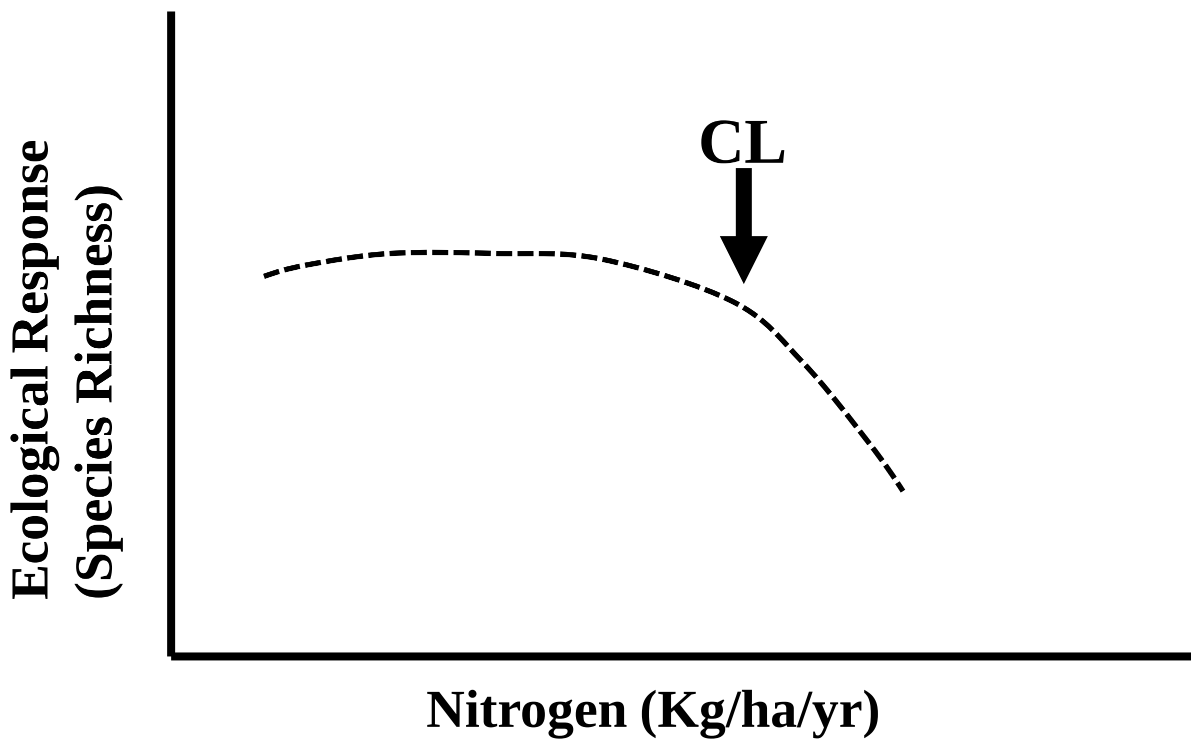
# National Critical Load Database: An Assessment of Atmospheric Deposition Effects Across the U.S.

Jason Lynch, Jack Cosby, Linda Pardo , Linda Geiser, Tamara Blett, Richard Haeuber, Richard Pouyat, Cindy Huber

UVA

# Critical Loads

- The level of an air pollutant or pollutants below which there are no adverse ecological effects



# Critical Loads

- Simplify complex scientific information on exposure to air pollutants
- Effective tool for informing policy and land management decisions
- However, only limited national assessment of critical loads have been undertaken in the U.S. because of a lack of a <u>repository</u> for critical load data and lack of <u>coordination</u> between scientists and federal managers

# Focal Center Utility Study (FOCUS)

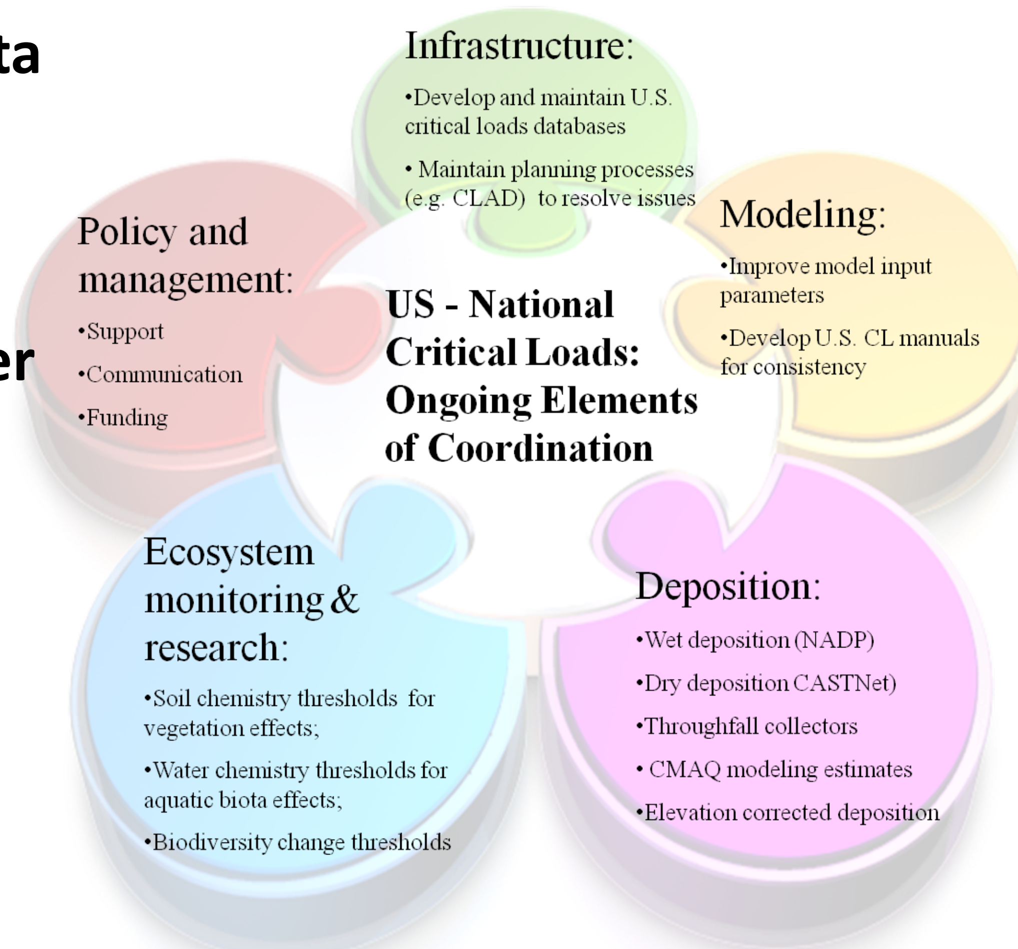
- Develop and implement clear, consistent repeatable process for creating standardized, mapable CLs within the US.

- Gather and Synthesize CL data in a national database

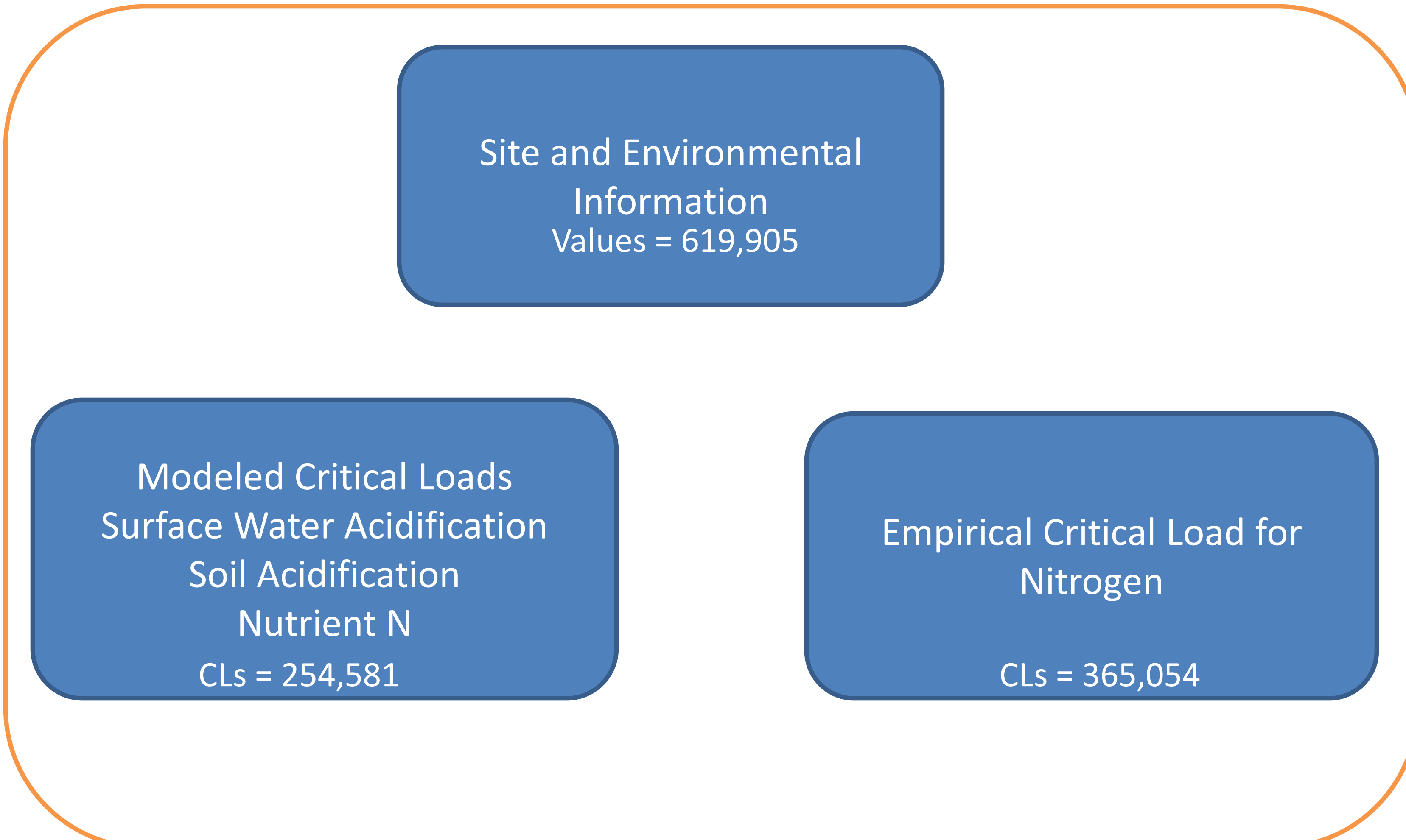
- Unofficial Submission to the UNECE Coordinating Center on Effects (CCE)

- Inform Policy and Land Management Decisions

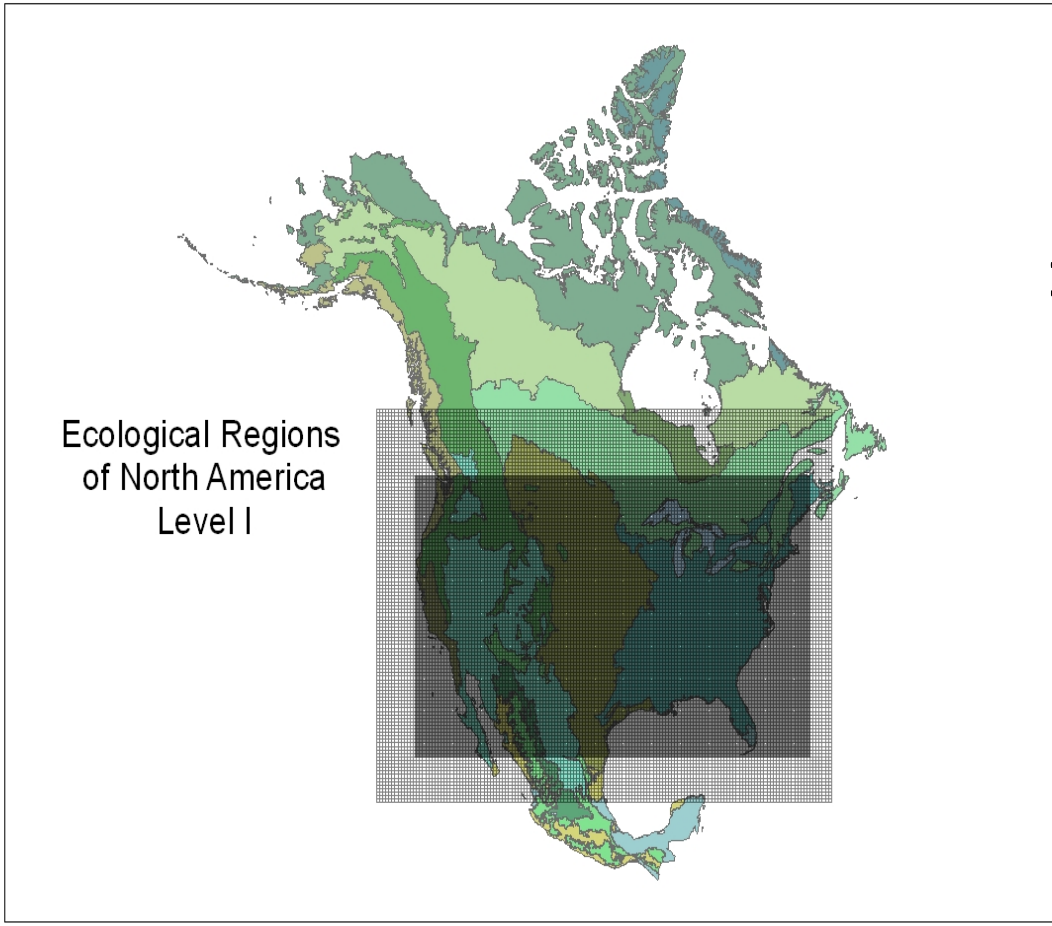
- Advance CL Science

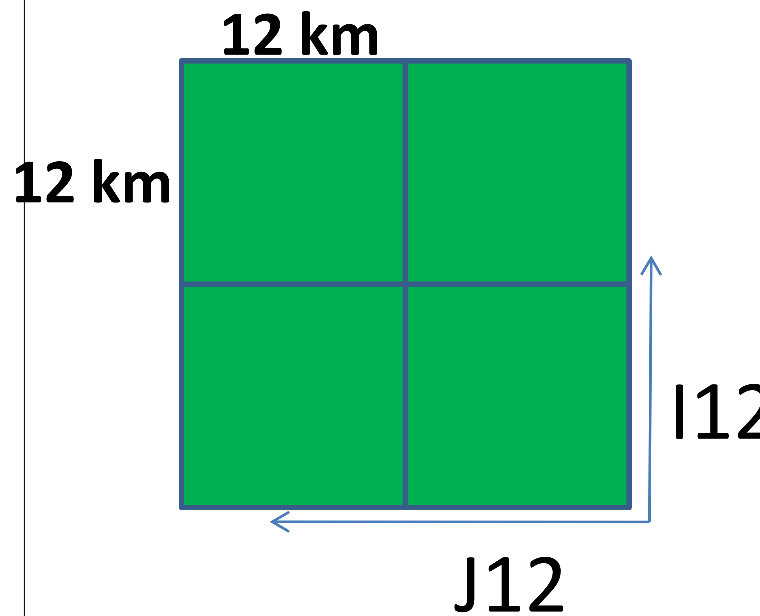


# National Critical Load Database



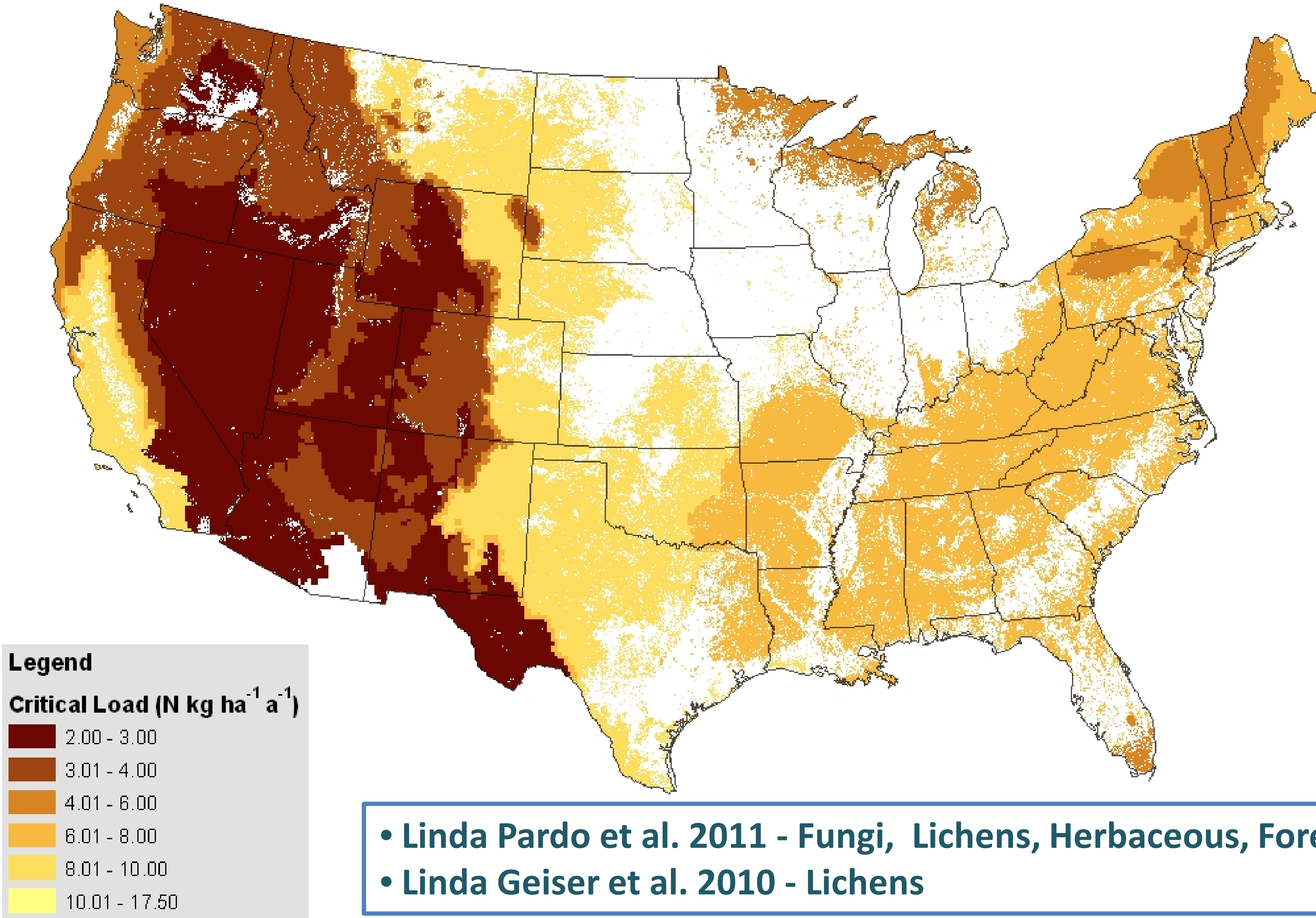
# EcoRegion and Grids (12x12km & 36x36km)



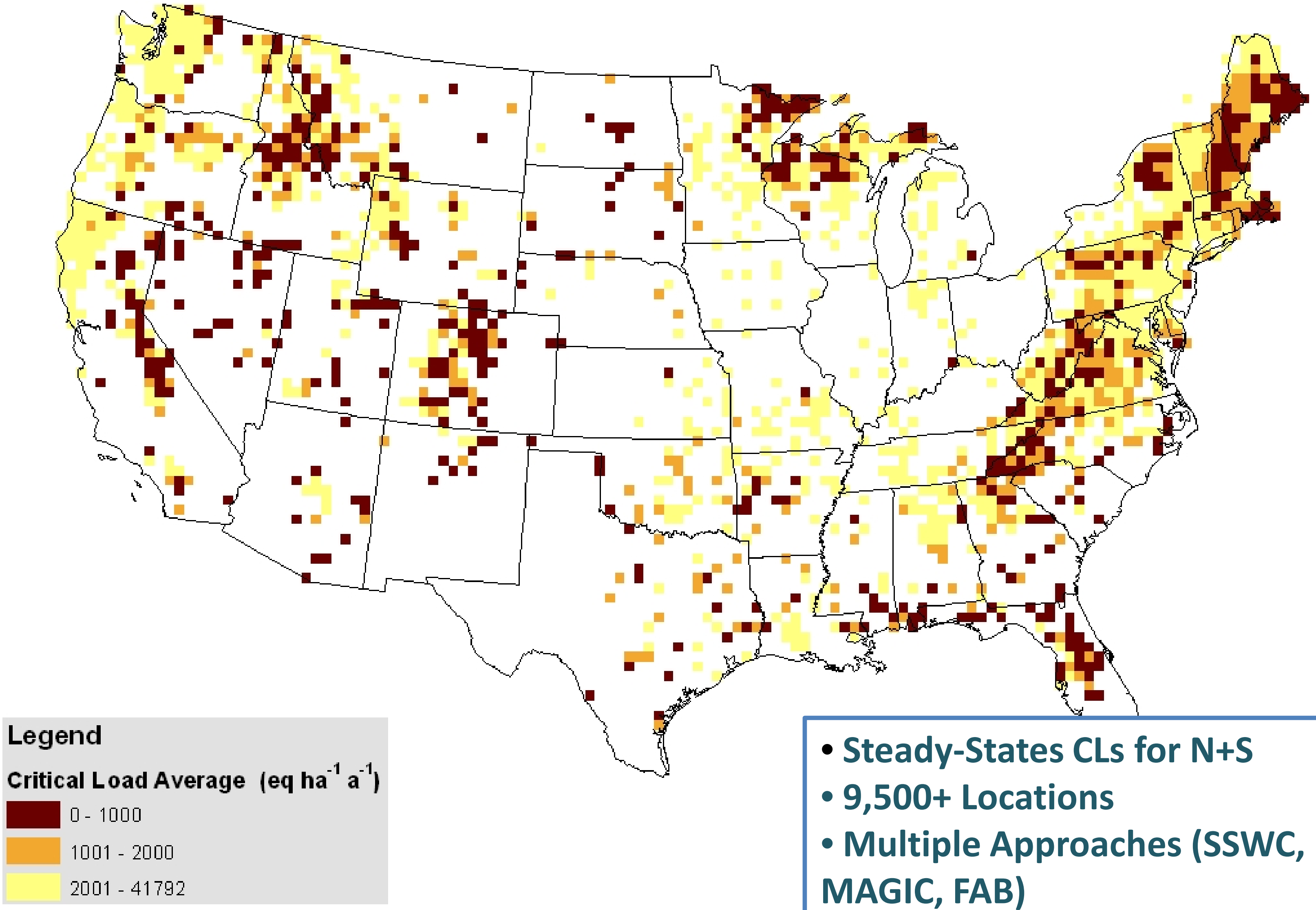
# Empirical N Critical Load Average (12kmx12km)

Based on Pardo et al., 2011 & Geiser et al., 2010

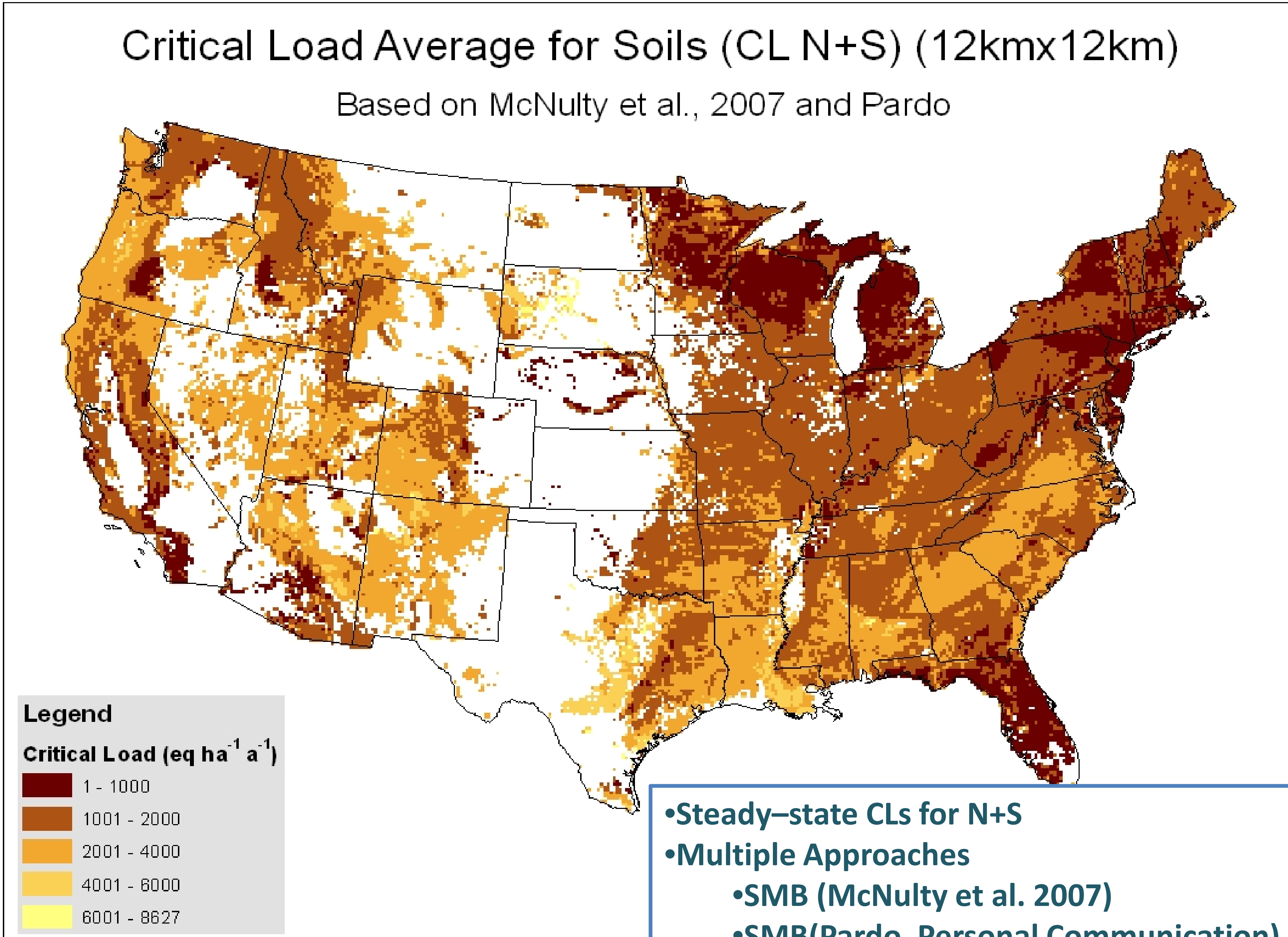



- **Linda Pardo et al. 2011 - Fungi, Lichens, Herbaceous, Forests**
- **Linda Geiser et al. 2010 - Lichens**

# Aquatic Critical Loads Average (CL N+S) (36x36km)




- Steady-States CLs for N+S
- 9,500+ Locations
- Multiple Approaches (SSWC, MAGIC, FAB)




- Steady–state CLs for N+S
- Multiple Approaches
    - SMB (McNulty et al. 2007)
    - SMB(Pardo, Personal Communication)

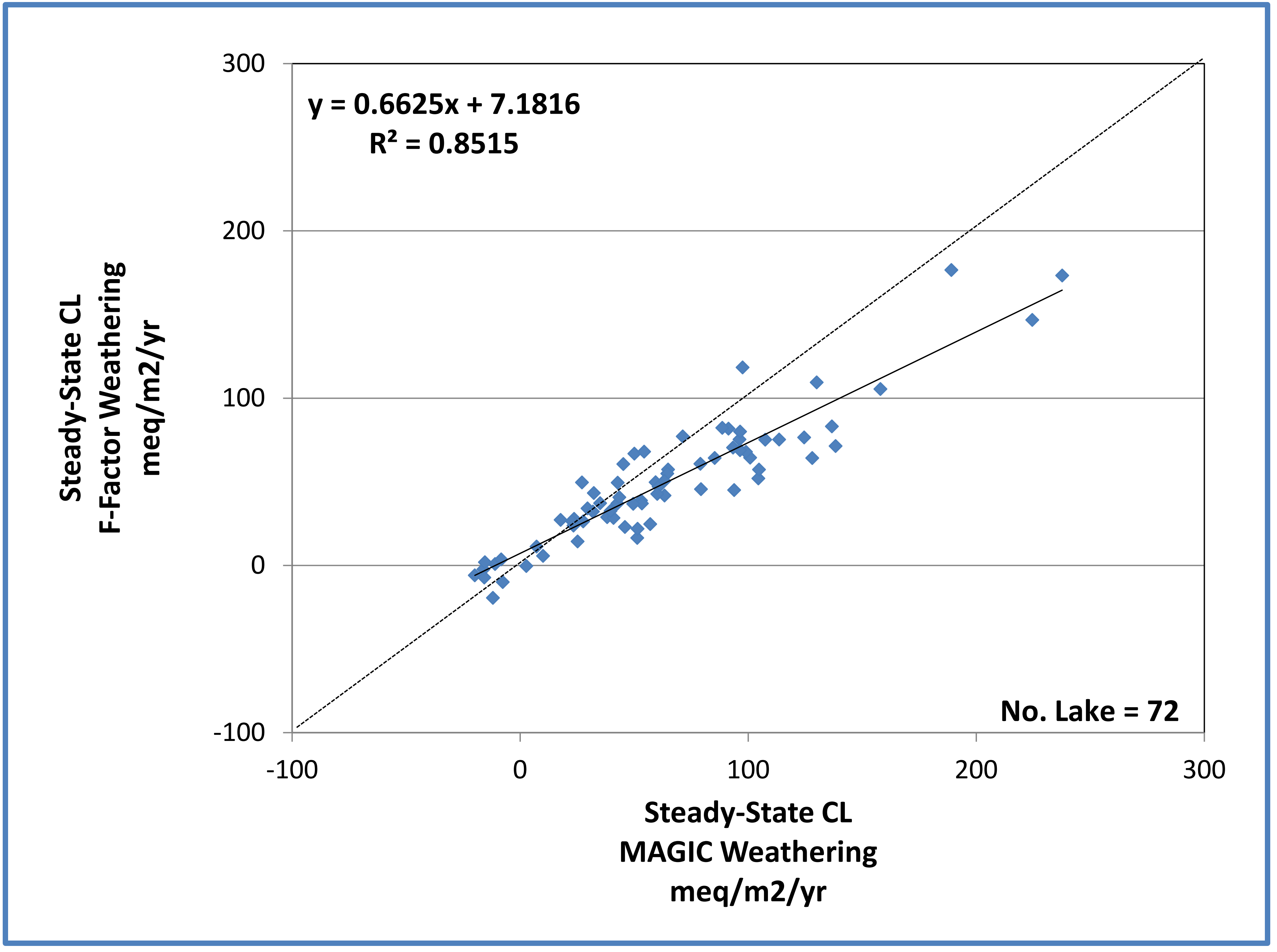
# Example of Uses of the National Critical Load Database

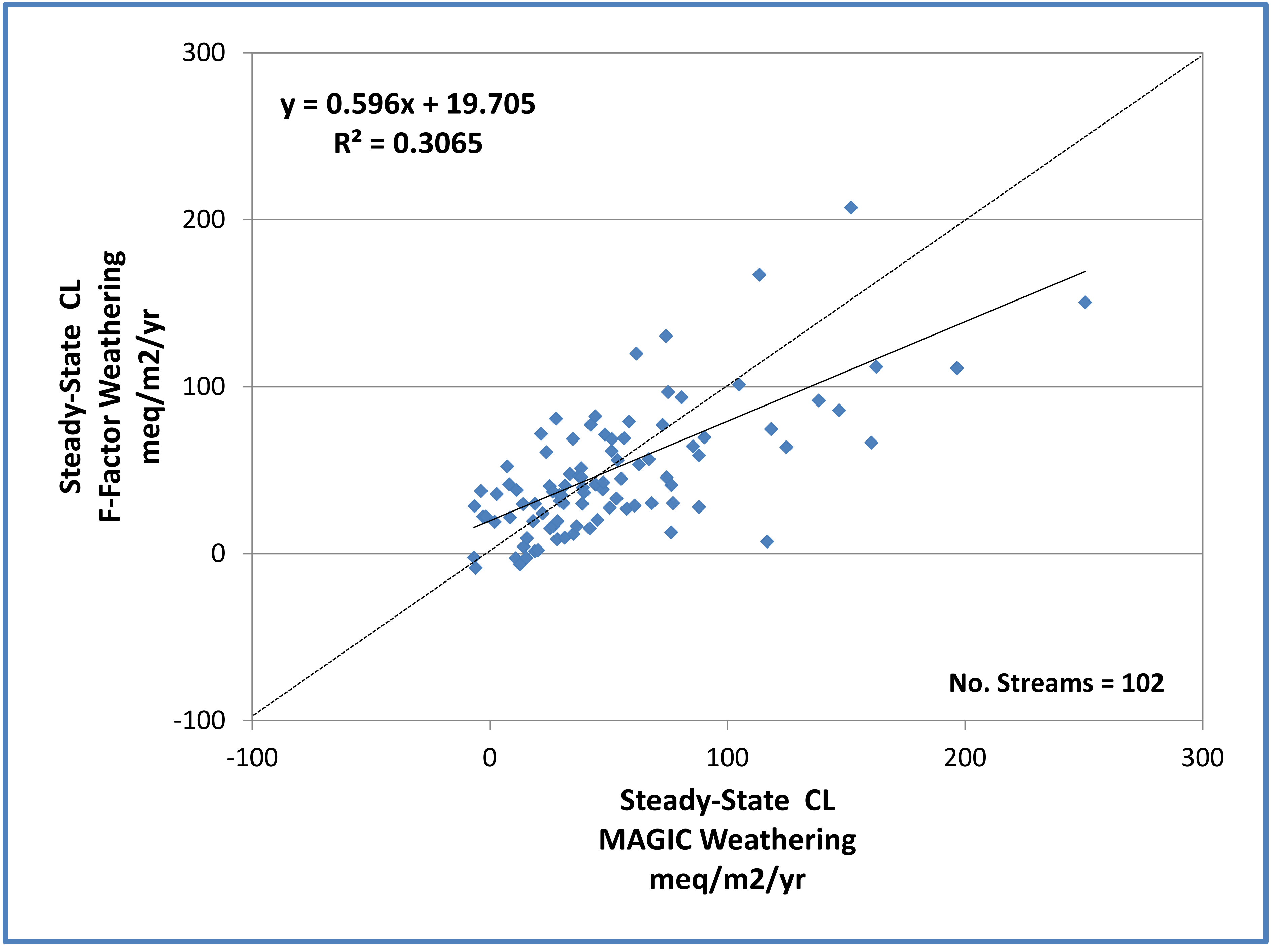
- Reliability and Uncertainty of CLs

- National Assessment of Surface waters

# Reliability and Uncertainty

- Surface Waters CLs
- Weathering Rates of Base Cations
- F-Factor vs. MAGIC
- Lakes and Streams
- Same Water Chemistry, Runoff, ANC limit


y = 0.6625x + 7.1816
R² = 0.8515
No. Lake = 72
300
200
100
0
-100
-100
0
100
200
300
Steady-State CL
F-Factor Weathering
meq/m2/yr
Steady-State CL
MAGIC Weathering
meq/m2/yr

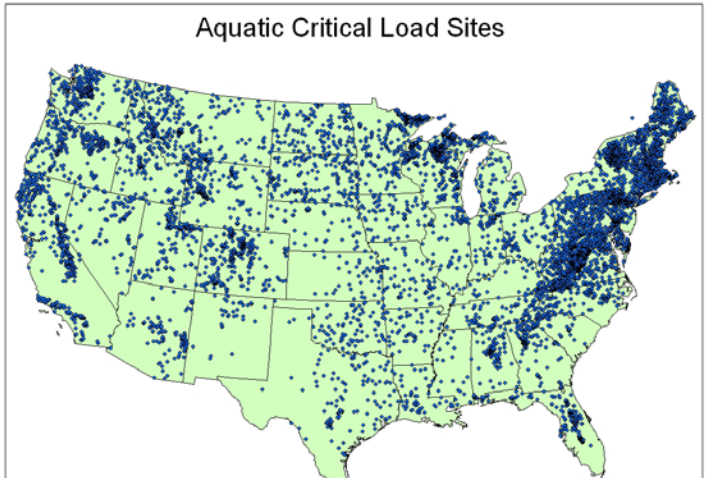


y = 0.596x + 19.705
R² = 0.3065
No. Streams = 102
Steady-State CL
F-Factor Weathering
meq/m2/yr
Steady-State CL
MAGIC Weathering
meq/m2/yr
300
200
100
0
-100
-100
0
100
200
300

# Example Uses of National Critical Load Database

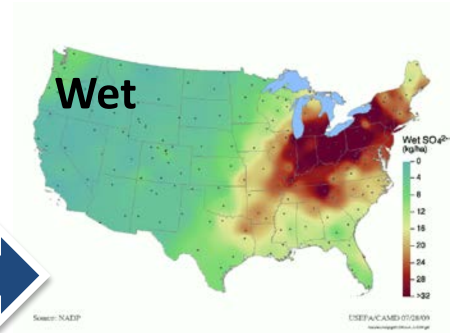
- Reliability and Uncertainty of CLs
- National Assessment of Surface Waters

# National Assessment of Surface waters




Point Locations

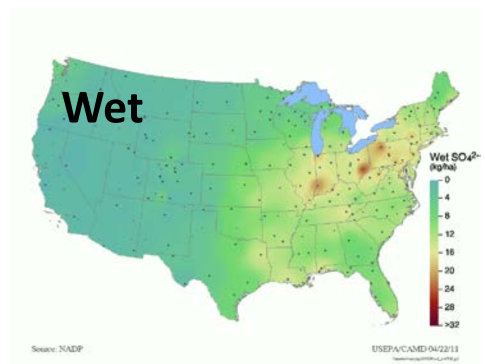
1989-1991



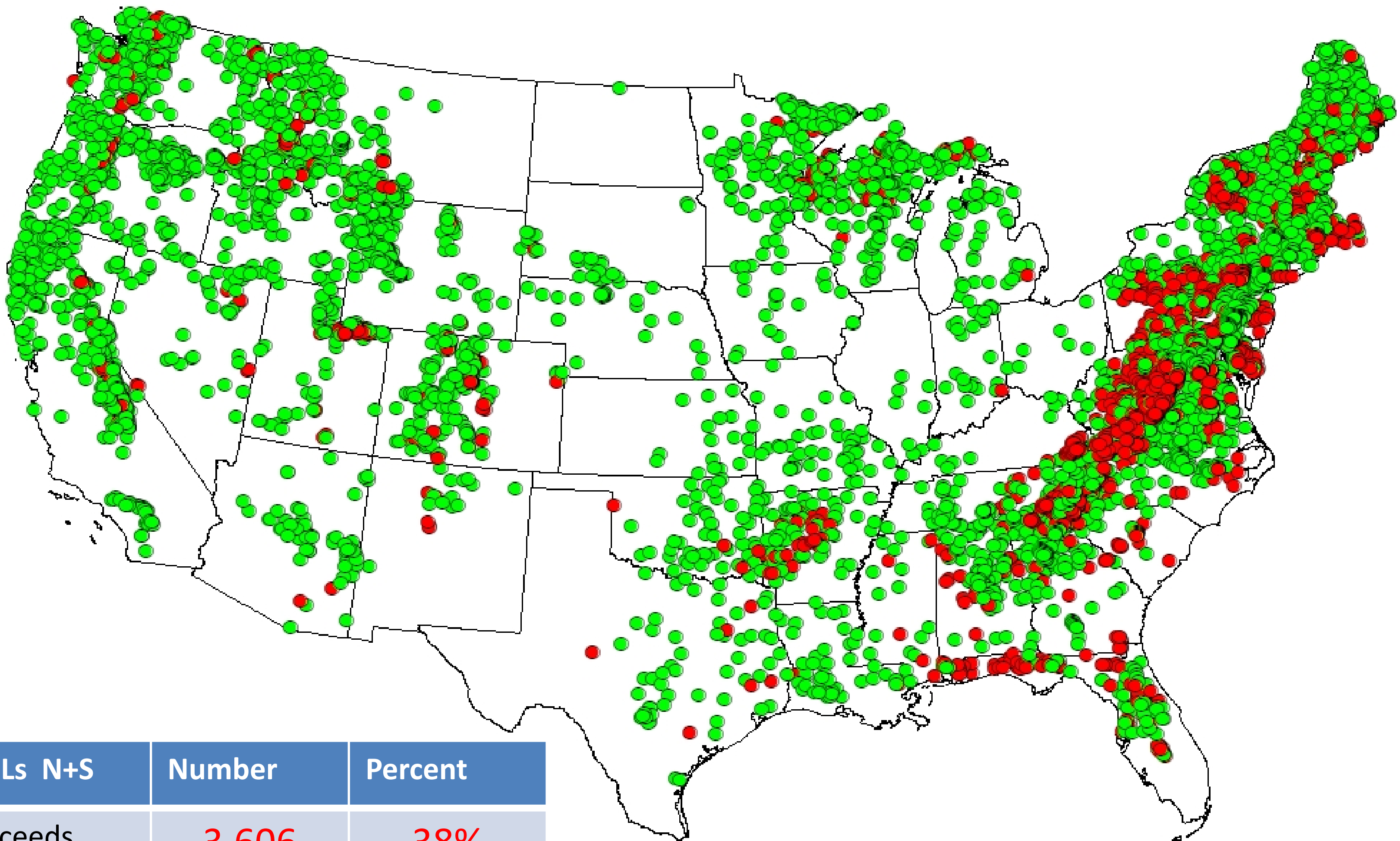

+

2002 Adjusted CMAQ


2008-2010

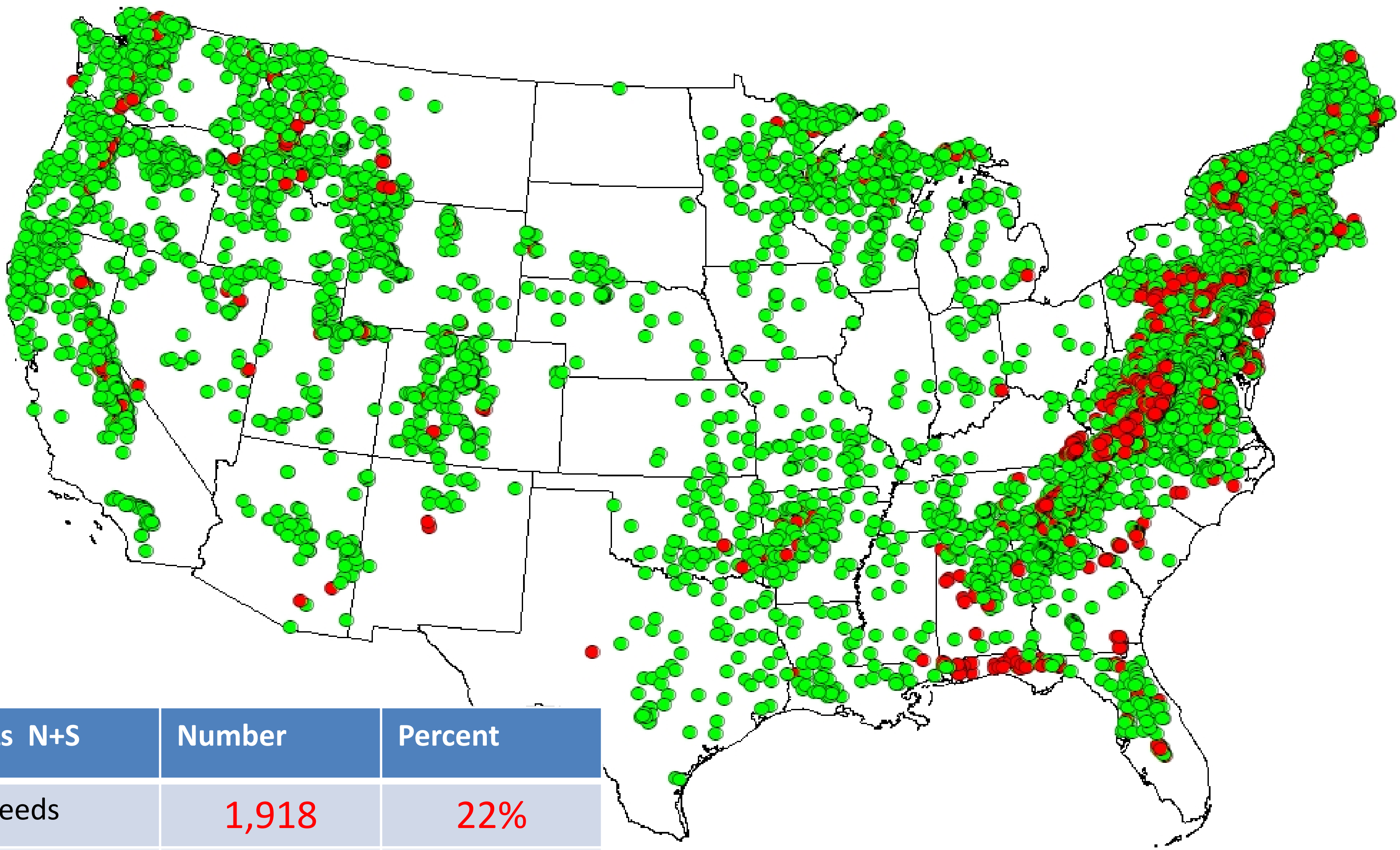


# Aquatic Critical Load Exceedances NCLD (1989-1991)



| CLs N+S | Number | Percent |
|---|---|---|
| Exceeds | 3,606 | 38% |
| Does Not Exceeds | 5,939 | 62% |

# Aquatic Critical Load Exceedances NCLD (2008-2010)



| CLs N+S | Number | Percent |
| --- | --- | --- |
| Exceeds | 1,918 | 22% |
| Does Not Exceeds | 7,444 | 78% |
| | Improvement | 42% |

# What do the 9,500+ CLs represent?

## National Lake and Stream Surveys

- Eastern Lake Survey (ELS)
- Western Lake Survey (WLS)
- EMAP Northeast Lakes
- Mid-Appalachian Highland Assessment (MAHA)
- National Stream Assessment (NSS)
- Wadeable Stream Assessment (WSA)

## Surveys Represent?

- Stratified random samples
- Estimates of:
    - Number of lakes
    - Km of streams

# Exceedances and Percent Difference/Improvement from 1989-1990 to 2008-2010 for Lakes

| Survey | Region | No. | Percent Exceeds CL | | Percent |
|---|---|---|---|---|---|
| | | | 1989-1991 | 2008-2010 | Improvement |
| ELS | Adirondacks | 1290 | 41% | 20% | 51% |
| | New England | 4361 | 32% | 14% | 56% |
| | Poconoc/Catskills | 1506 | 24% | 12% | 50% |
| | Southeast | 286 | 2% | 1% | 50% |
| | Upper Midwest | 8575 | 20% | 11% | 45% |
| WLS | Rockies | 6666 | 20% | 11% | 45% |
| | Sierra/Cascades | 4155 | 64% | 27% | 58% |
| EMAP | Adirondacks | 1786 | 50% | 16% | 68% |
| | New England | 6594 | 18% | 8% | 55% |
| | Total | 35,219 | 30% | 13% | 56% |

# Exceedances and Percent Difference/Improvement from 1989-1990 to 2008-2010 for Streams

| Survey | Region | Stream | Percent Exceeds CL | | Percent |
|---|---|---|---|---|---|
| | | KM | 1989-1991 | 2008-2010 | Improvement |
| WSA | All | 1,017,299 | 8% | 4% | 50% |
| MAHA | All | 379,667 | 45% | 21% | 53% |
| NSS | Poconoc/Catskills | 3,505 | 44% | 26% | 41% |
| | N. Valley & Ridge | 14,918 | 33% | 16% | 52% |
| | N. Appalachians | 8,958 | 71% | 48% | 33% |
| | Piedmont | 7,514 | 46% | 25% | 46% |
| | Ozarks & Ouachita | 4,204 | 29% | 11% | 62% |
| | S. Appalachians | 5,179 | 29% | 19% | 35% |
| | Total | 1,441,244 | 38% | 21% | 45% |

# Conclusions

- **NCLD slightly over represents CLs and exceedances as compared to the probabilistic surface water surveys today**

- **On average about 50% of lakes/streams that exceeds their CLs in 1989-1991 do not in 2008-2010**

- **Emission reductions Since 1990 have resulted in improved environmental conditions of surface water <u>across</u> the U.S.**

- **However, lakes and streams in many regions still remain at risk from current acid deposition loads**

- **Streams seem to have a higher exceedance rates today than lakes**


Questions
Jason Lynch
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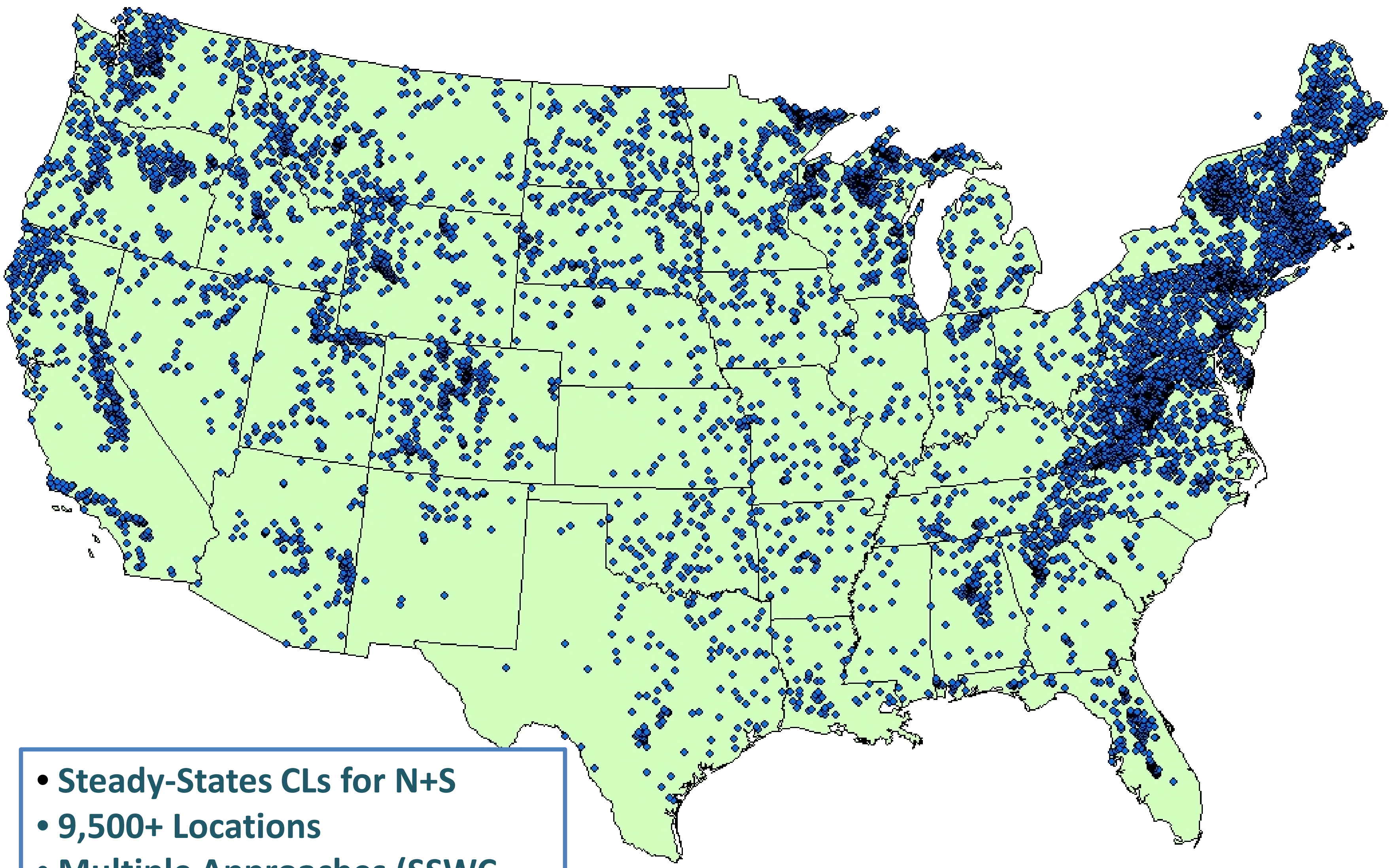
We want your Critical Load data!!!

# Additional Information

# Aquatic Critical Load Sites



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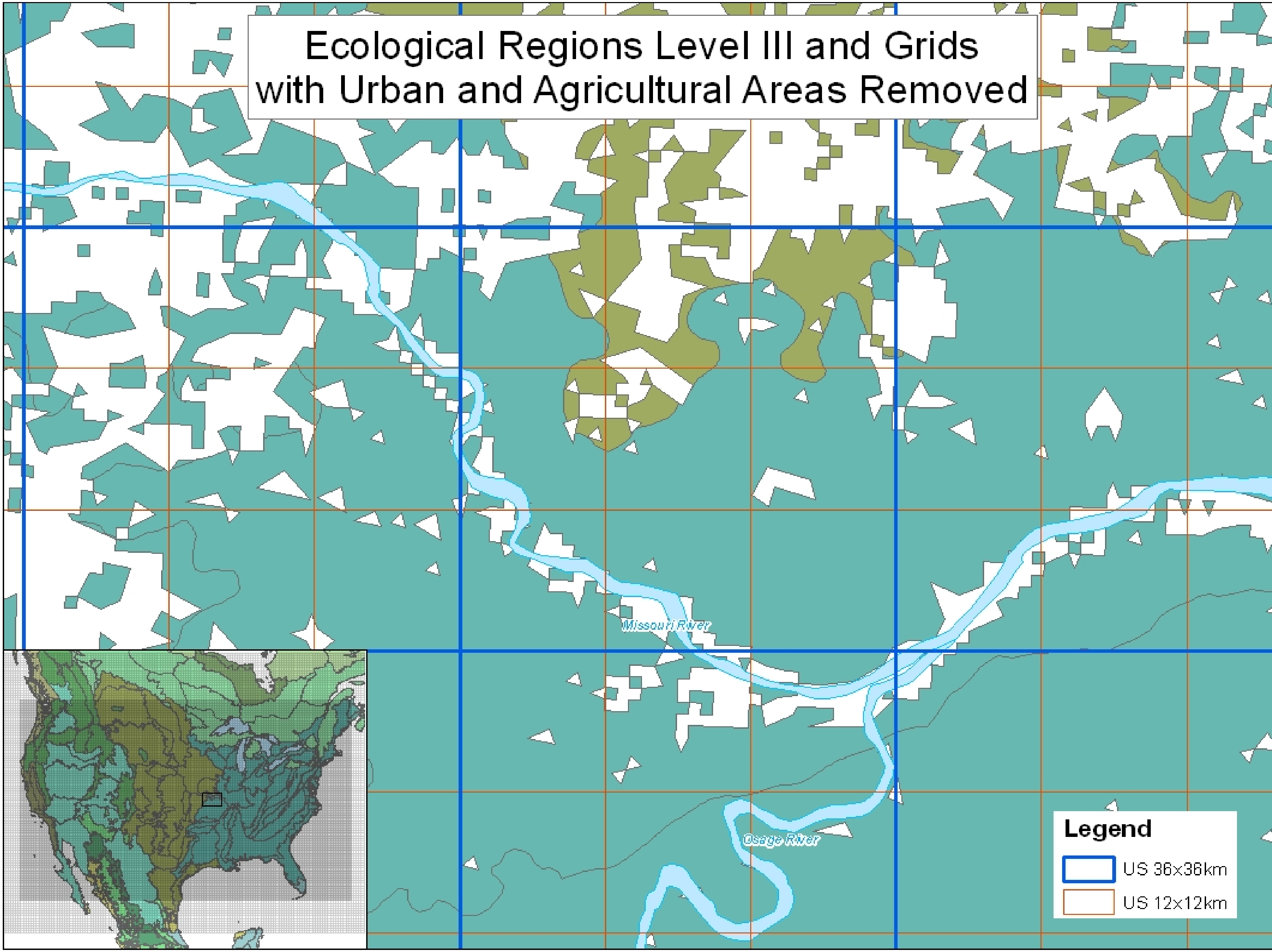
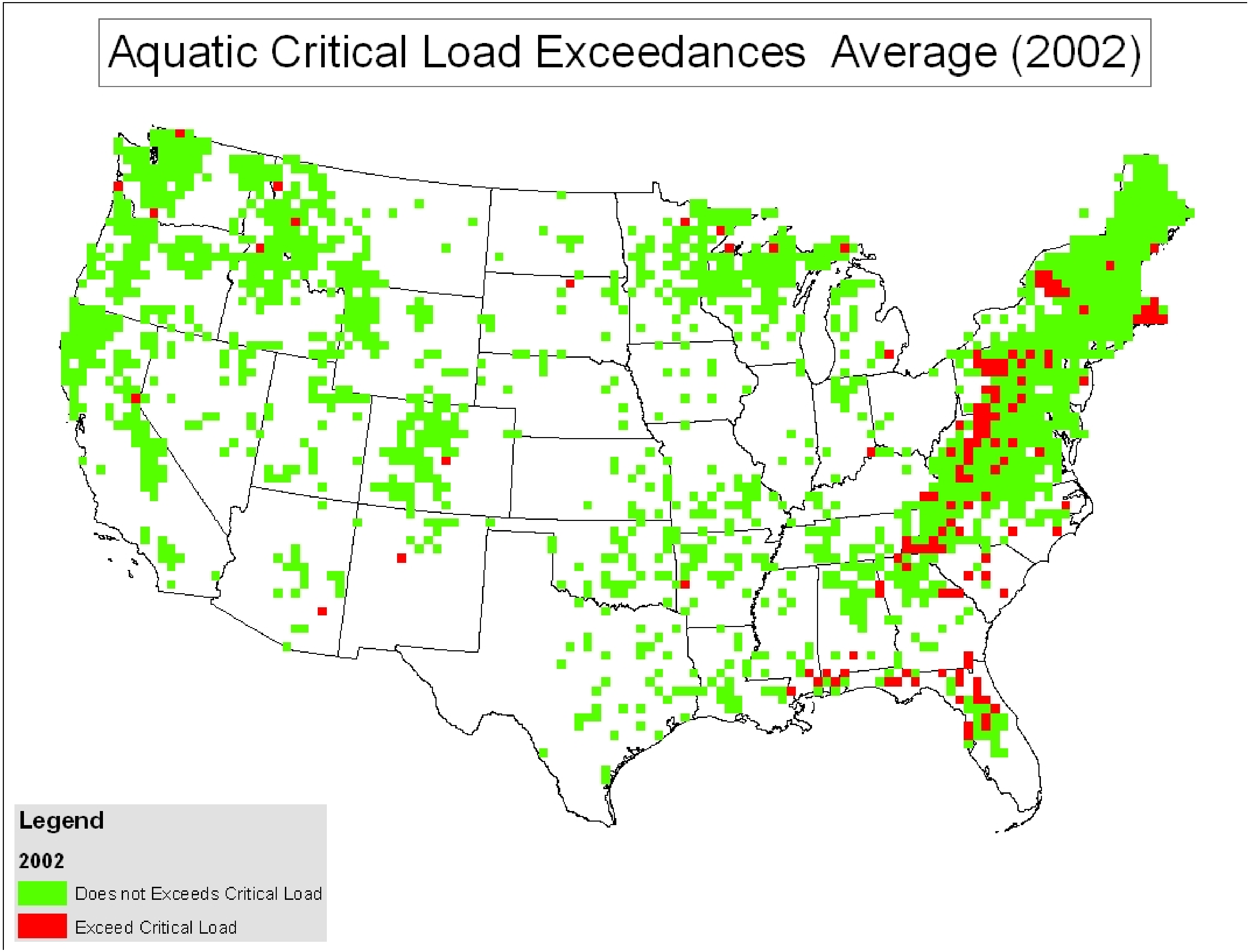
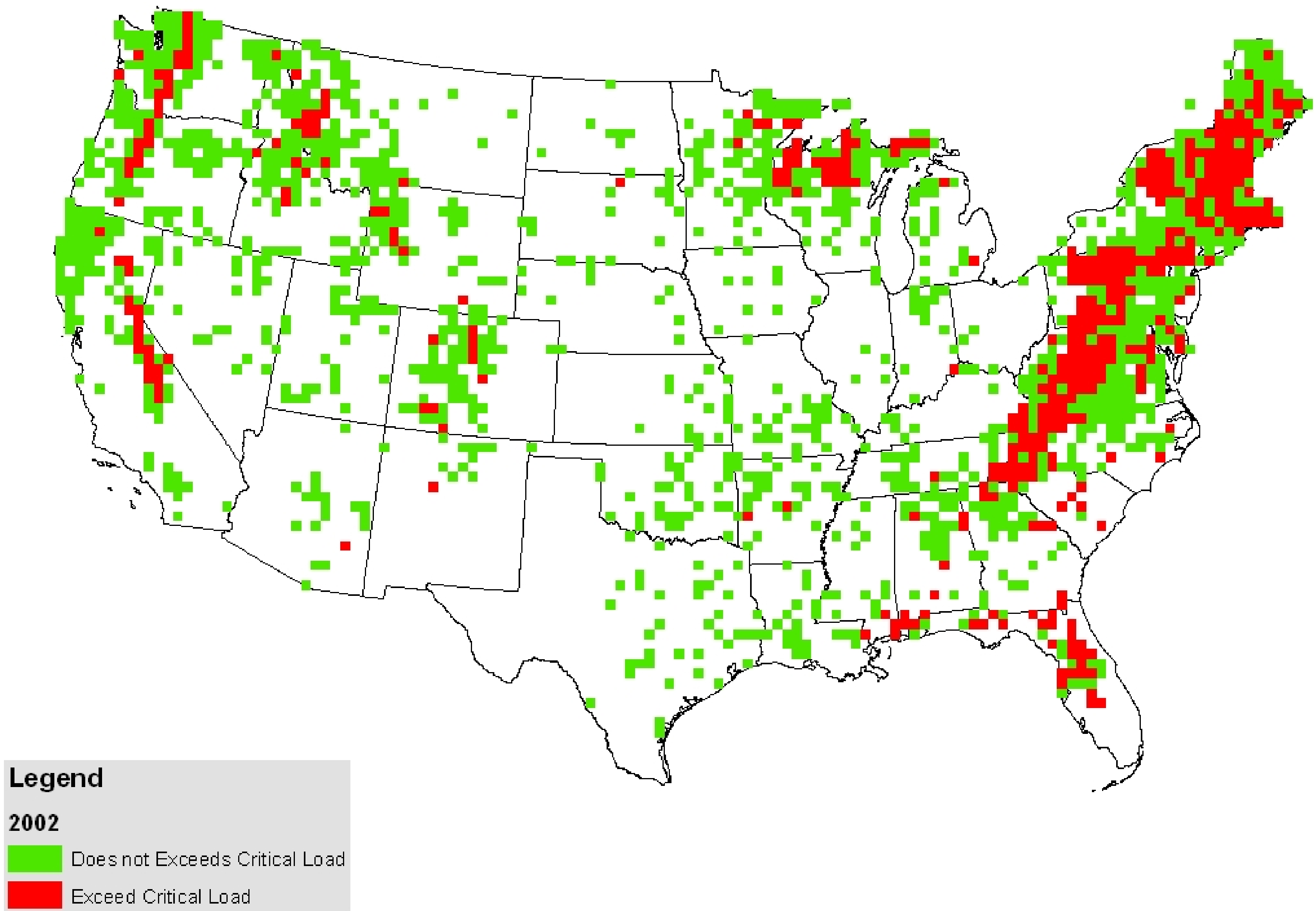
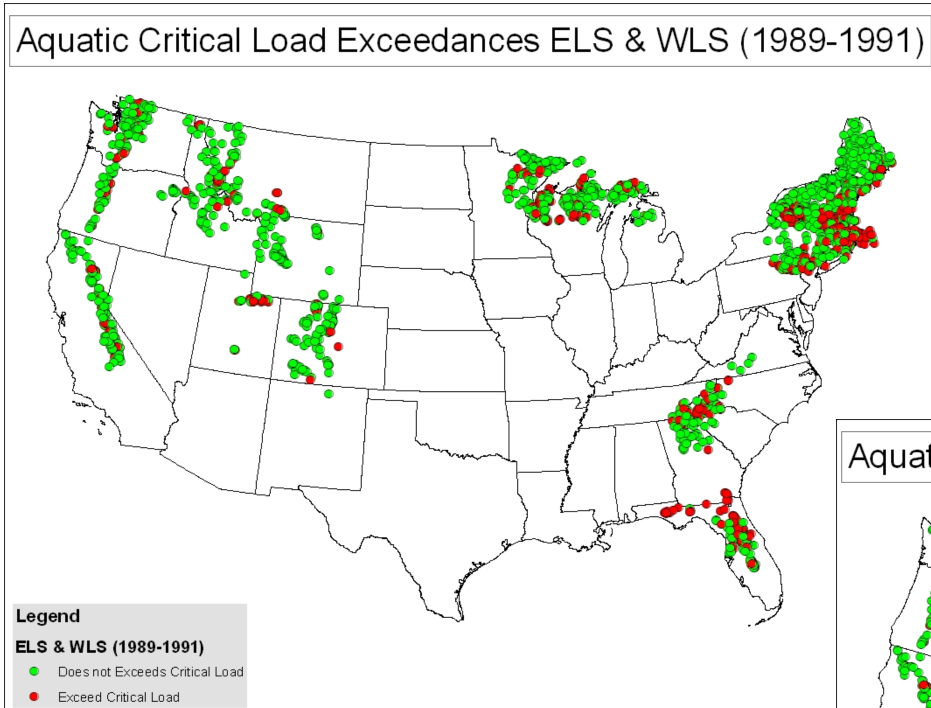

Ecological Regions Level III and Grids
with Urban and Agricultural Areas Removed
Missouri River
Osage River
Legend
US 36x36km
US 12x12km


Aquatic Critical Load Exceedances Average (2002)
Legend
2002
Does not Exceeds Critical Load
Exceed Critical Load

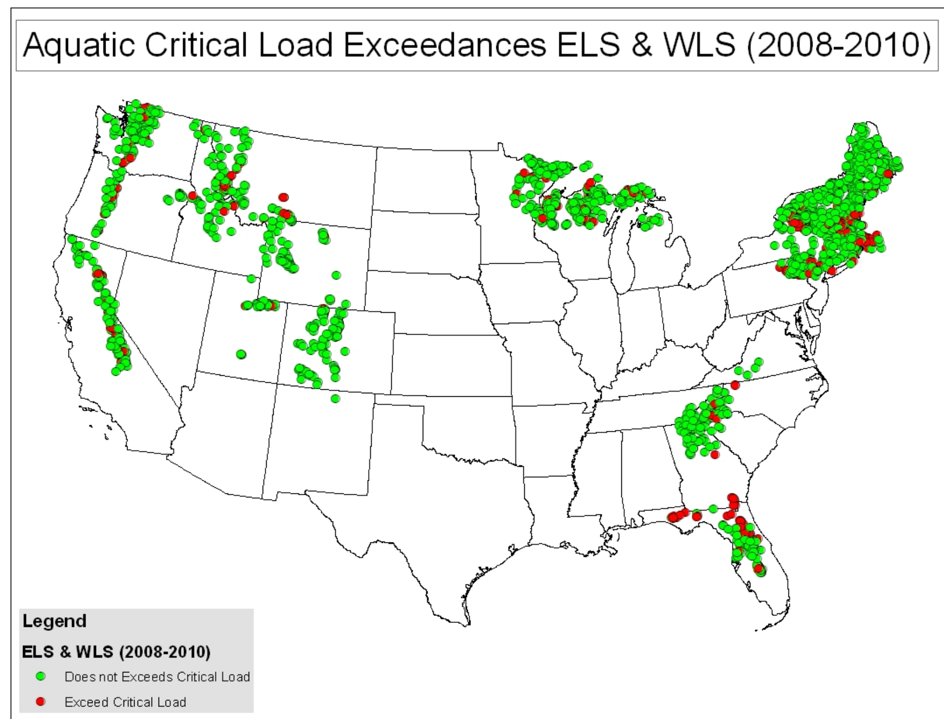
# Aquatic Critical Load Exceedances Minimum (2002)



# ELS and WLS



Aquatic Critical Load Exceedances ELS & WLS (1989-1991)
Legend
ELS & WLS (1989-1991)
Does not Exceeds Critical Load
Exceed Critical Load

Aquatic Critical Load Exceedances ELS & WLS (2008-2010)
Legend
ELS & WLS (2008-2010)
Does not Exceeds Critical Load
Exceed Critical Load