The Relative Significance of Environmental and Anthropogenic Factors Affecting Zooplankton Community Structure in Southeast Wisconsin Lakes

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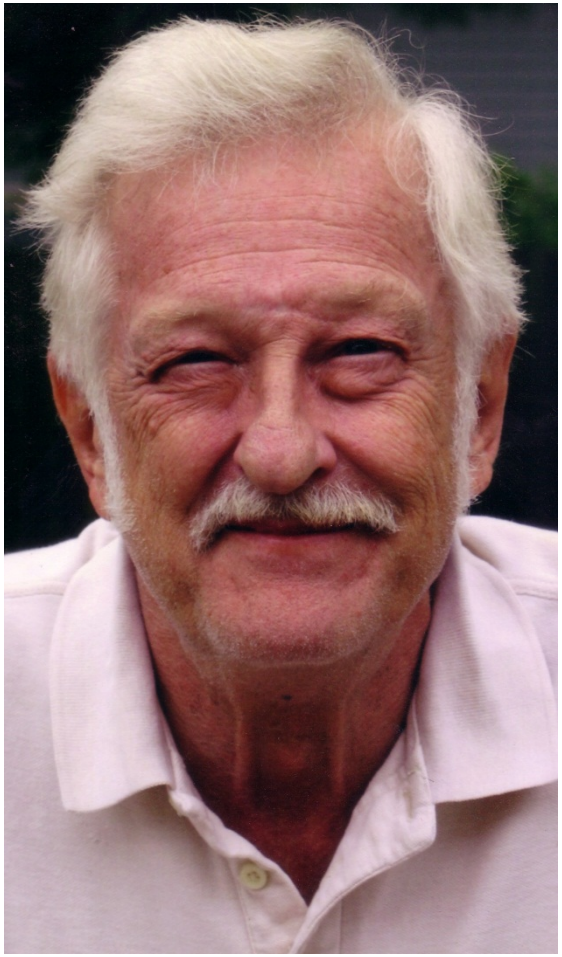
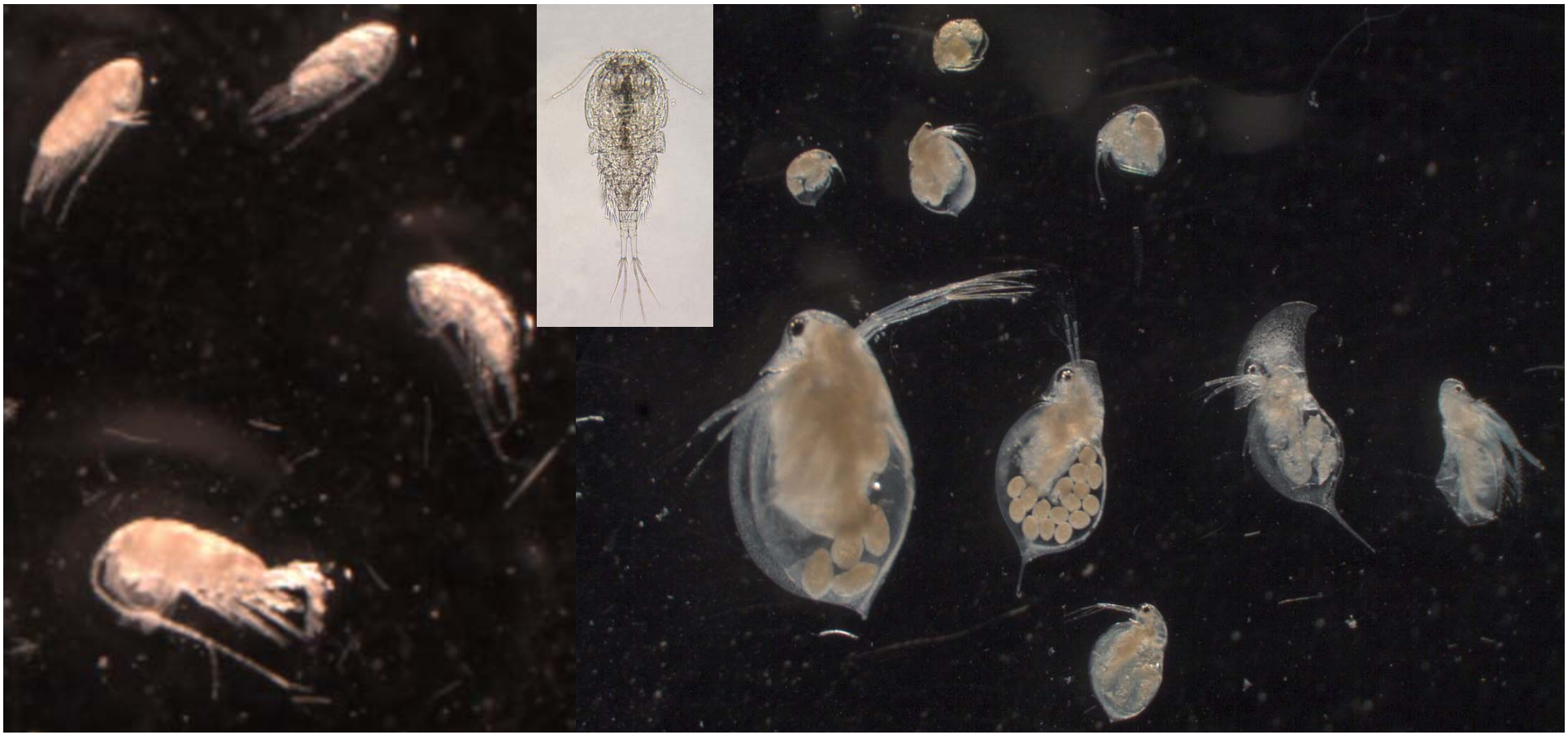
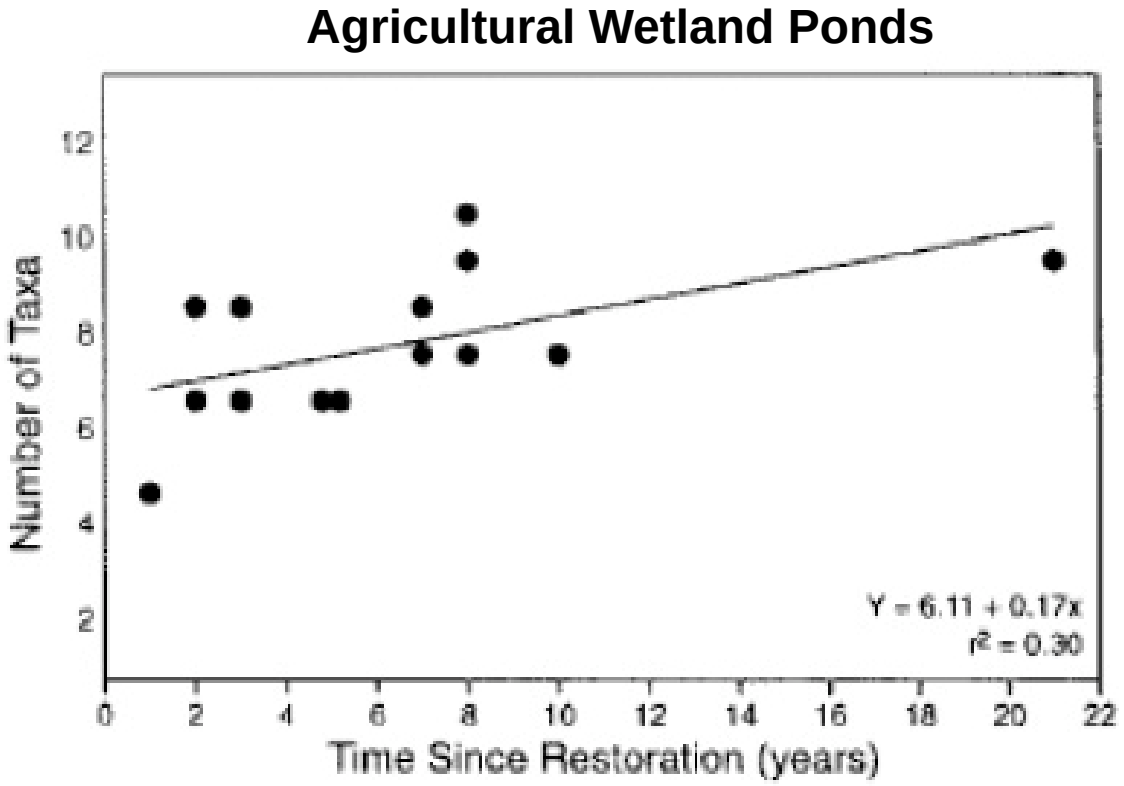
In Memoriam



Zooplankton are a diverse group of organisms.

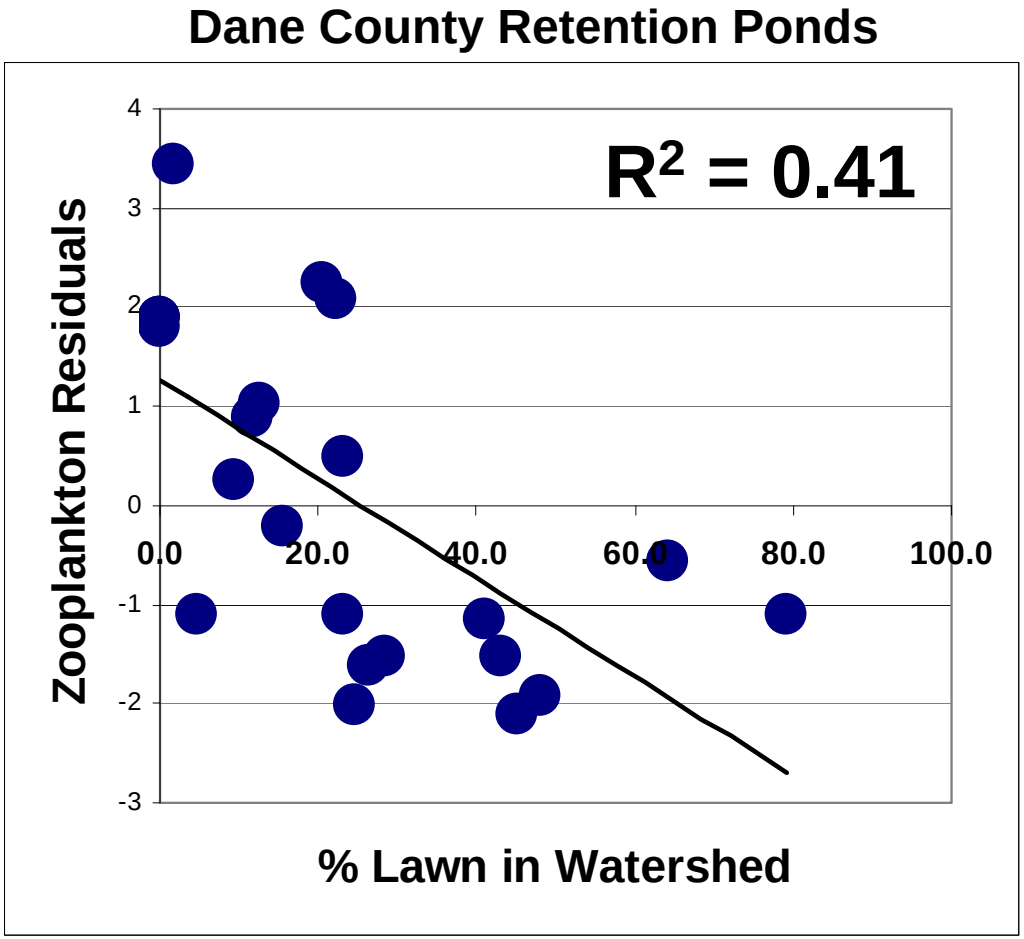


Lake managers define water quality using aquatic organisms.



From Dodson and Lillie 2001.

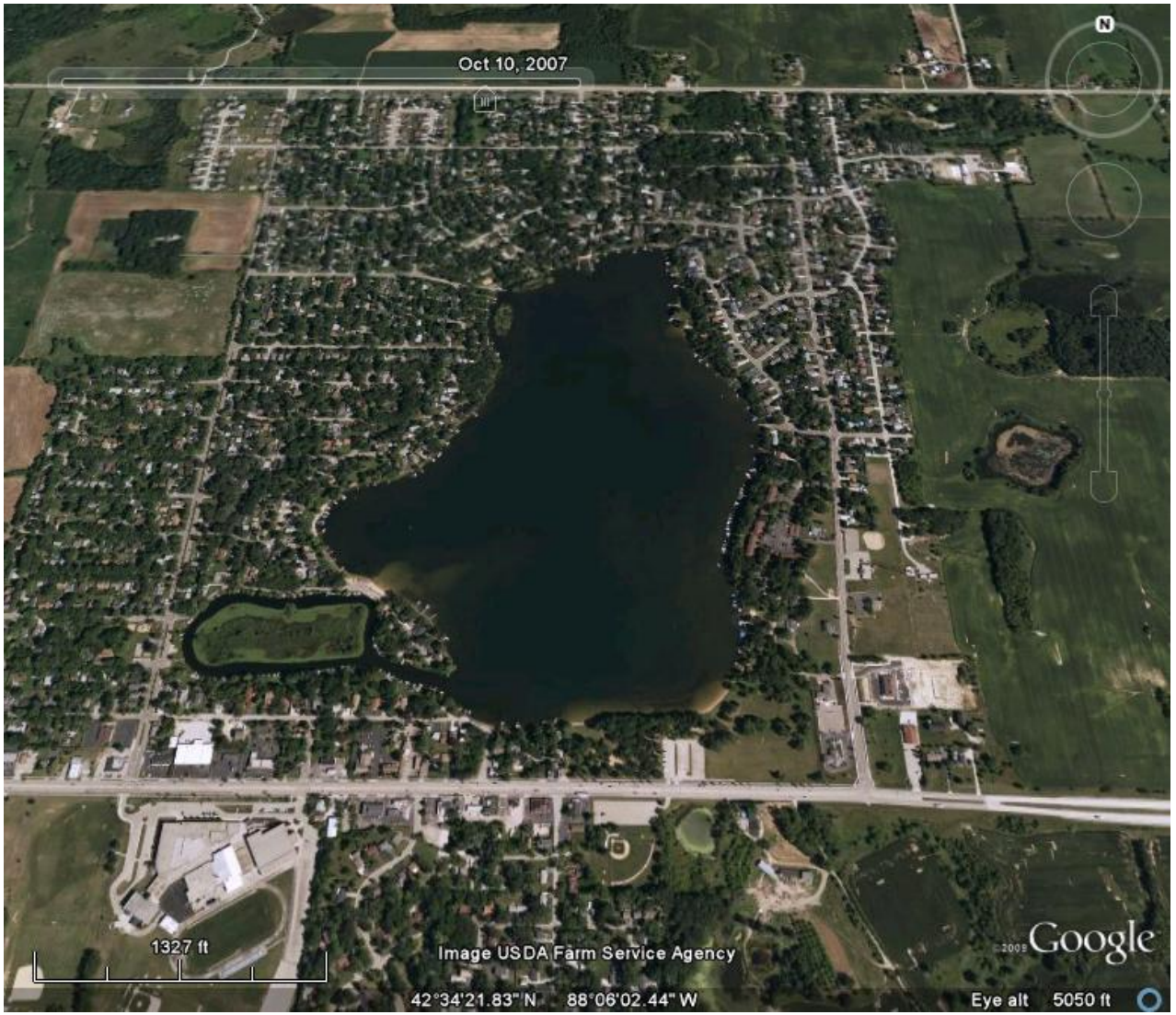
Land-use strongly correlated with zooplankton diversity.



From Dodson Et al 2009.

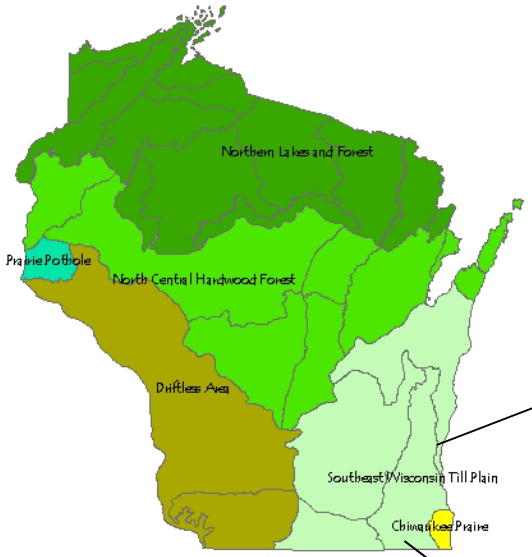
Riparian zone disturbance directly affects organisms.

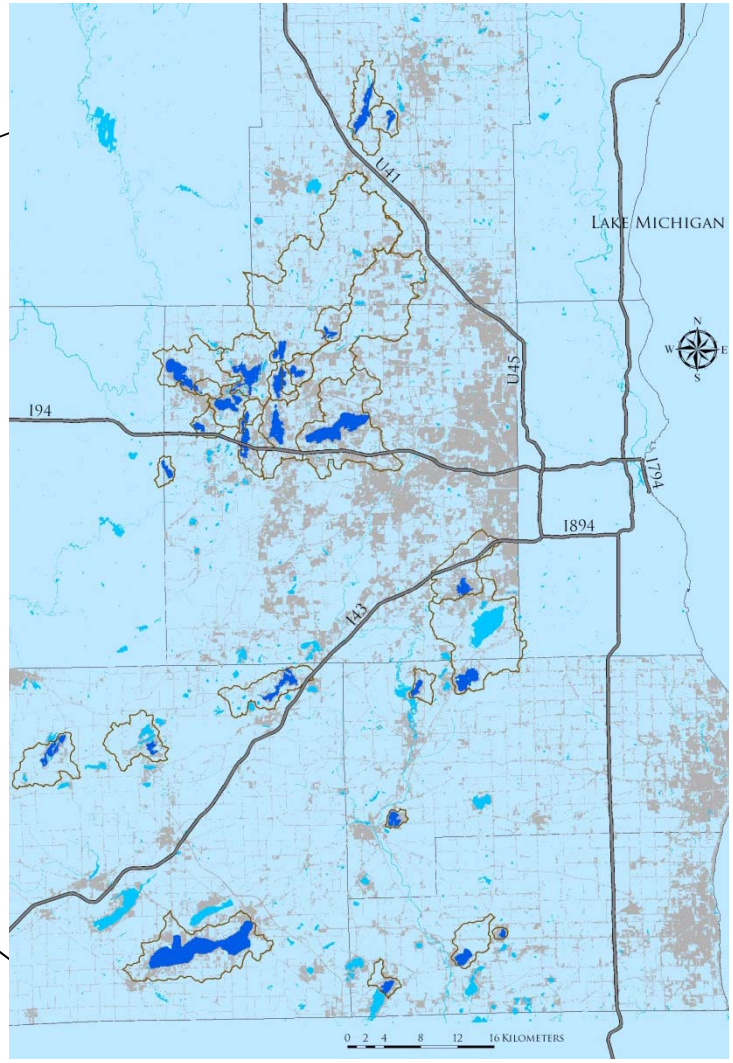
Does watershed land-use best explain aquatic community structure?



What relationships exist between land-use and zooplankton community?

Site Selection





<u>Lake Selection</u>

- N = 29
- All dimictic lakes

<u>Zooplankton Collection</u>

- Every three months
- Zooplankton counted and placed into ordinal rankings (1-4)

Data Collection

Lake Morphology
Watershed Size

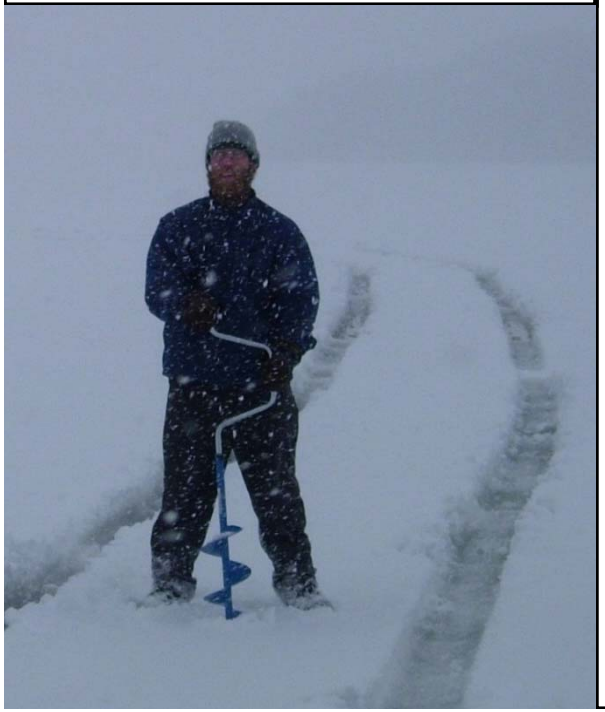
Surface area

Max Depth

Lake Order

Watershed Size

Watershed:Lake



Water Quality

Total Phosphorus

Total Nitrogen

Chlorophyll-a

Secchi depth

Chloride

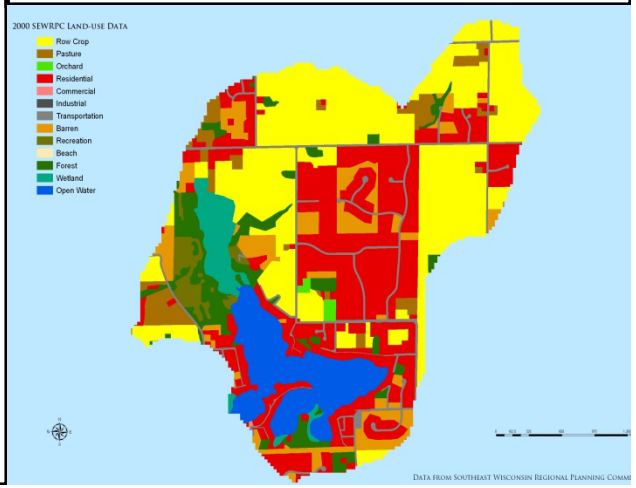
Conductivity

pH

Sulfate

Watershed Land Use

- **Urban**
  - **Residential**
  - **Commercial**
  - **Transportation**
- **Agricultural**
  - **Pasture**
  - **Cropland**
- **Natural**
  - **Forest**
  - **Wetland**
- **Barren/Open**
- **Recreation**
- **Industrial**



Data Analysis

- Variables transformed
  - Land-use proportions arcsin sq-rt transformed
  - Variables with skewness >1 log-transformed
- Forward selection of explanatory variables
- Variance partitioning (with select variables.)
- Redundancy analysis (with select variables.)
- Pearson correlation with species richness

Results

Forward Selection

Lake Morphology
Watershed Size

Surface area
Max Depth
Lake Order
Watershed Size
Watershed:Lake

Water Quality

Total Phosphorus
Total Nitrogen
Chlorophyll-a
Secchi depth
Chloride
Conductivity
pH
Sulfate

Watershed Land Use

- **Urban**
  - **Residential**
  - **Commercial**
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- **Agricultural**
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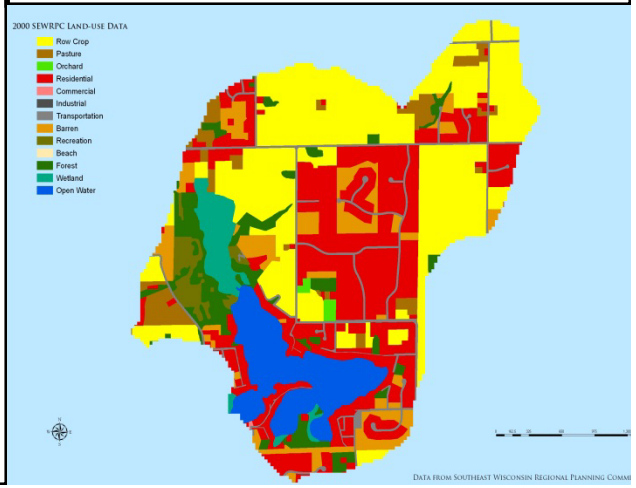


Forward Selection

($p < 0.01$)

Lake Morphology
Watershed Size

Surface area

Max Depth

Water Quality

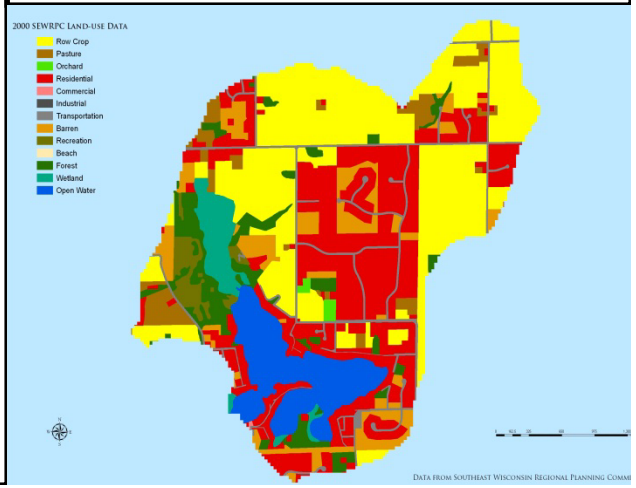
Summer TP

Land Use

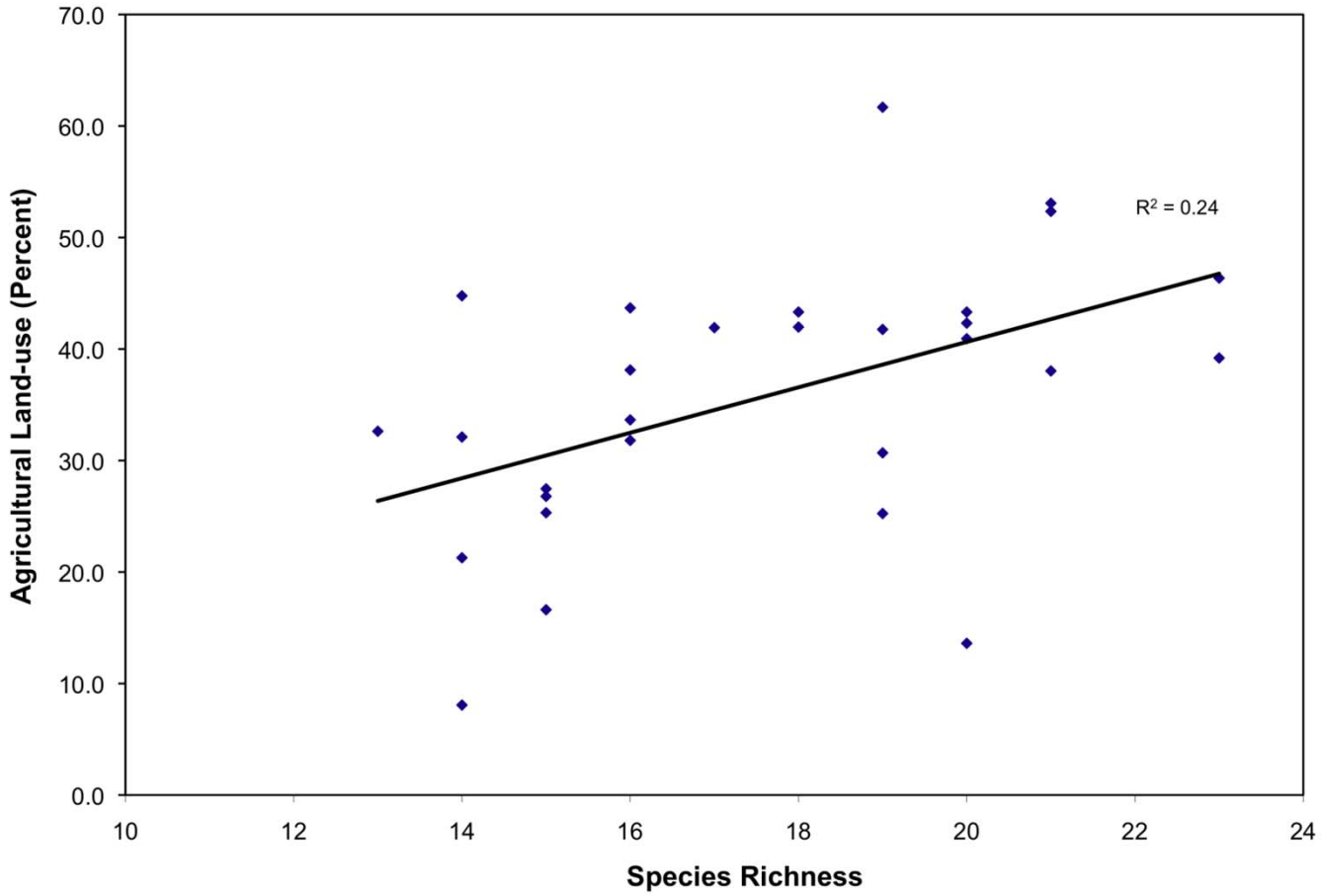
Urban buffer

Forest buffer

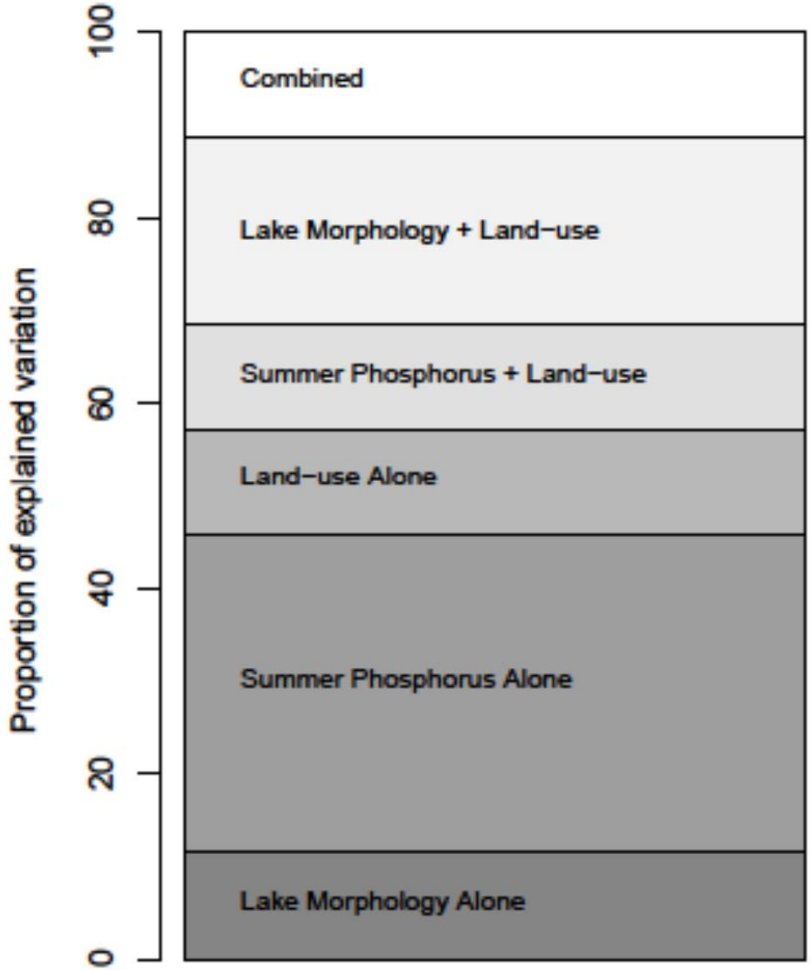
Natural watershed



Species richness increases with watershed agriculture.



Community relationship with land-use not simple.

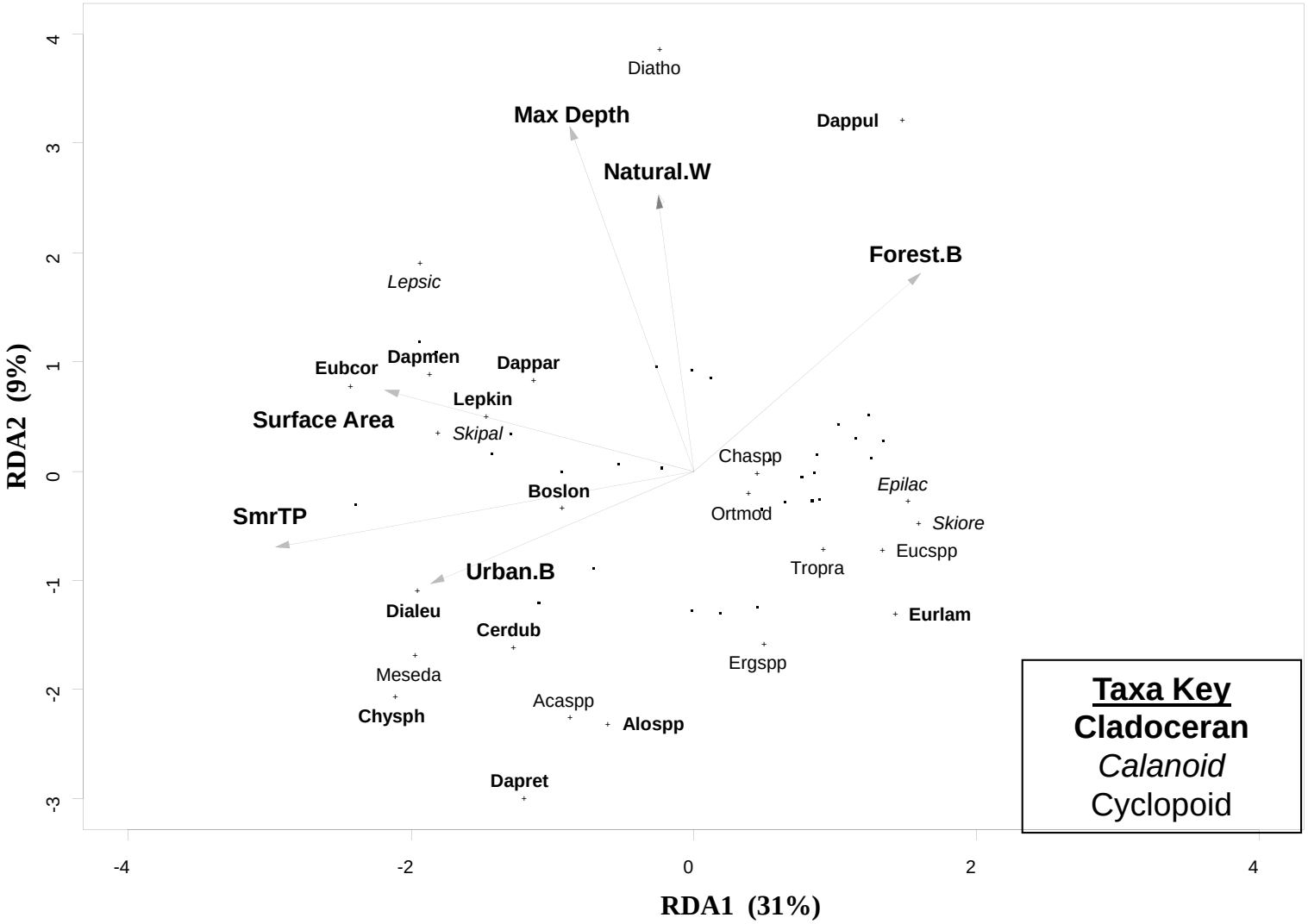


$R^2 = 0.49$

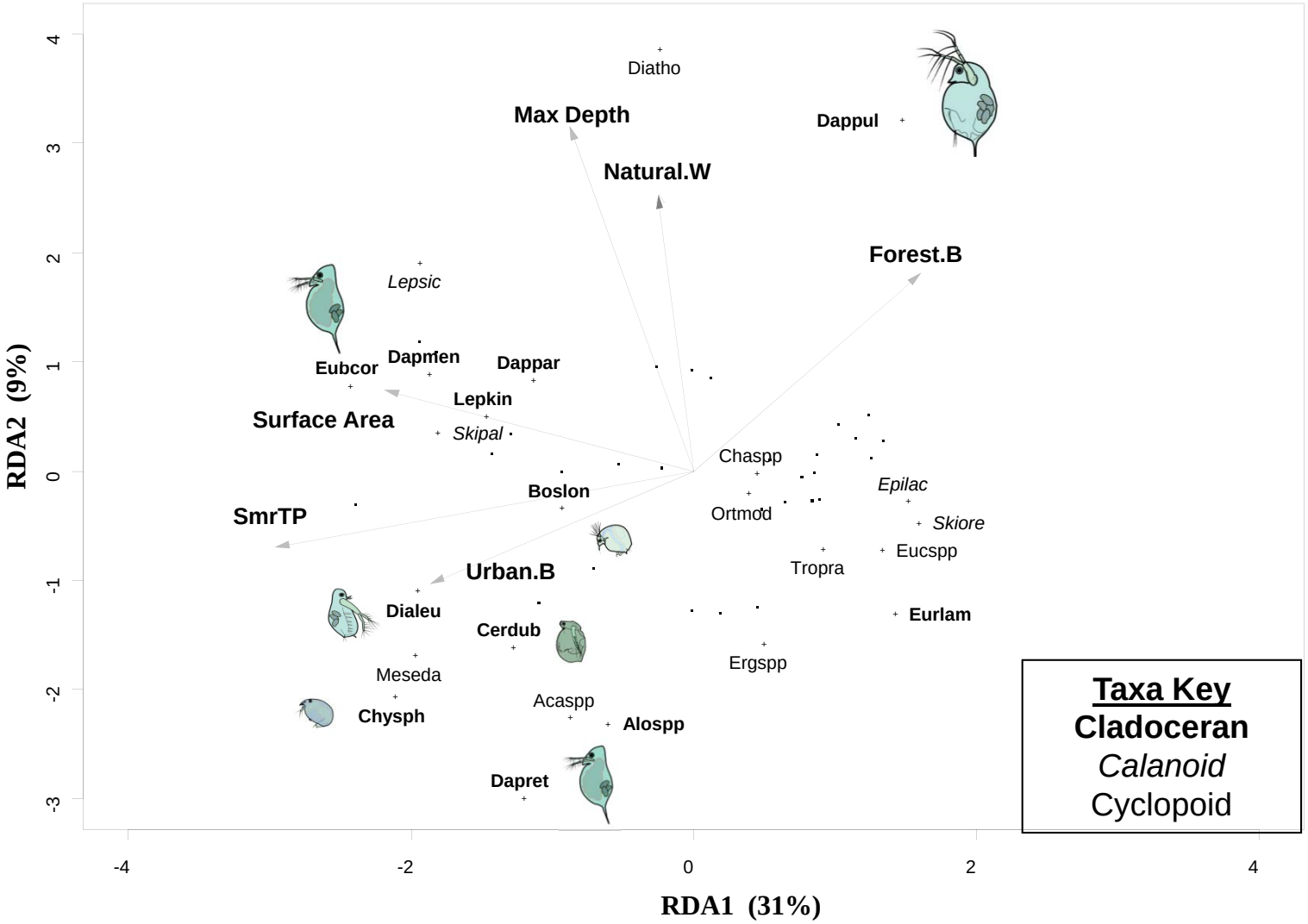
Explained Variation in Zooplankton Community

- Water Quality = 18%
- Land-use = 19%
- Lake morphology = 15%

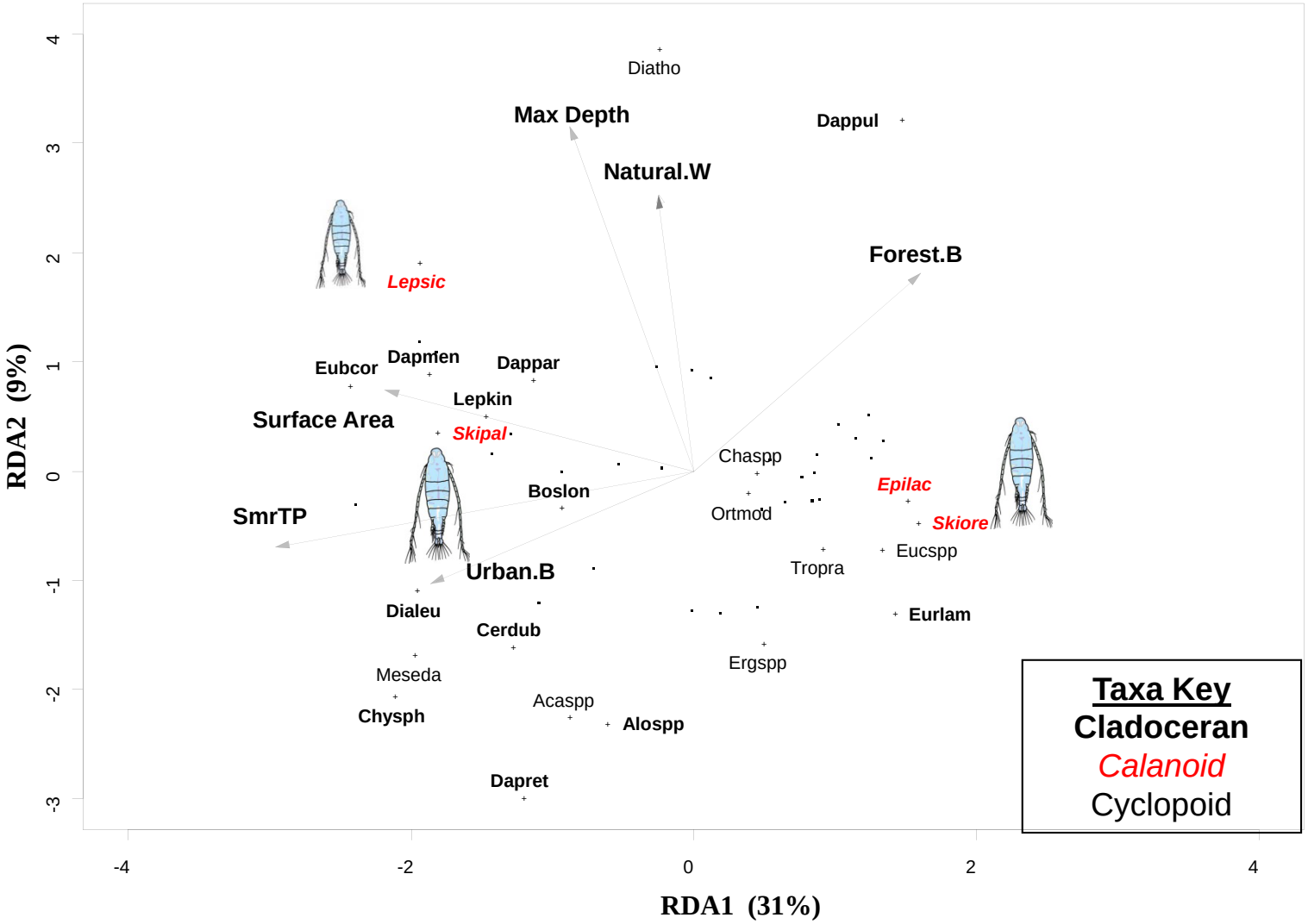
Environmental Relationships



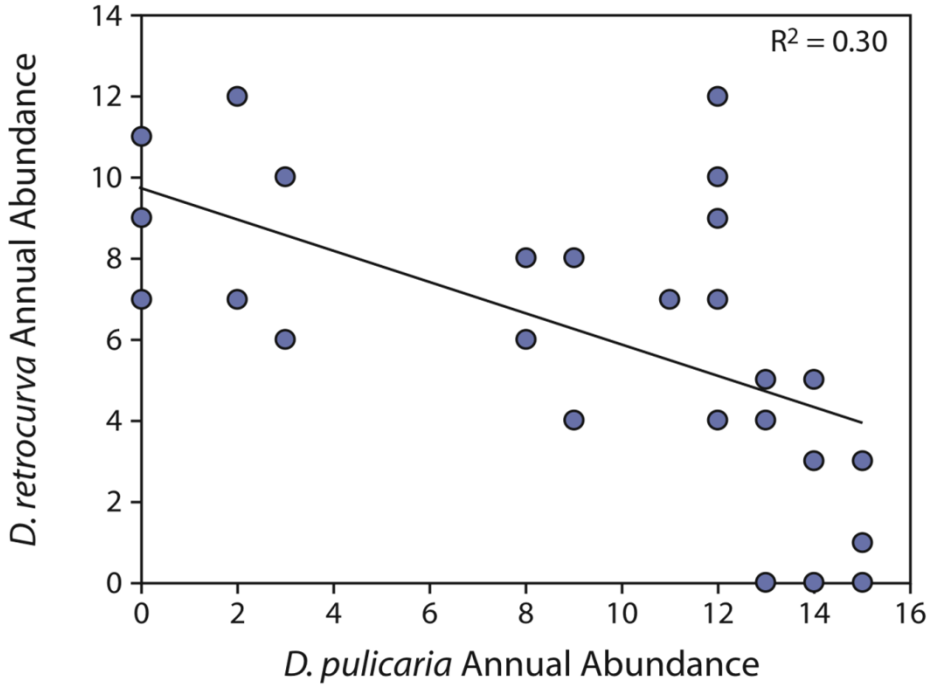
Cladoceran Community Relates to Multiple Factors

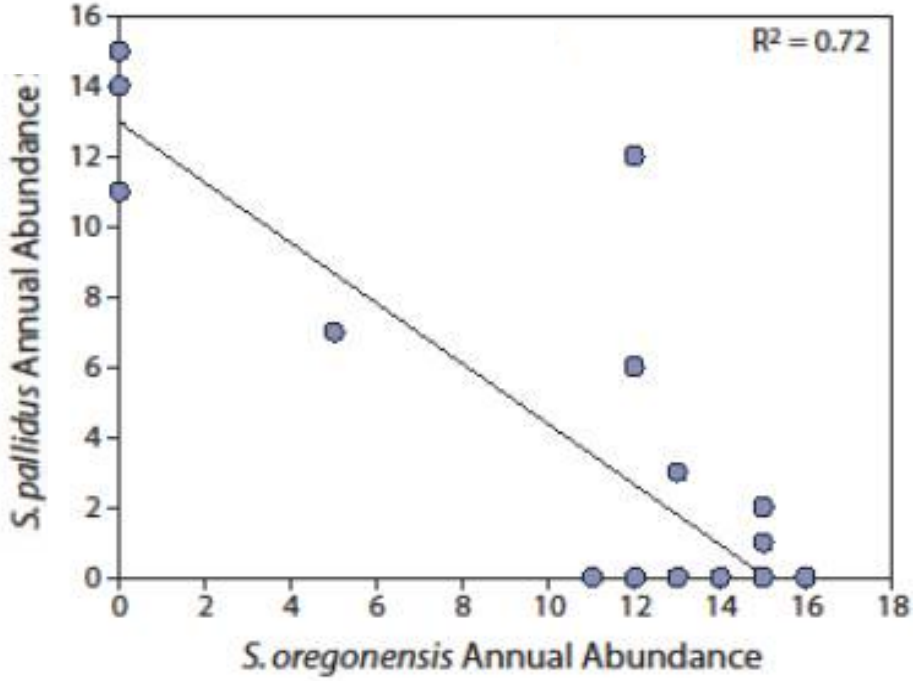


Calanoid Copepods Relate to Trophic Status

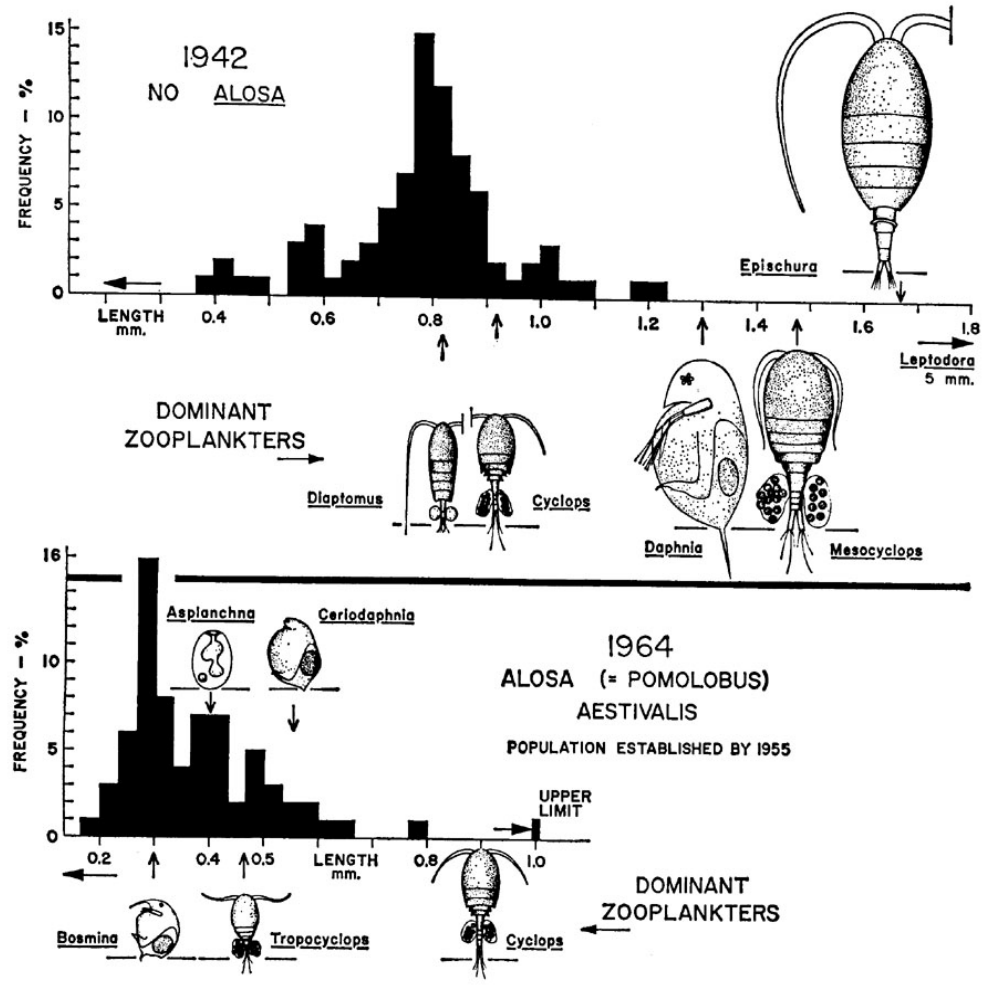


Species specific interactions explain much of the community variability.





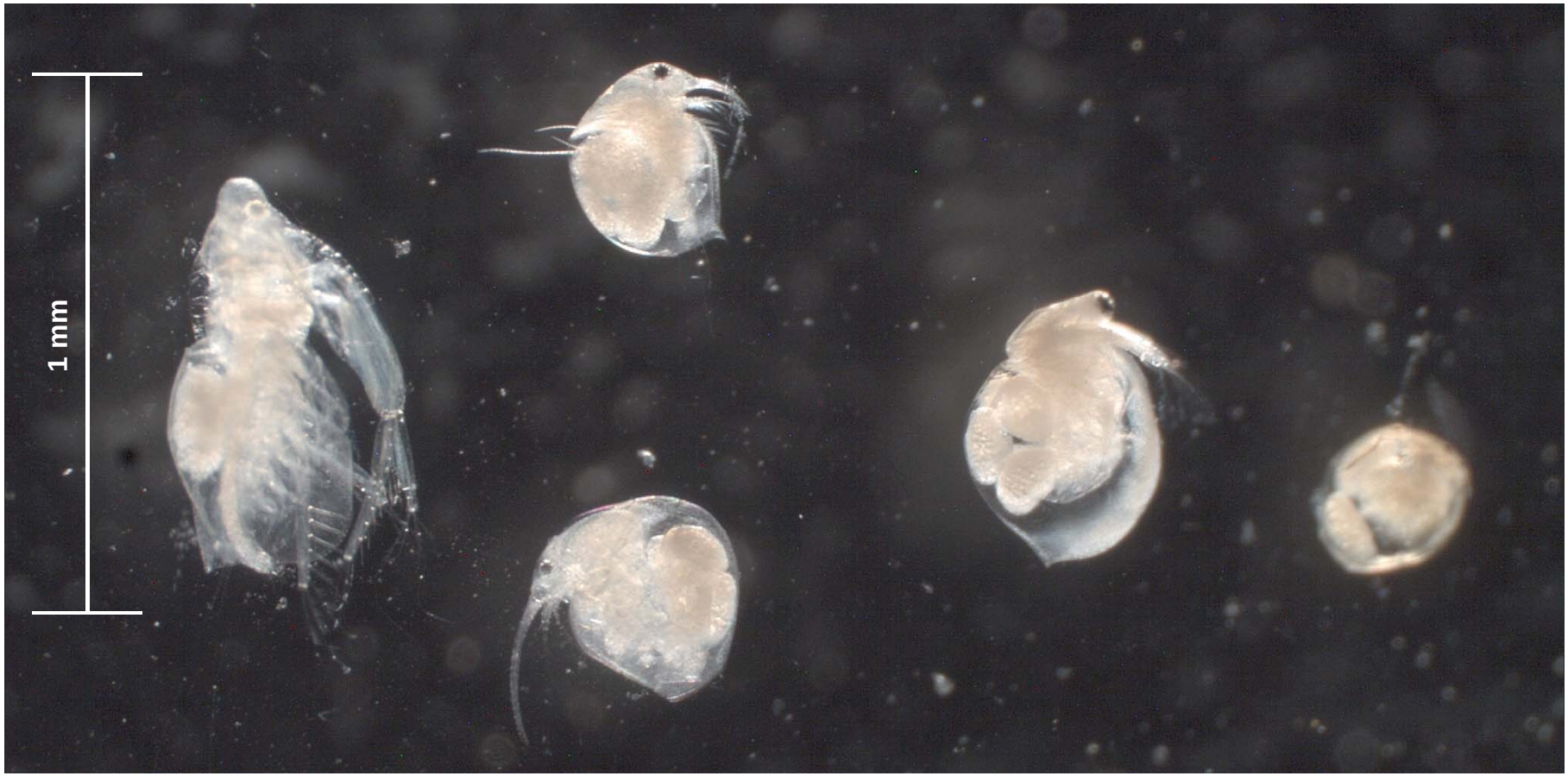
Size selective predation determines species composition.



Brooks & Dodson 1965

Daphnia species composition is likely related to planktivory and urban land-use.

Small cladocera are linked with productivity and lack of *D. pulicaria*.

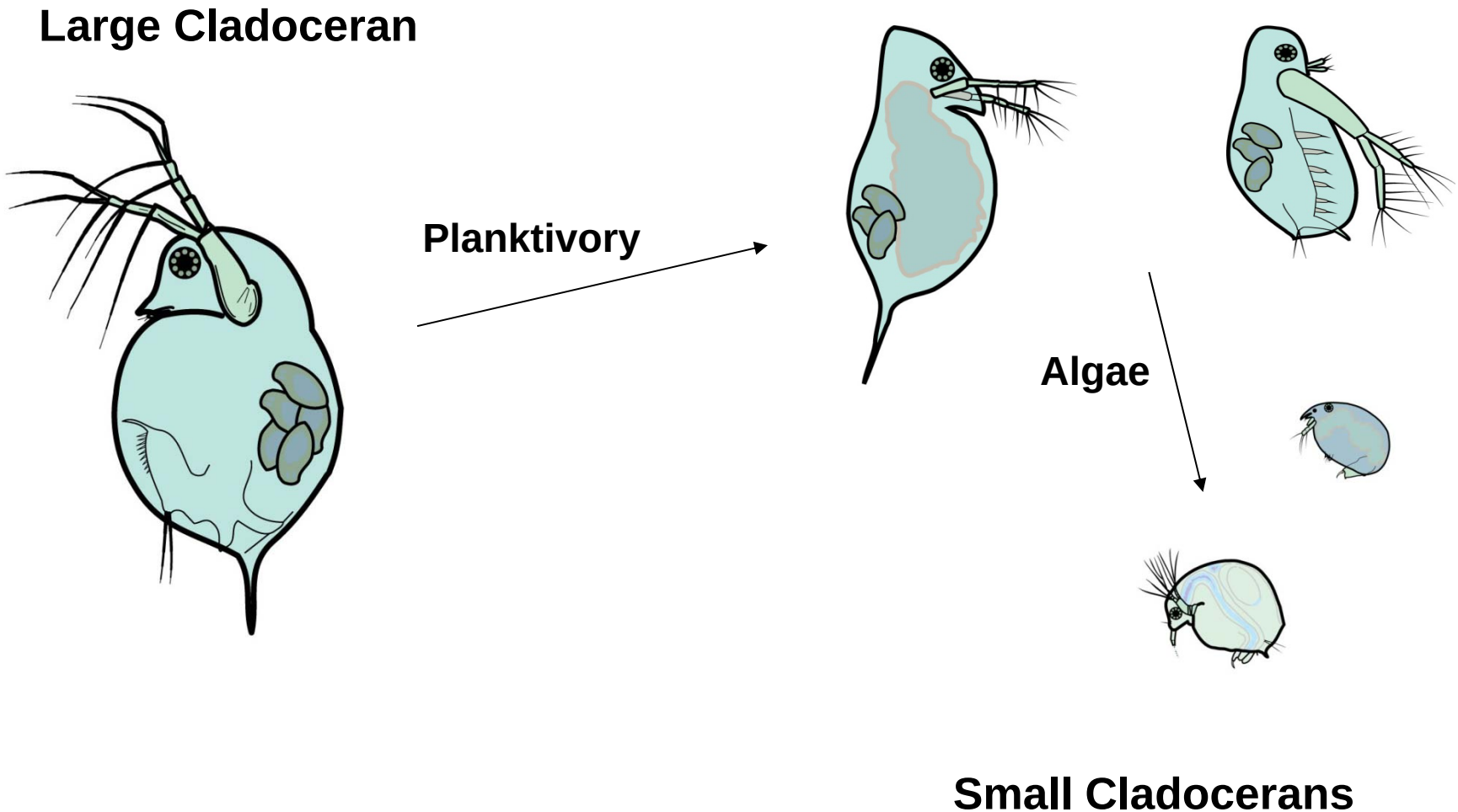


Conclusions

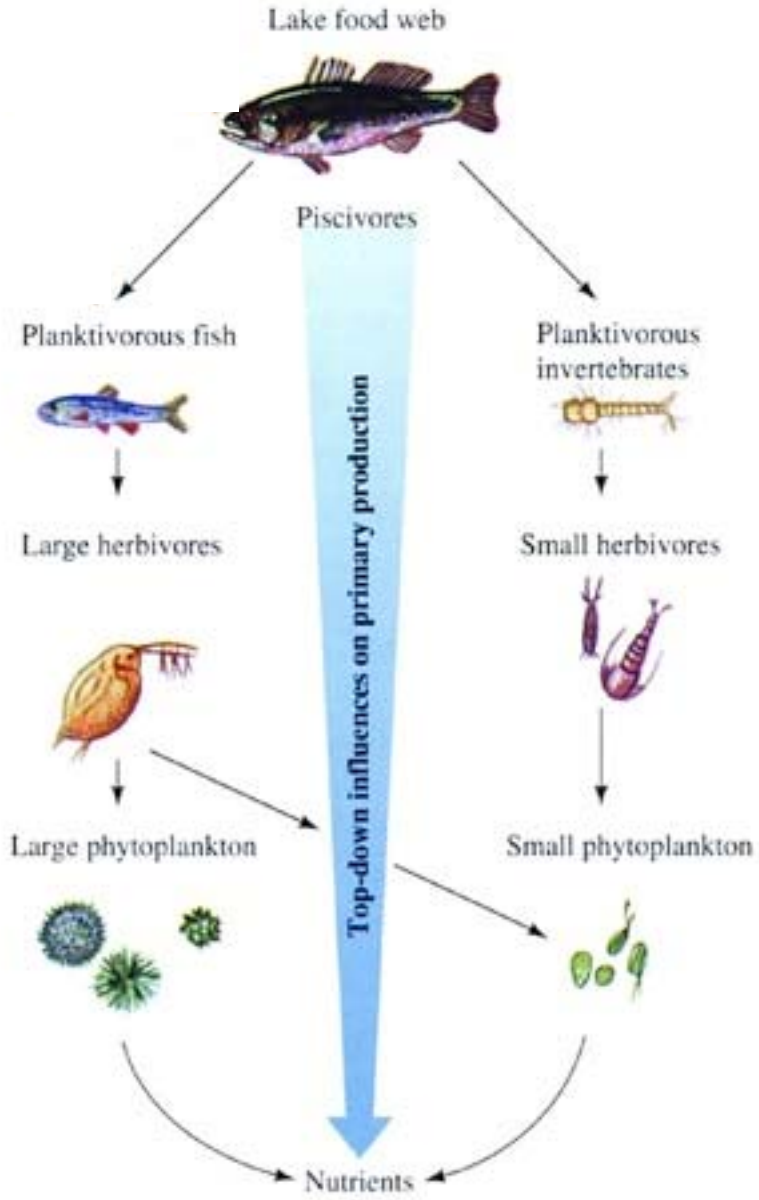
- Important to understand covariance between predictor variables.
- Larger relationship with water quality and land-use than in other regions (Dodson et al 2009, Gelinas et al 2008).
- Specialist zooplankton species may serve to assess lake ecosystems.
  - Changes in Daphnia species most likely indicate a change in planktivory.
  - Changes in dominant calanoid copepod or small cladoceran community indicate an increase in nutrient concentrations.

Implications for Lake Assessment and Management

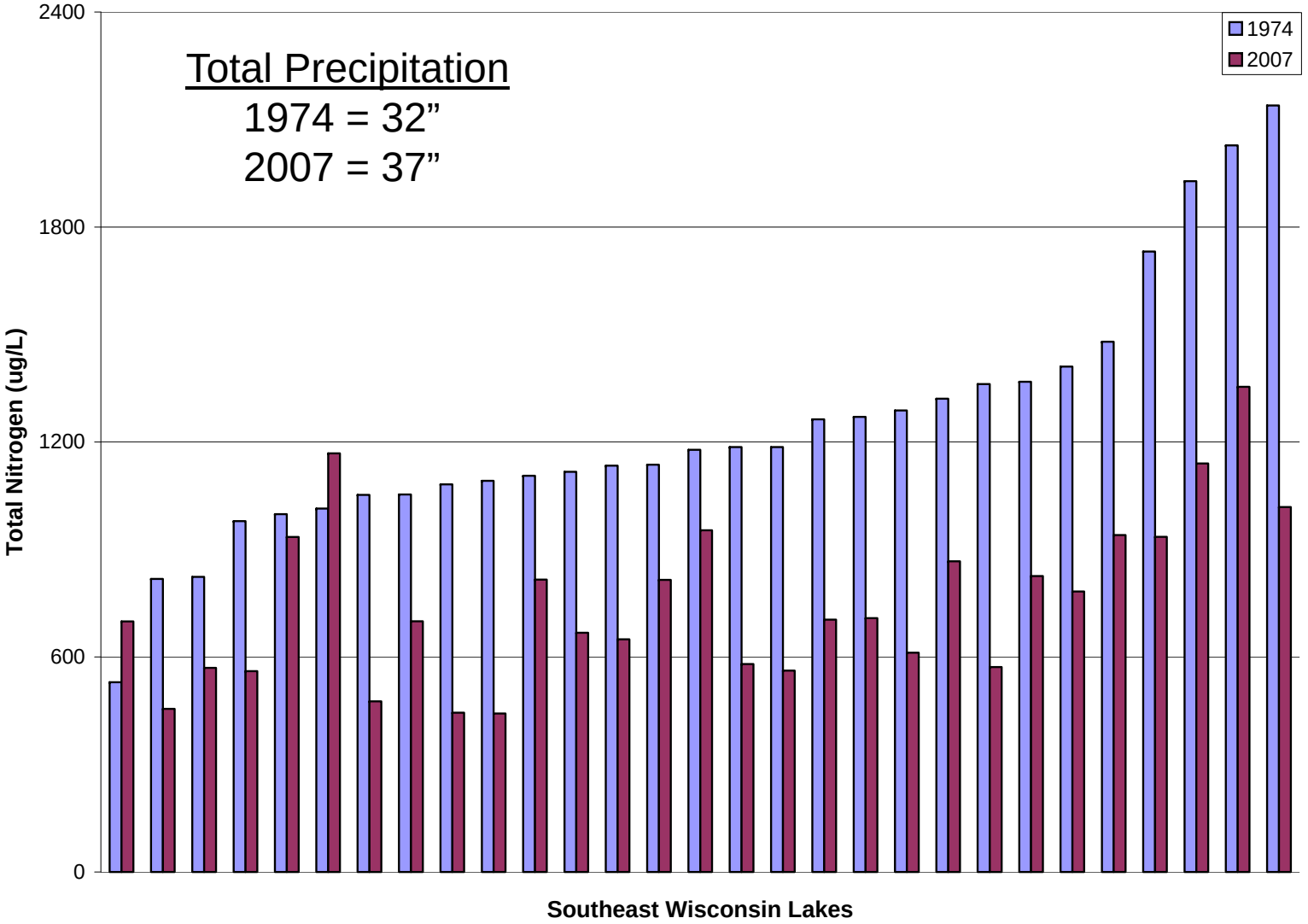
Cladoceran community is correlated with trophic state.



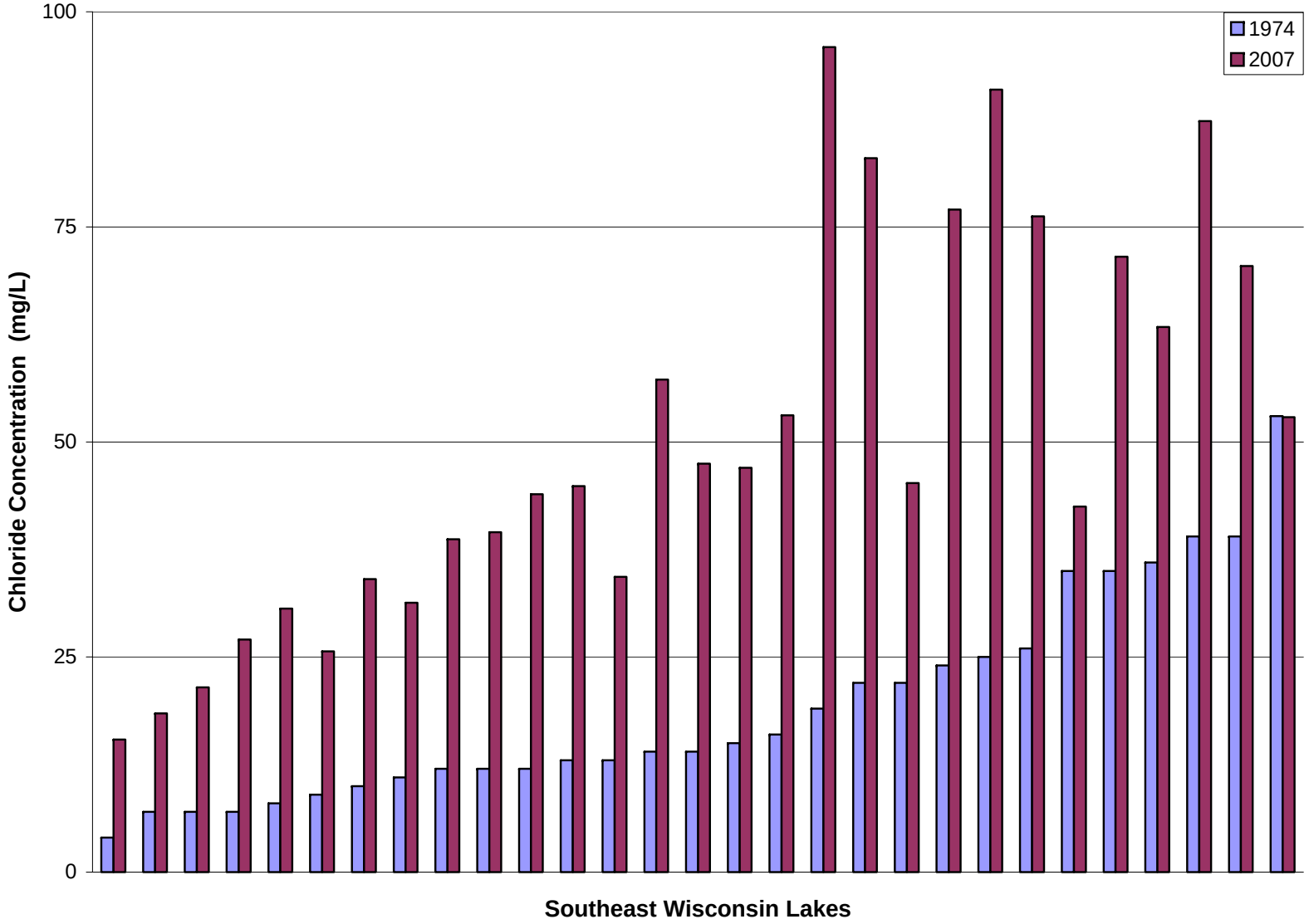
Relationships with Water Quality



Lake nitrogen levels have decreased in the region.



Lake chloride concentrations have risen dramatically.



Land-use affects water quality

- An environmental gradient representing summer total phosphorus and chlorophyll-*a* was positively correlated with watershed agriculture and urban land-use in the buffer zone, while negatively related to watershed natural land.
- Chloride concentration is positively correlated with transportation and negatively correlated with forest.

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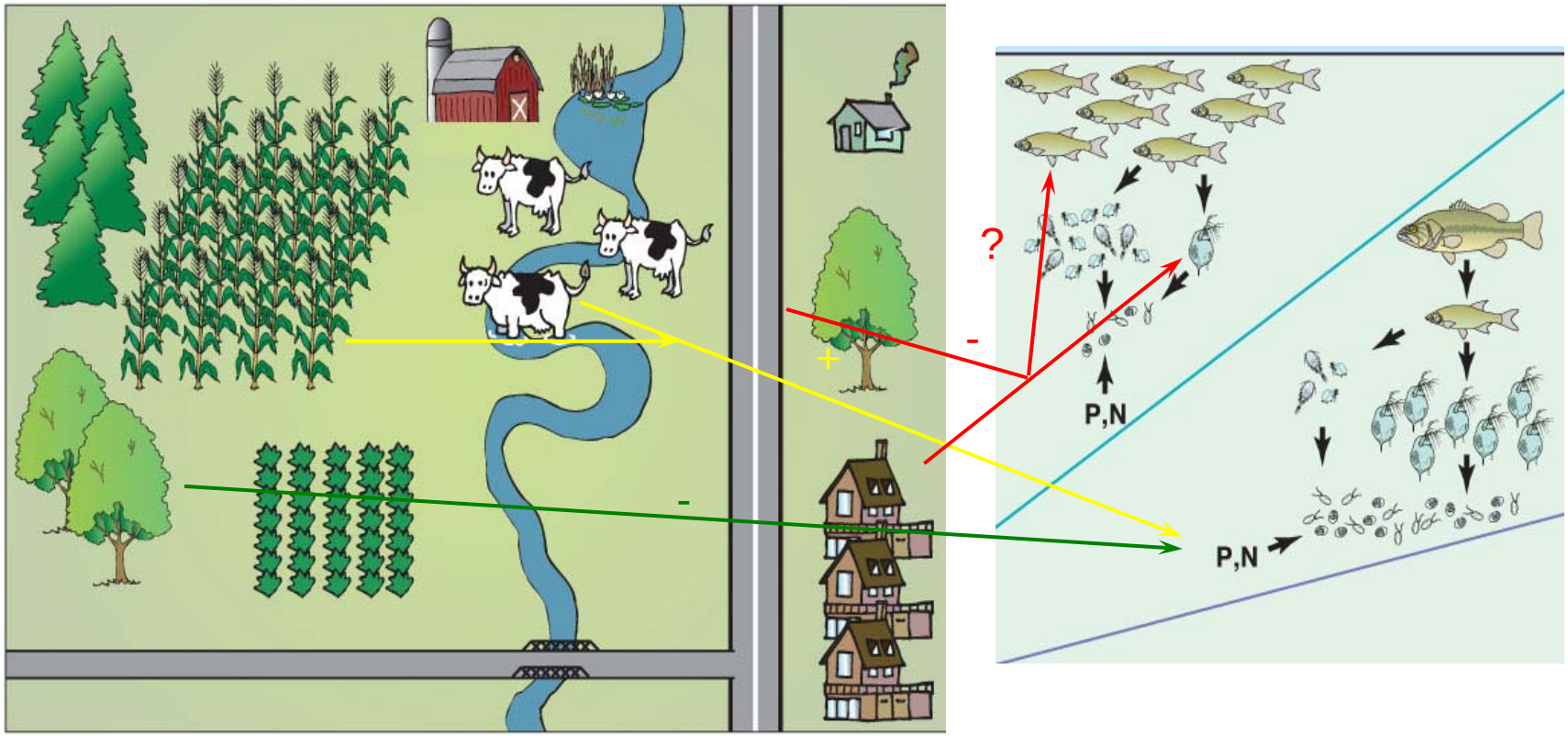
Land-use has cascading effects on aquatic community structure



Slide 31

sve1 scott van egeren, 05/13/2009

Acknowledgements

Dr. Stanley Dodson

Southeast Wisconsin Regional Planning Commission

Ashley Derr

Eric Moody

Heather Kreft

James Thoyre

Math Heinzel

Sarah Foltz

Katie Lee

Sara Jelen

Bill Feeny

Jeff Maxted

Questions?