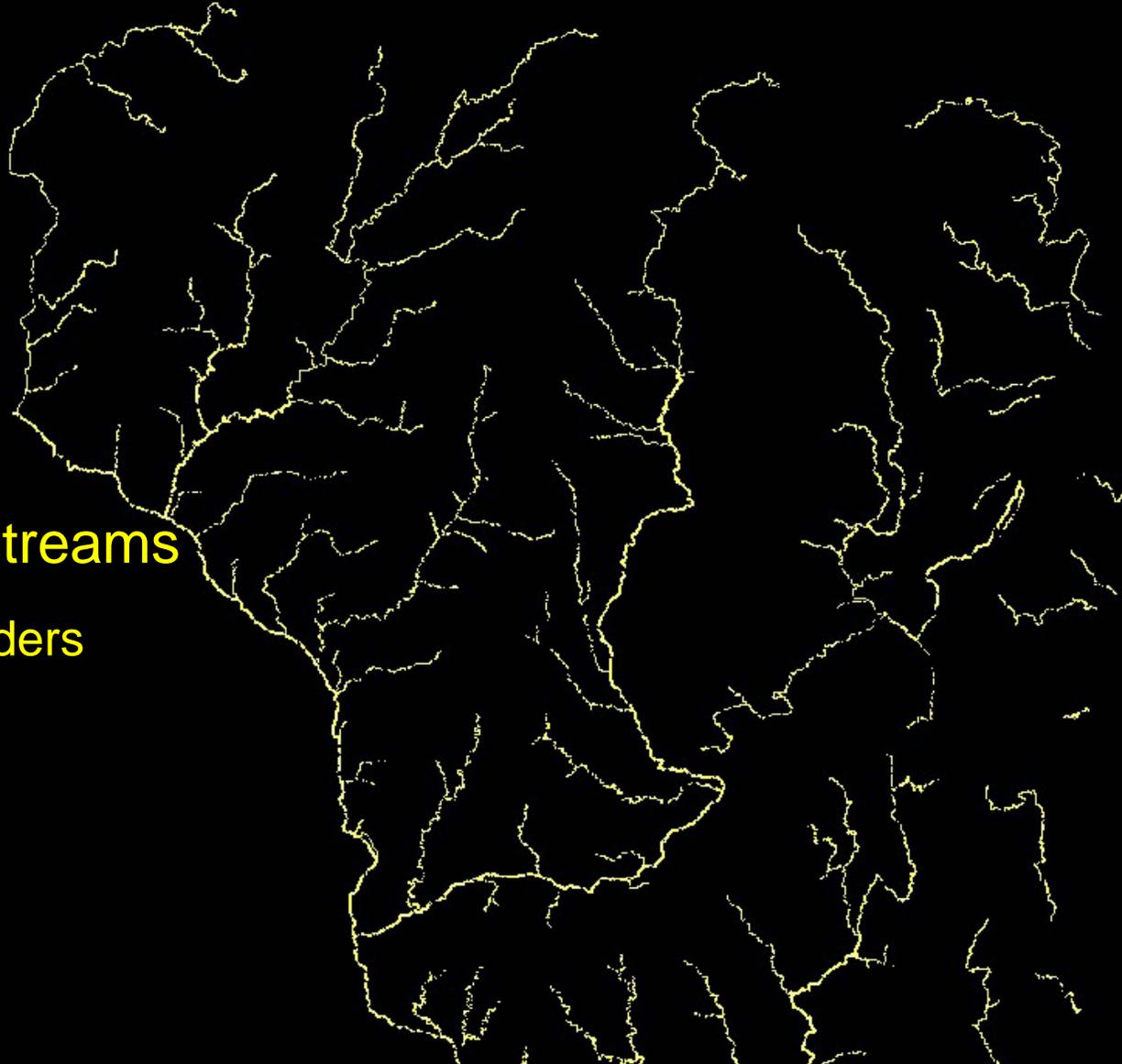
2,300 Miles Miss. River Shoreline

1.2×10^{15} Gallons Groundwater

Wisconsin's Flowing Water by Stream Order

Rivers / Streams

6th & 5th Orders



6th & 5th Orders
4th Orders



6th & 5th Orders

4th Orders

3rd Orders

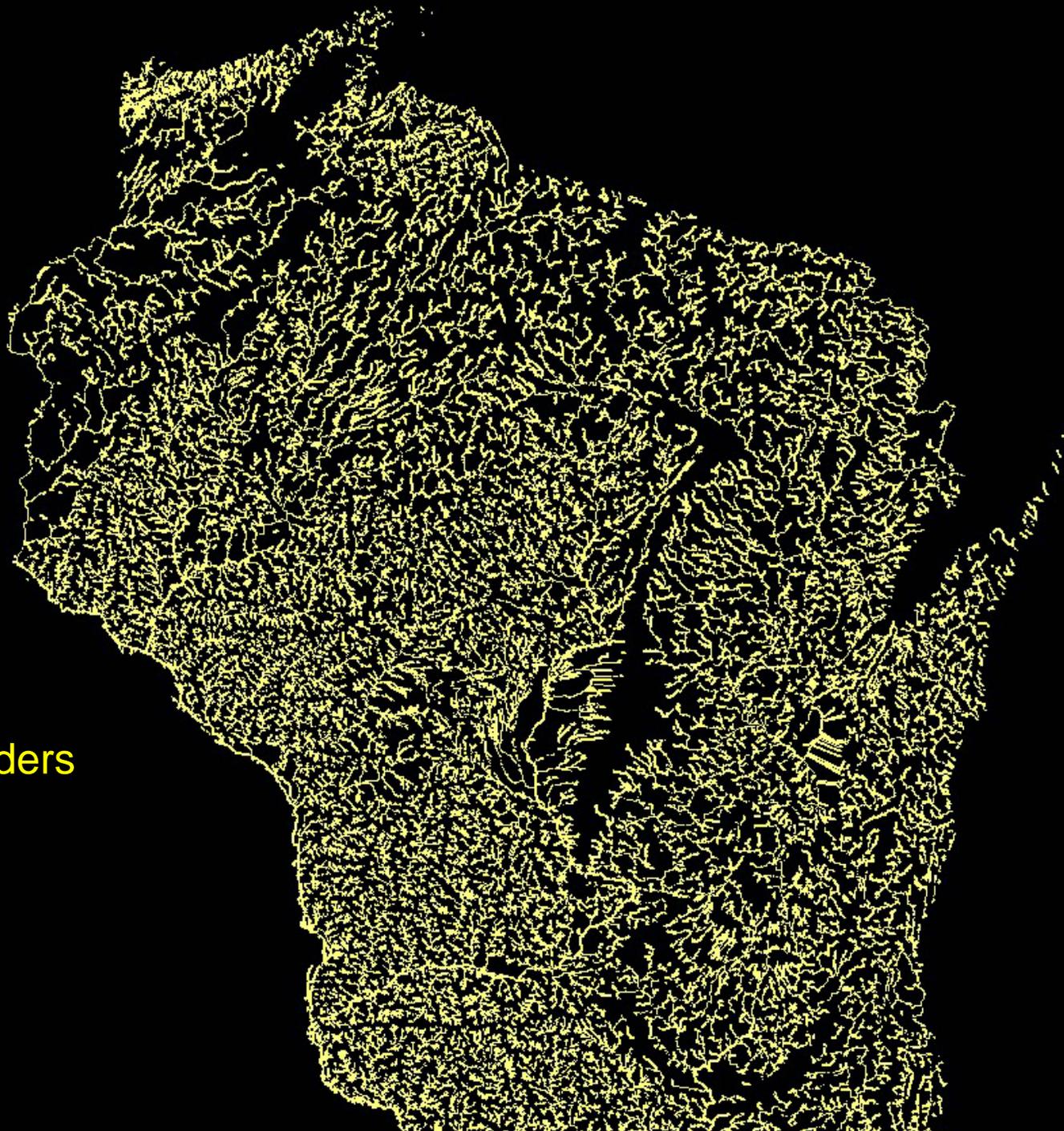


6th & 5th Orders

4th Orders

3rd Orders

2nd Orders



22,000 Perennial Streams in Wisconsin

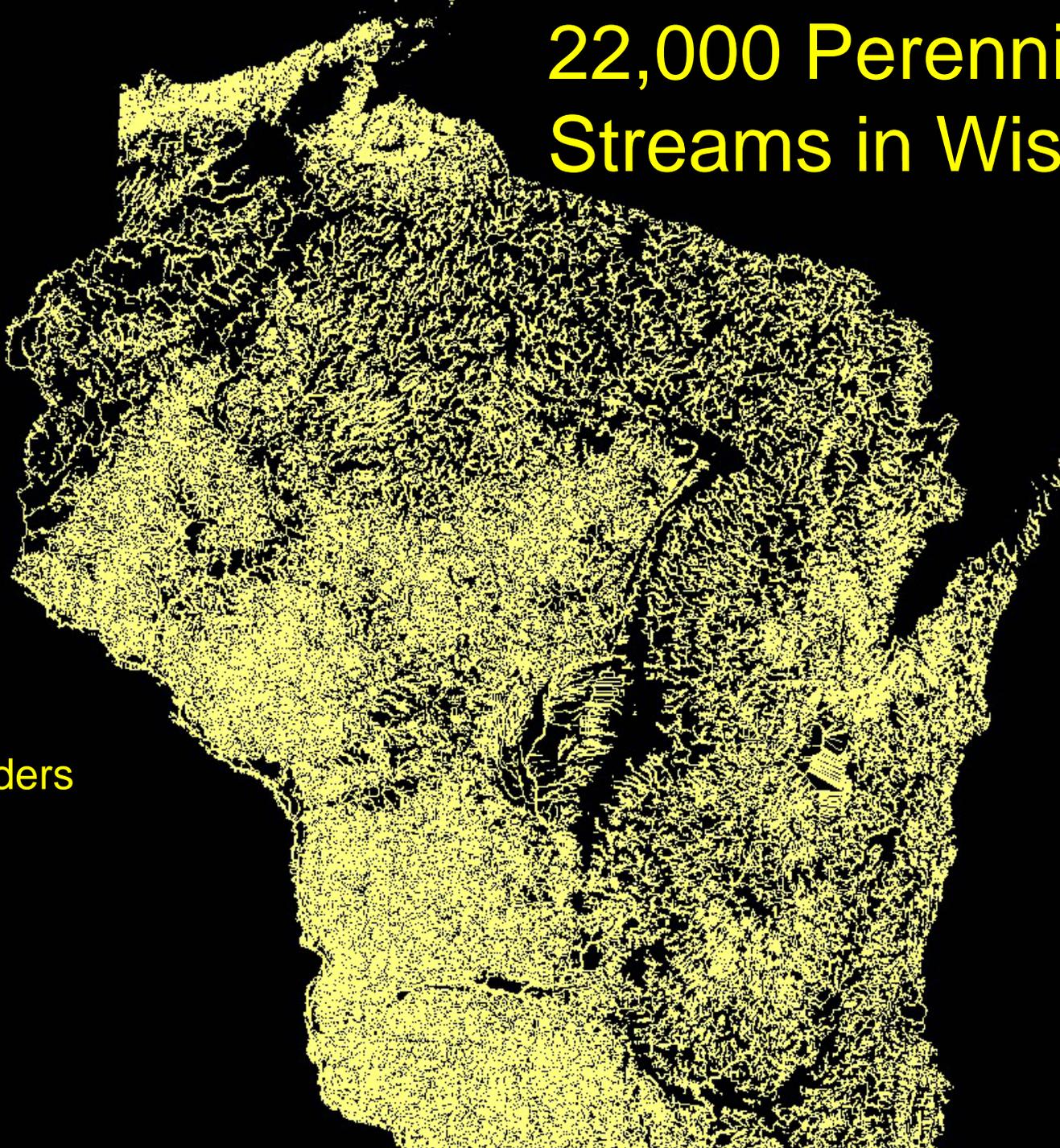
6th & 5th Orders

4th Orders

3rd Orders

2nd Orders

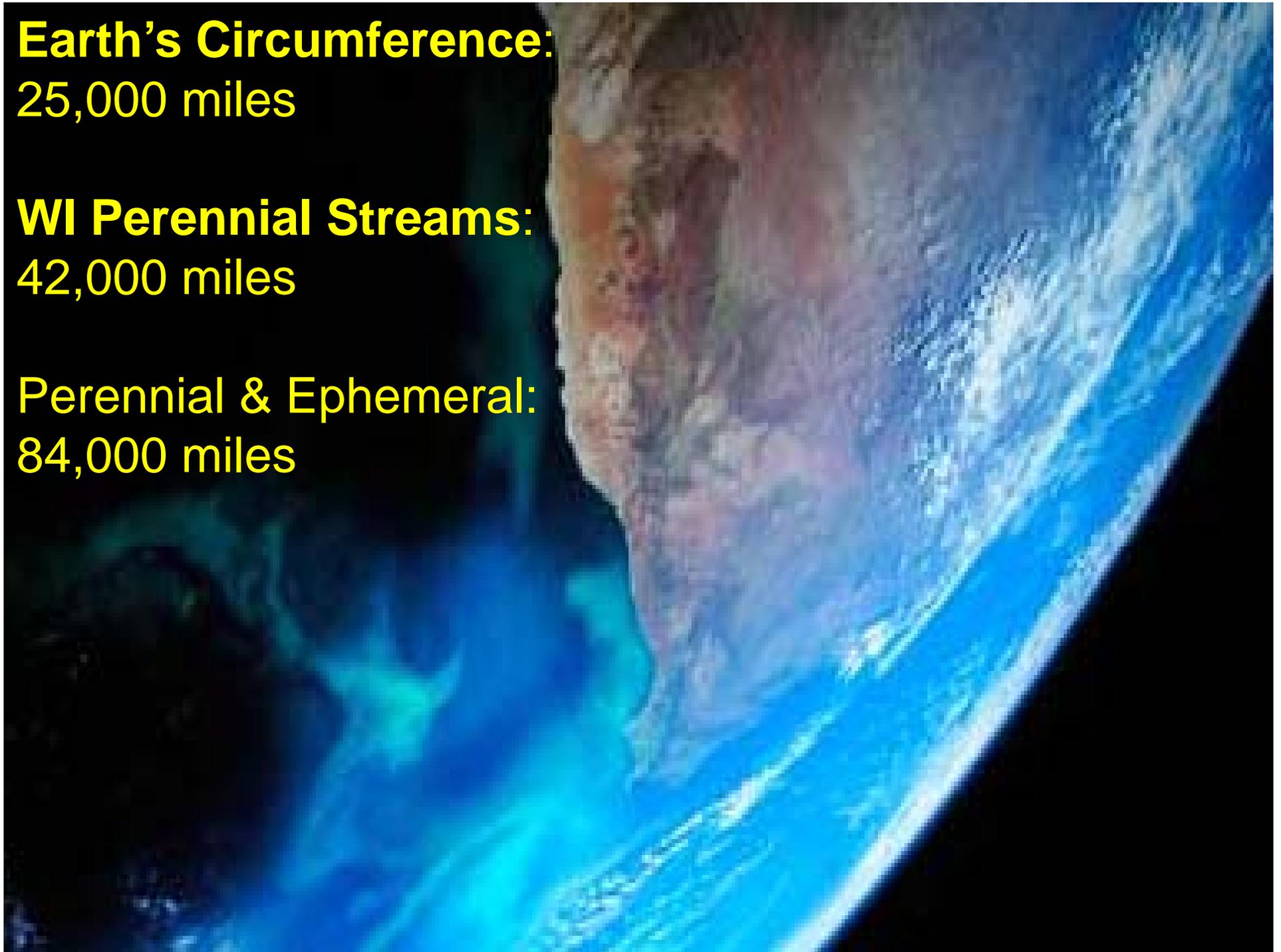
1st Orders



Earth's Circumference:
25,000 miles

WI Perennial Streams:
42,000 miles

Perennial & Ephemeral:
84,000 miles



Stream Stressors:

Legacy Impacts Still Affecting
WI Streams

Timber Harvest Begins ~ 1860's



Wisconsin Clear-cut by ~1910





Soil Erosion in Western WI

Stream Stressors:

Current Land Use Impacts

Sedimentation



Eutrophication

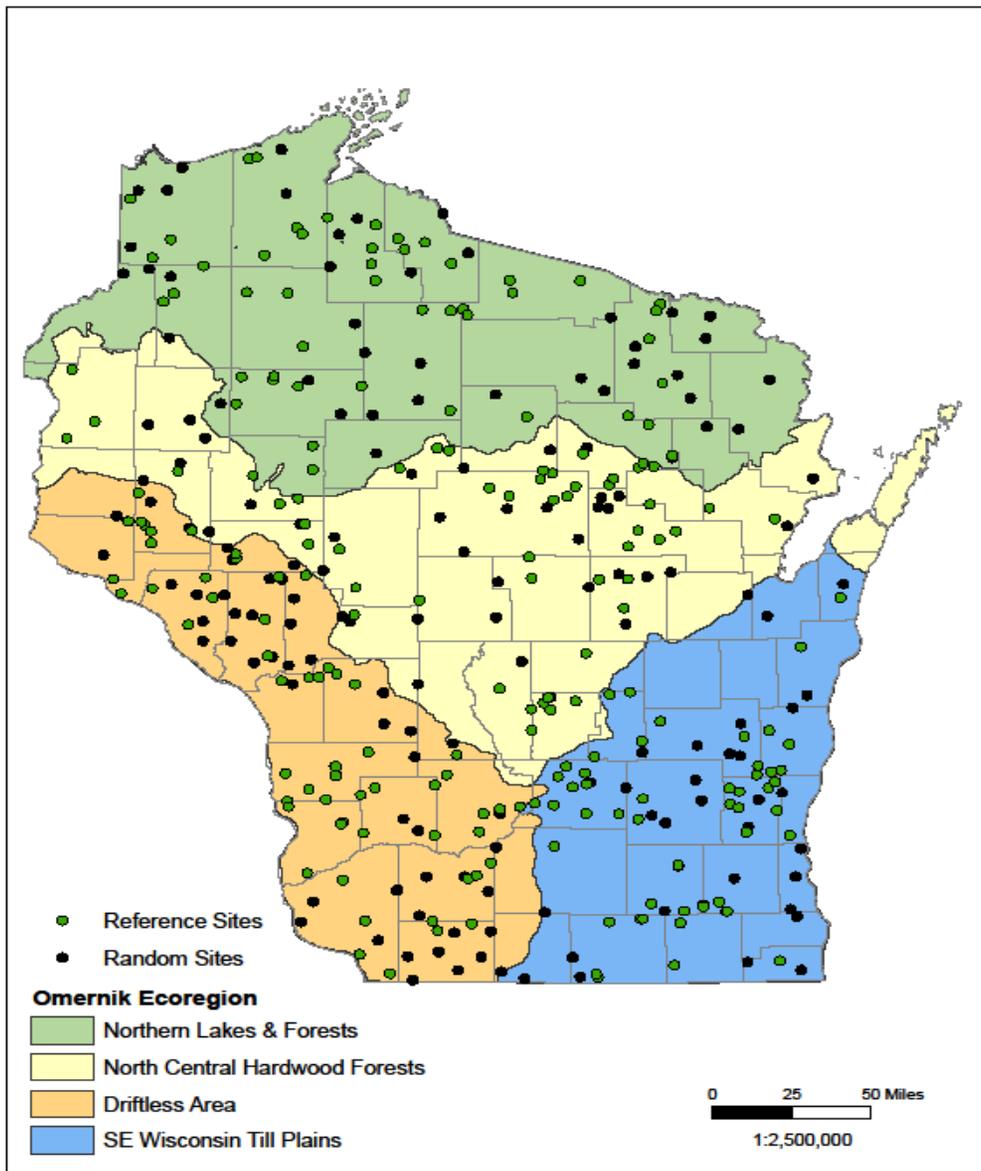


Wisconsin's 1.2 million dairy cows produce 65 billion lbs. manure / yr.

Stream Assessment Objectives:

1. Random sampling to assess streams statewide and by ecoregion
2. Sample “least-disturbed” stream sites to develop reference conditions
3. Rank the influence of various physical and chemical “stressors” on stream biota

Sampling Design and Data Collected



Stratified Random

50 sites per Ecoregion –
(10 sites per stream orders 1 – 5)

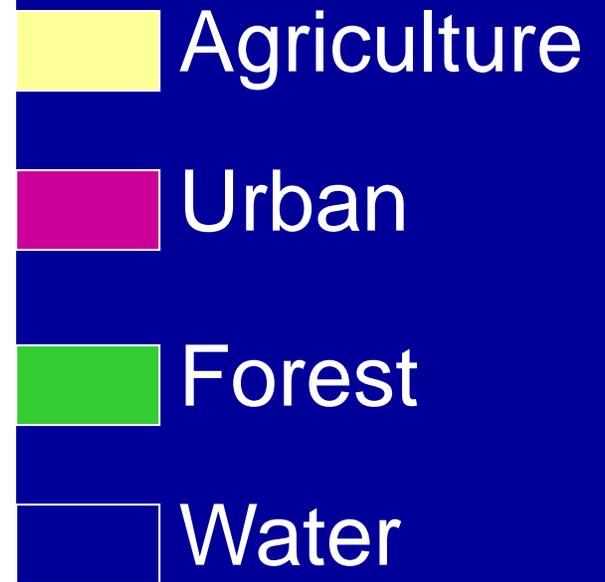
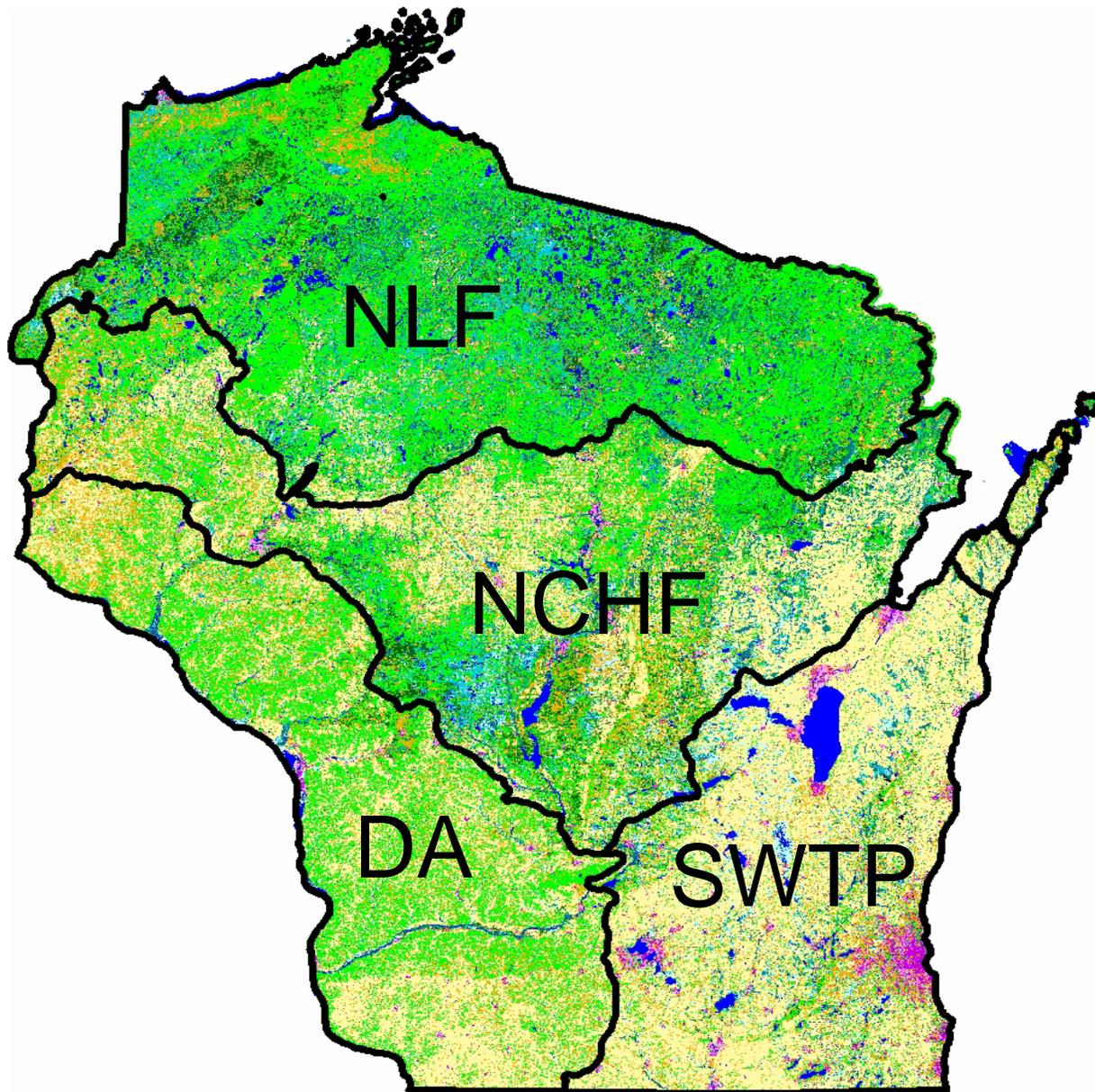
“Least-Disturbed” Ref. Sites

355 sites scattered about state.

Data Collected:

- Stream / Riparian Habitat
- Water Chemistry
- Macroinvertebrates
- Fish

Land Use Stressors Within Ecoregions



First Order Stream



Fifth Order Stream

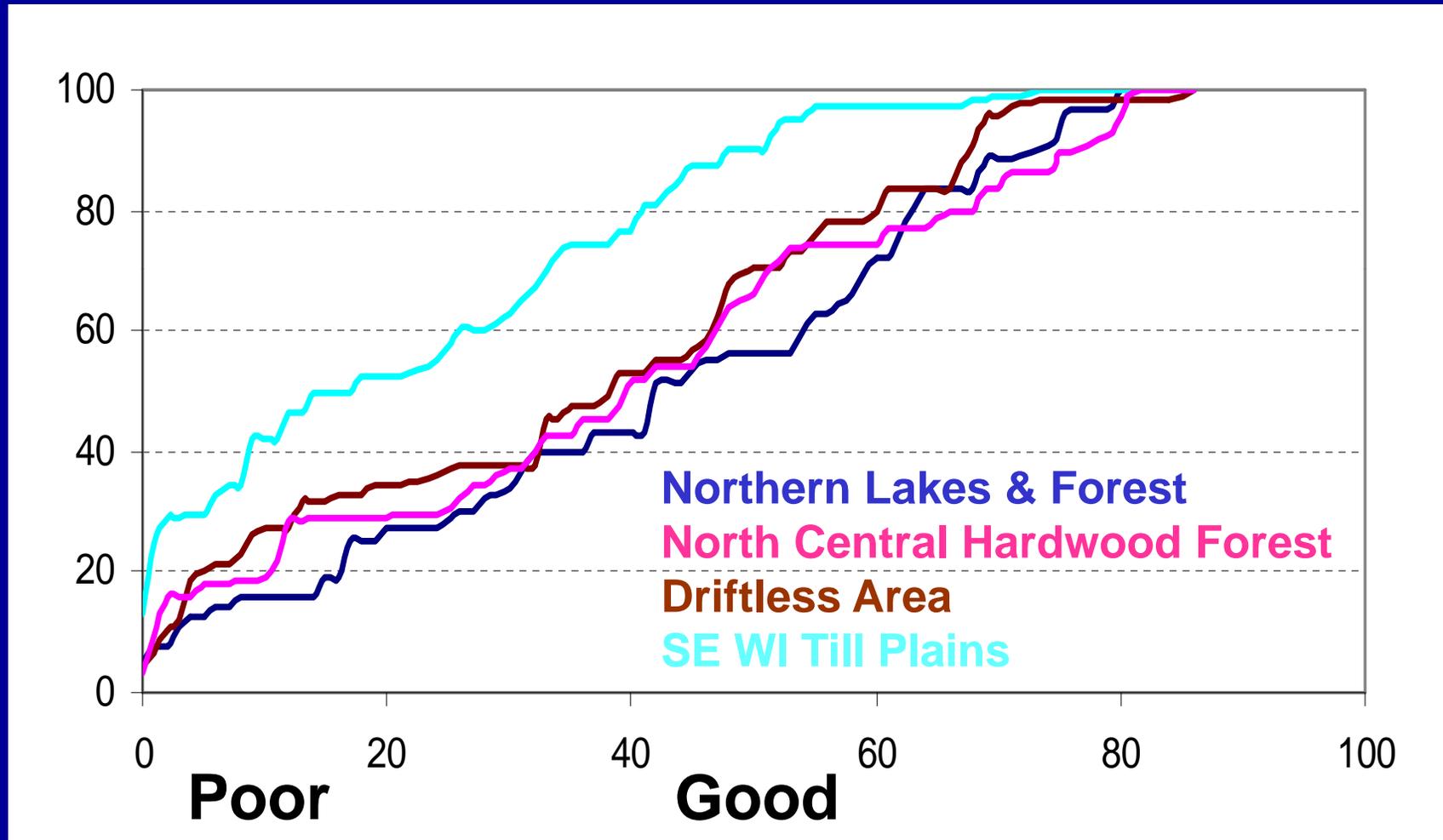


Study Results:

1. Used random sampling to assess stream conditions statewide and by ecoregion

Proportion Estimates of Healthy Streams (e.g. invertebrate index (%EPT))

Percent Stream Miles



Percent EPT Taxa at Stream Site

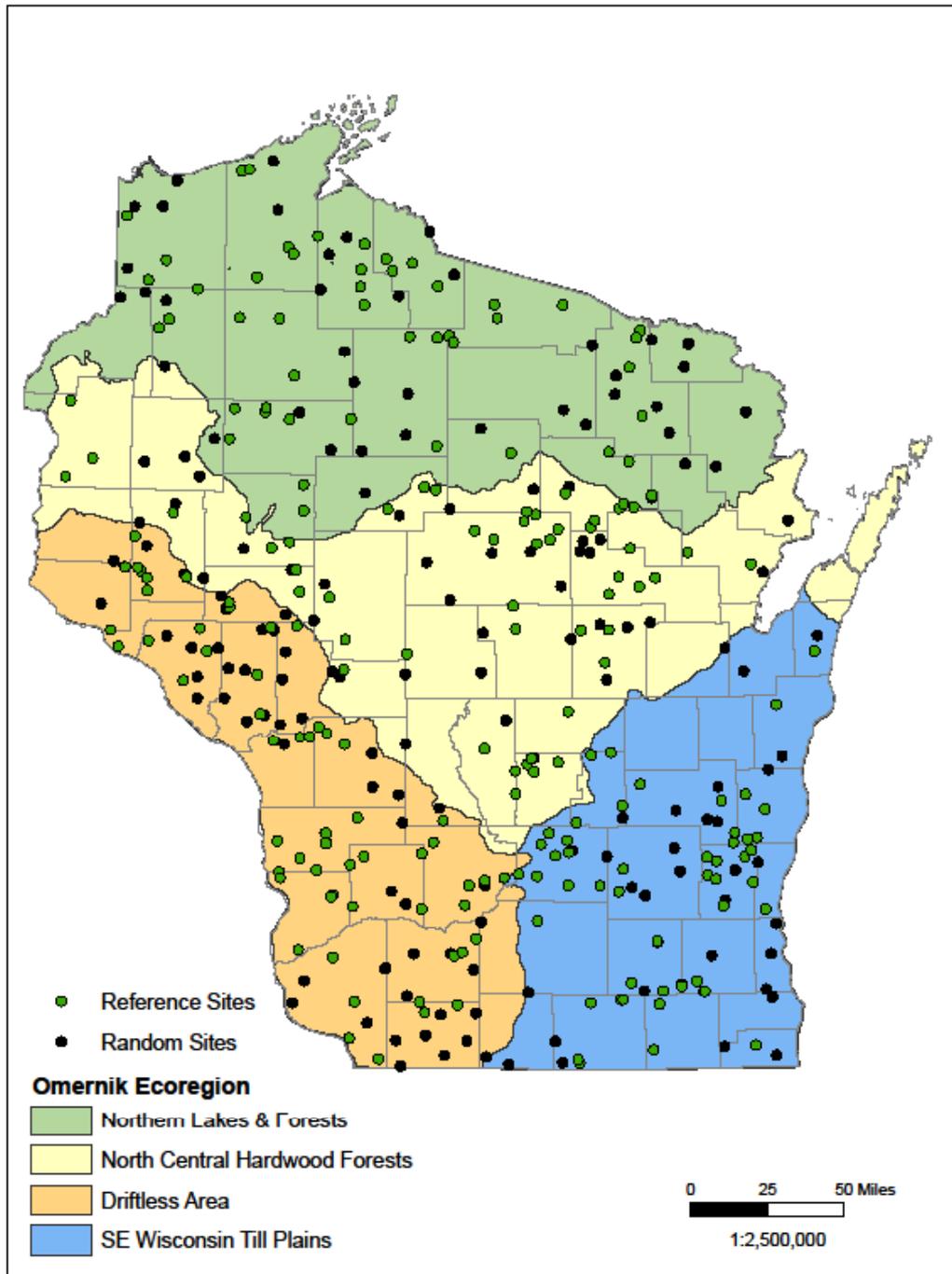
Study Results:

2. Sampled “least-disturbed” stream sites to develop **reference conditions**

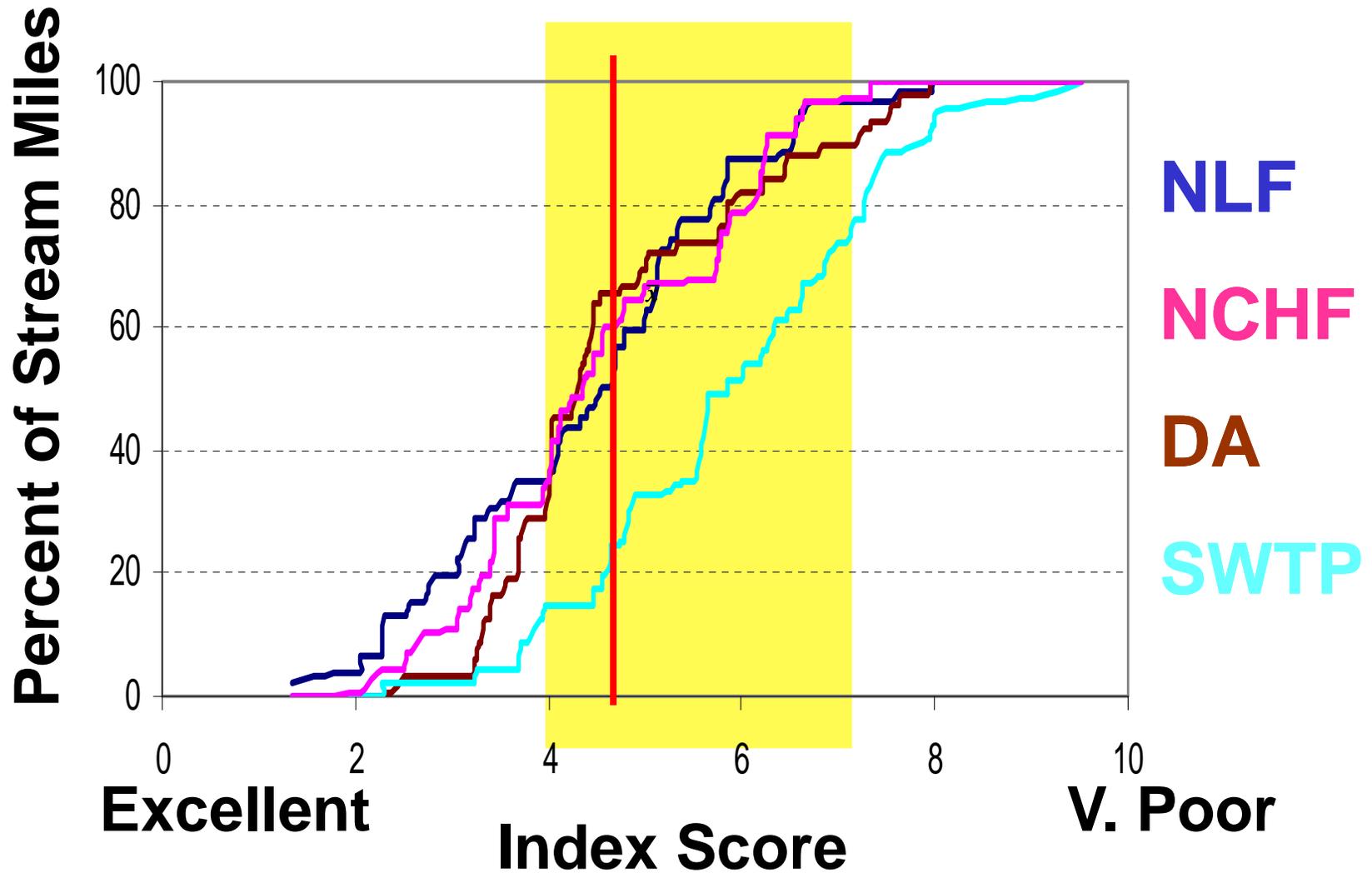


Least - disturbed” stream sites
picked using GIS Land Use Model
and site reconnaissance

● “Candidate”
Least-Disturbed
Reference Sites
(n = 355)



Proportion Estimates of Healthy Stream Miles (e.g. invertebrates: Hilsenhoff's Biotic Index)



Statewide Streams Assessment

(Using invertebrate index: (HBI))

Good

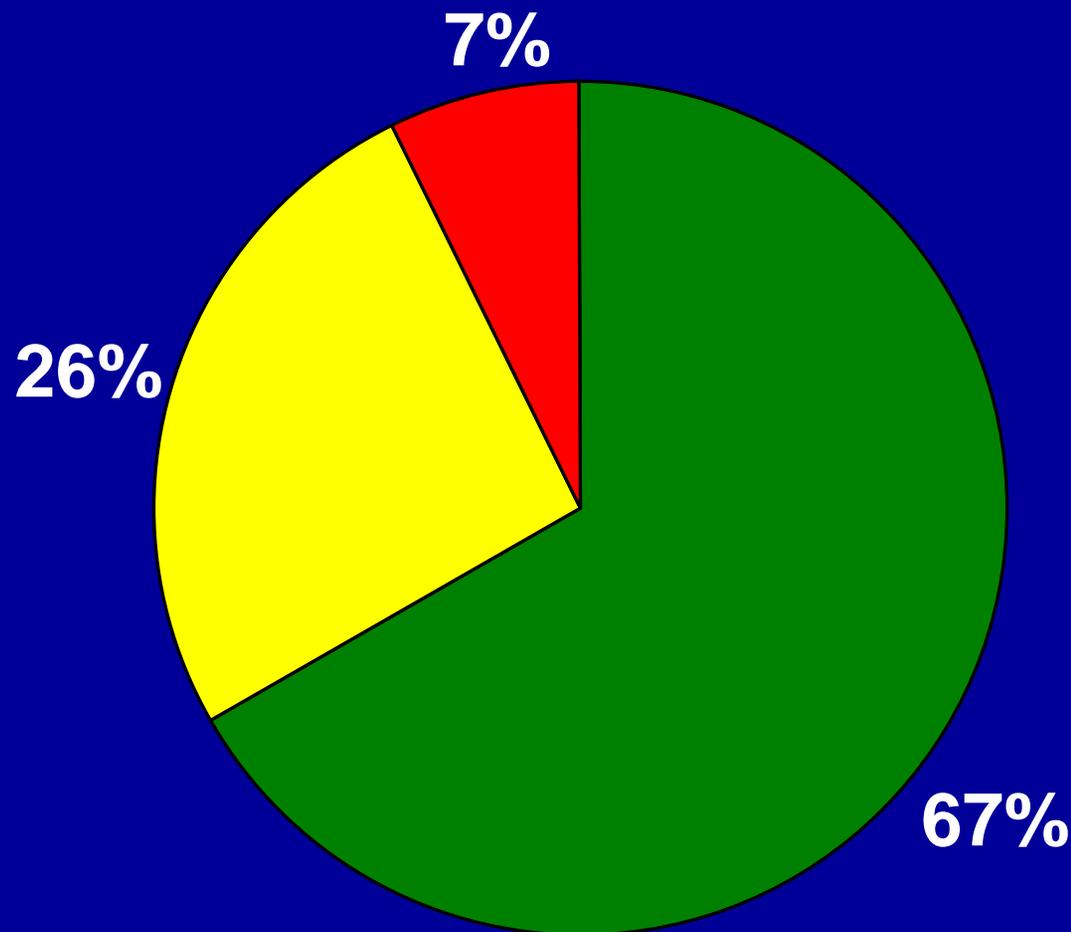
Scores $< 5^{\text{th}}$ Percentile of Reference site scores

Fair

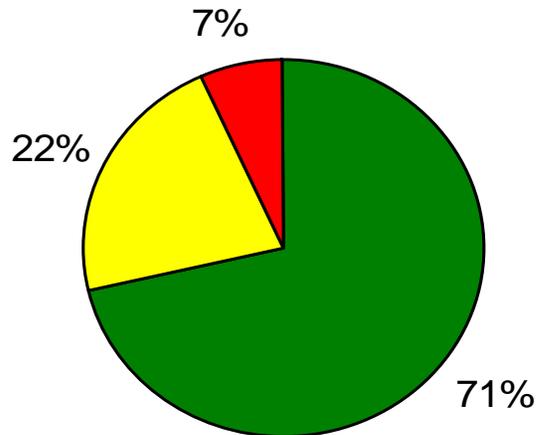
Scores $> 5^{\text{th}}$ & $< 25^{\text{th}}$ of Reference site scores

Poor

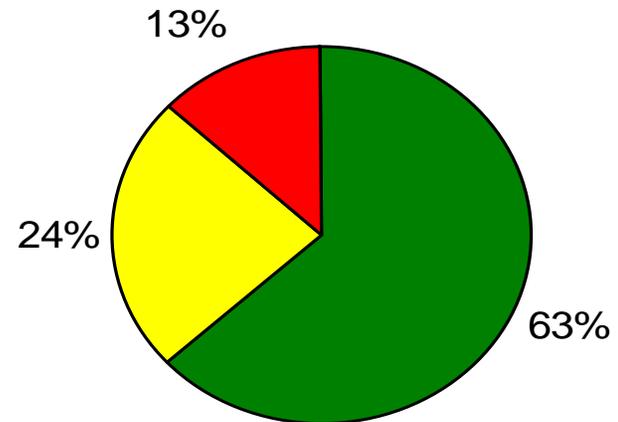
Scores $> 25^{\text{th}}$ Percentile of Reference site scores



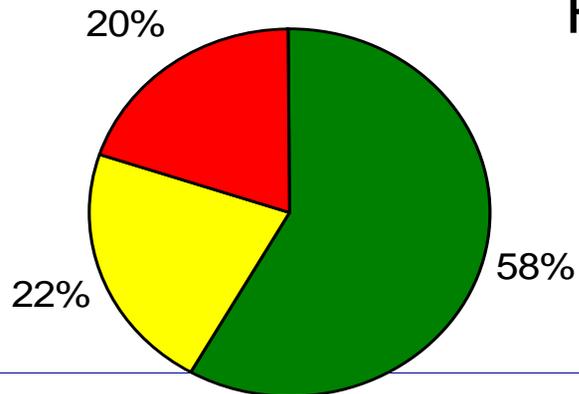
Statewide Condition Estimates



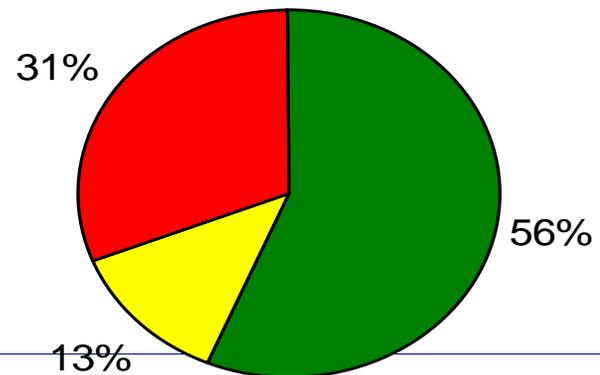
Inverts
(%EPT)



Habitat



[Phosphorus]

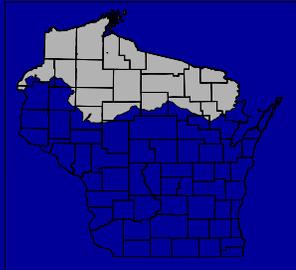


Fish

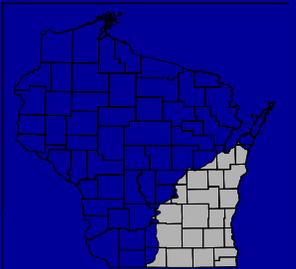




State Wide

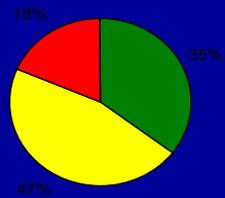
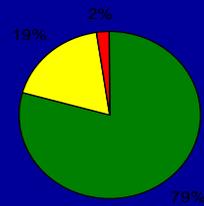
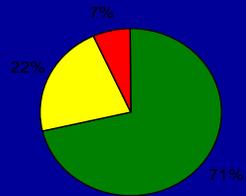


Northern Lakes & Forests

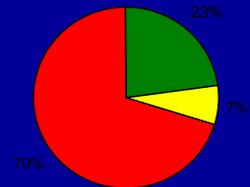


Southeastern Wisconsin Till Plains

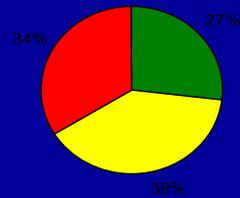
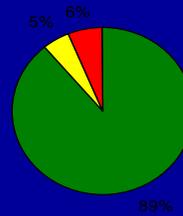
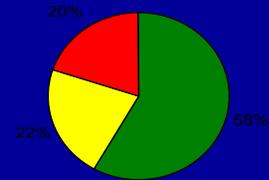
Inverts



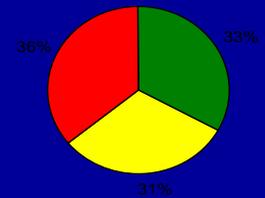
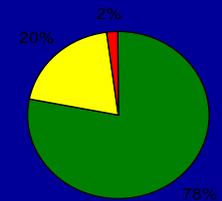
Fish



Tot. [P]



P-Hab.



Good

Fair

Poor



Study Results:

3. Ranked the influence of various physical and chemical “stressors” on stream biota

– Multiple regression

➔ **Risk Analysis**



What factors are associated with "poor" fish index scores?



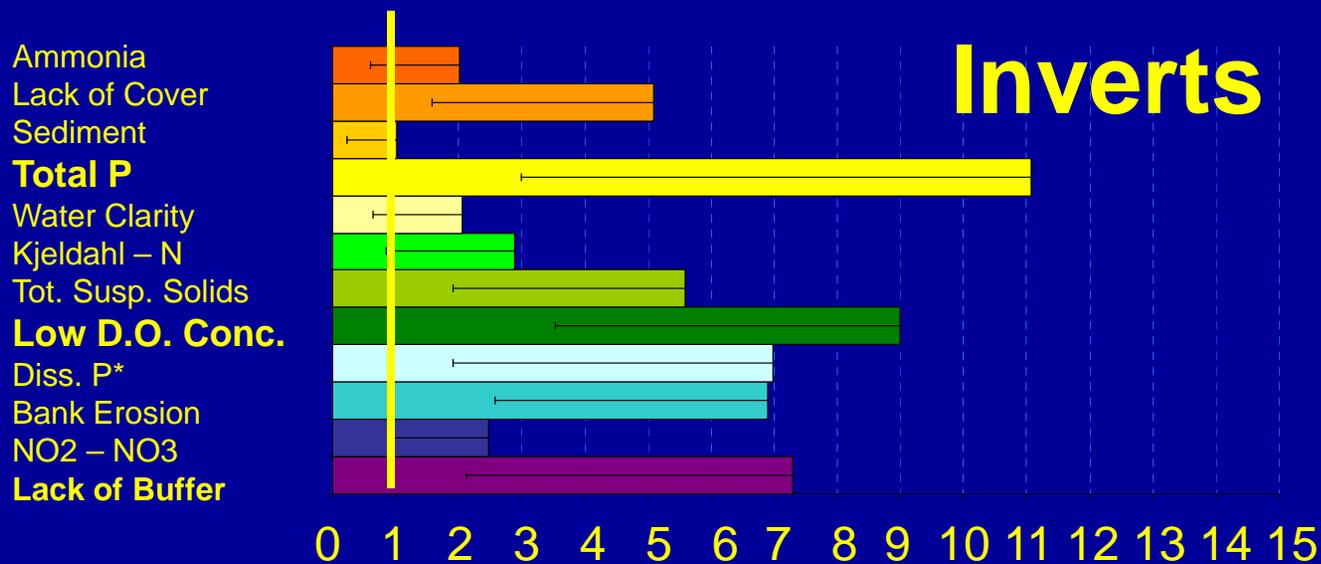
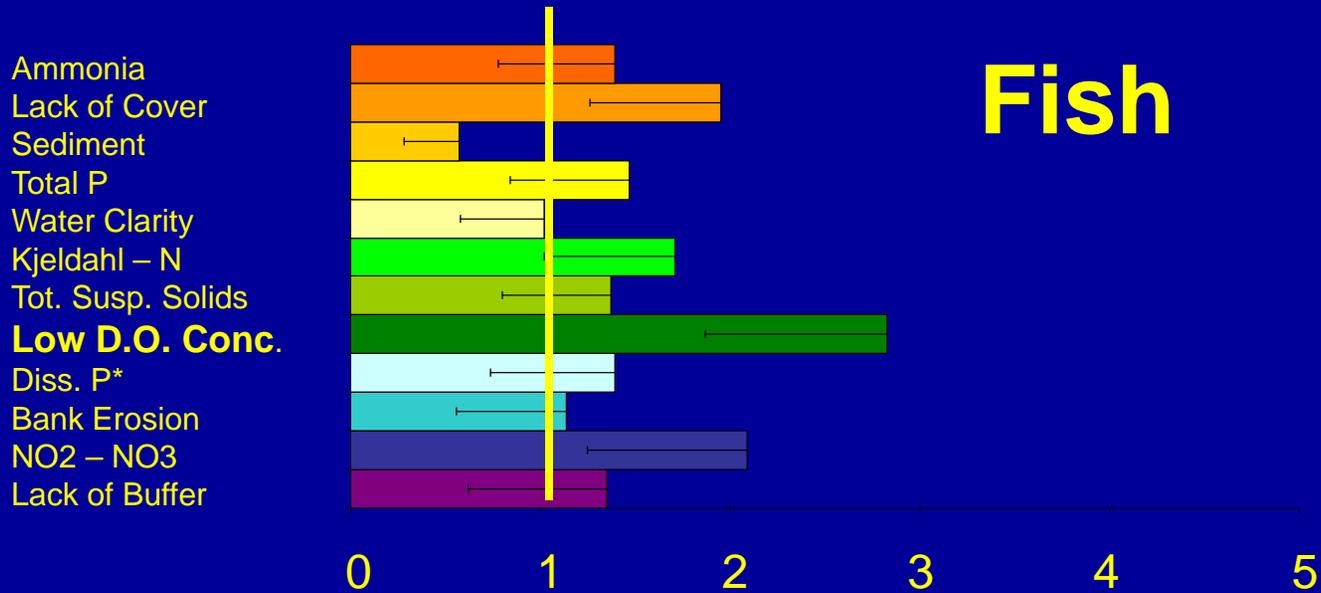
**What factors are associated with
“poor” invertebrate index scores?**

“Relative Risk”: estimate of a stressor’s association with biota, in terms of the likelihood that poor stressor conditions and poor biotic conditions co-occur (in streams).

Van Sickle and Paulsen

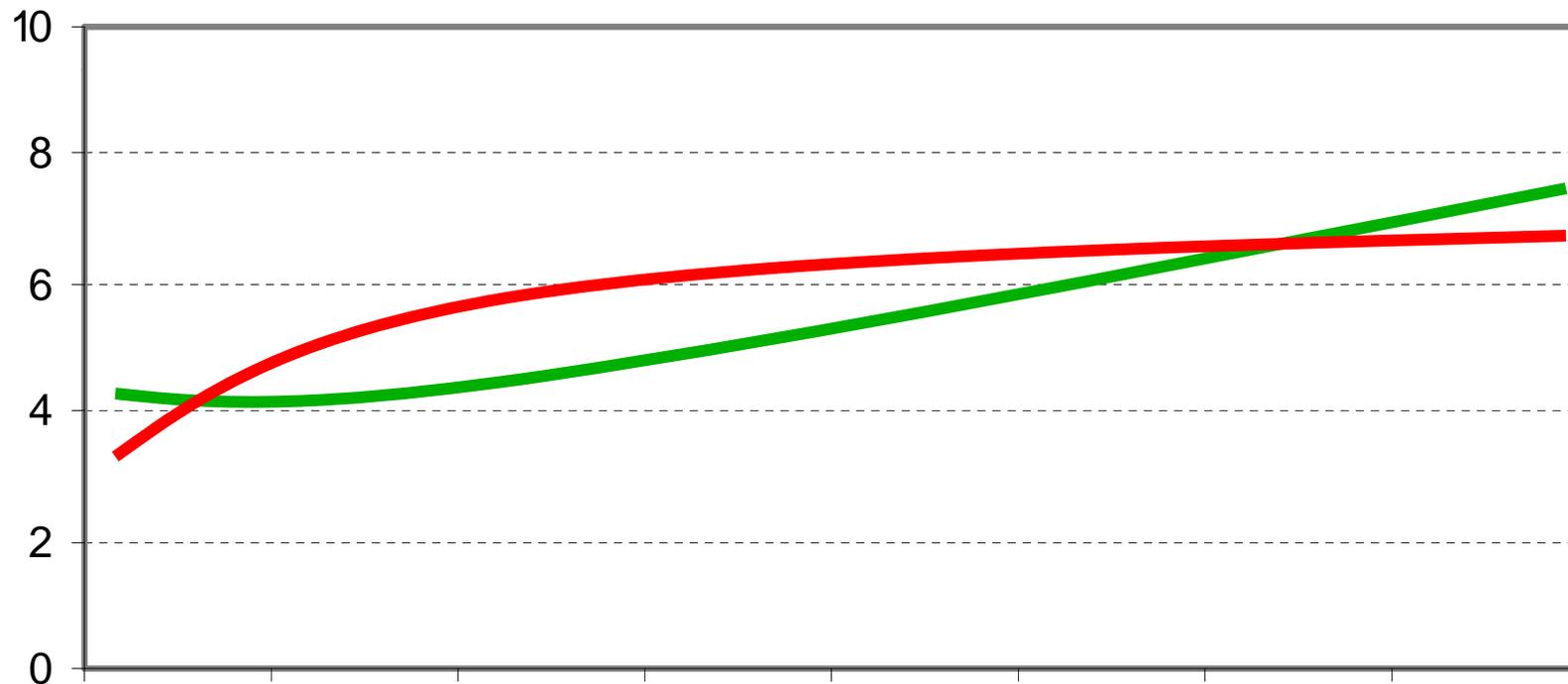
J. N. Am. Benthol. Soc. 2008, 27(4): 920 - 931

Relative Risk Stressors Pose To Stream Biota



Co-related Stressors e.g. sediment and [P]

Need to tease apart the influence of individual stressors



Units of **TSS** & **Dissolved P**

Summary:

1. Probabilistic sampling was used to characterize stream qualities, statewide and ecoregionally
2. Sampling least disturbed sites provides objective criteria to assess stream conditions
3. Risks various physical and chemical stressors pose to stream biota can be estimated

Next Steps:

- Evaluate additional classification schemes
- Filter candidate reference sites and stratify
- Further explore relationships between stressors and biotic responses
- Convert / disseminate study findings into **“actionable” information**

Questions?