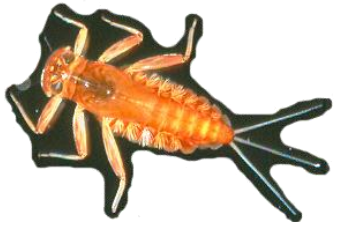
Invertebrate Biotic Integrity and Watershed Condition of Headwaters



N.H. Troelstrup, Jr., R.W. Vander Vorste, E. Rasmussen

Department of Natural Resource Management

South Dakota State University

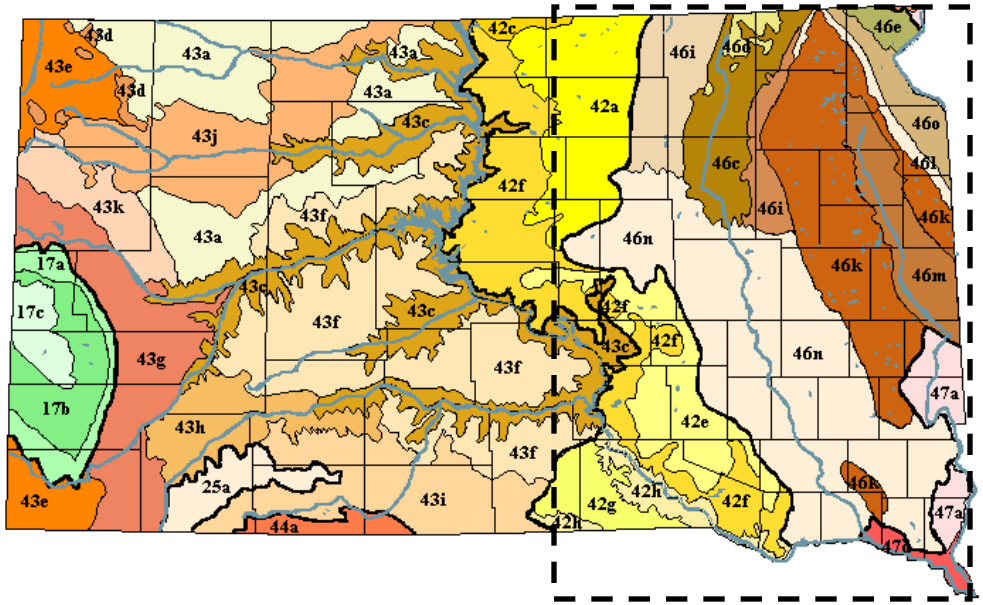
Importance of Headwaters

- Stream management generally focuses on larger perennial streams
- Headwaters comprise the bulk of watershed area and stream lengths for management
  - 90% of stream kilometers in South Dakota
- Headwaters contribute to downstream pollutant loads, habitat and biotic conditions
- Headwaters provide critical habitat for unique and sensitive species (e.g., *Notropis topeka*)
- Regional monitoring tools are needed to evaluate headwater condition

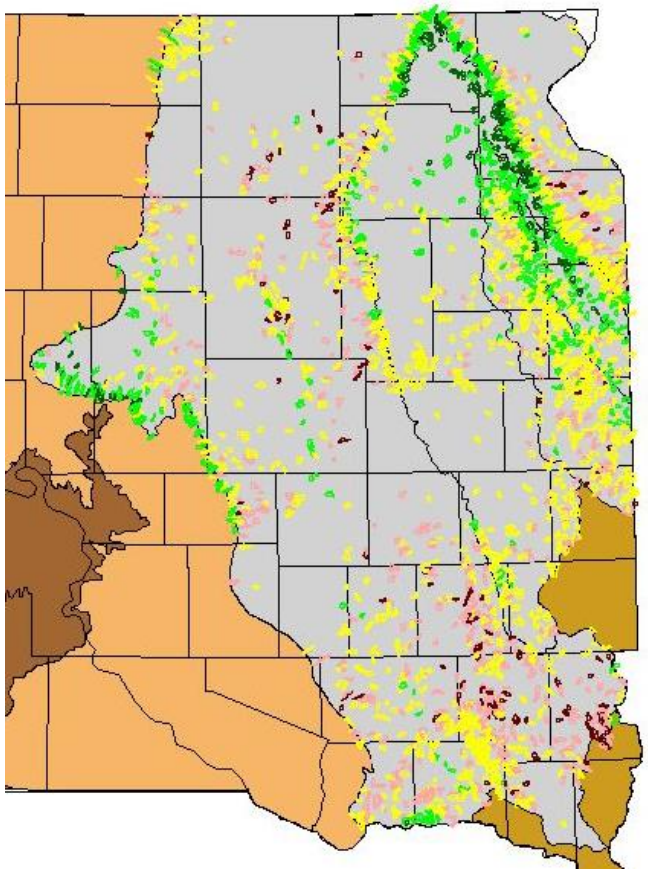
Project Objectives

- Define the composition, guild structure, diversity and pollution tolerance of headwater communities within the NGP
- Develop an invertebrate community-based IBI for headwater streams
- Determine if IBI scores vary among LIV ecoregions
- Model the relationship between the invertebrate IBI and watershed condition

Study Area



Bryce et al. (2002)



ATtILA Condition Scores (Ebert and Wade 2007)

Poor ⟷ **Excellent**

	Watershed Score Percentile Group			
Low 5%	5-25%	25-75%	75-95%	Upper 5%

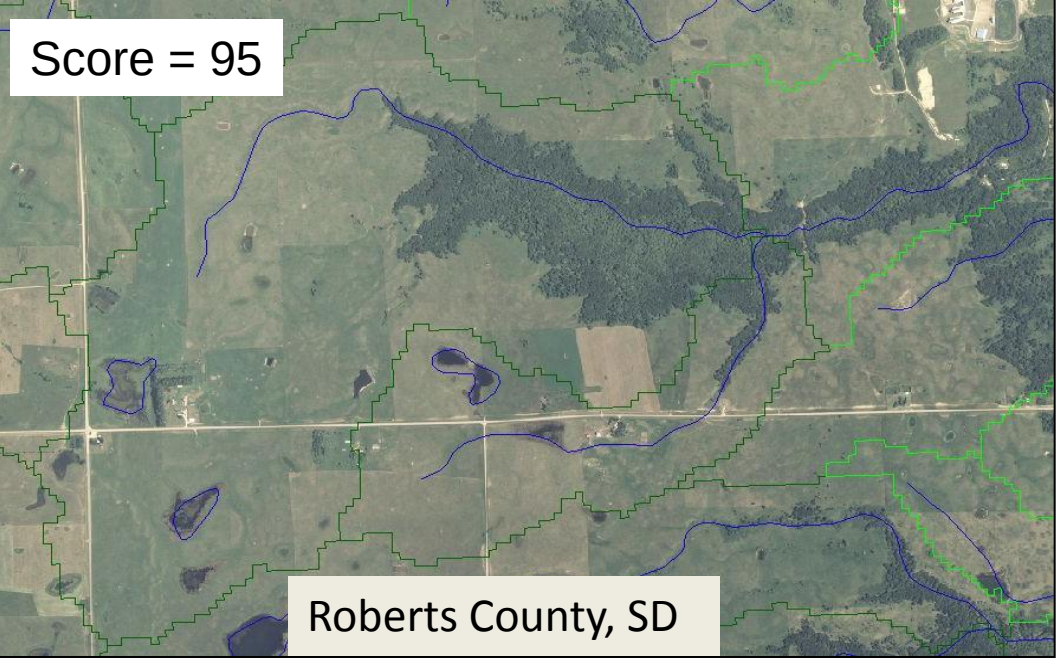
Site Selection

- Stream Selection Criteria
  - Strahler order = 1 (NHD Plus 1:100,000 scale)
  - Watershed size between 1.0 and 6.0 km^2
  - Stream is not a lake outlet
  - Intermittent flow regime
  - Well defined bed and bank features

GIS

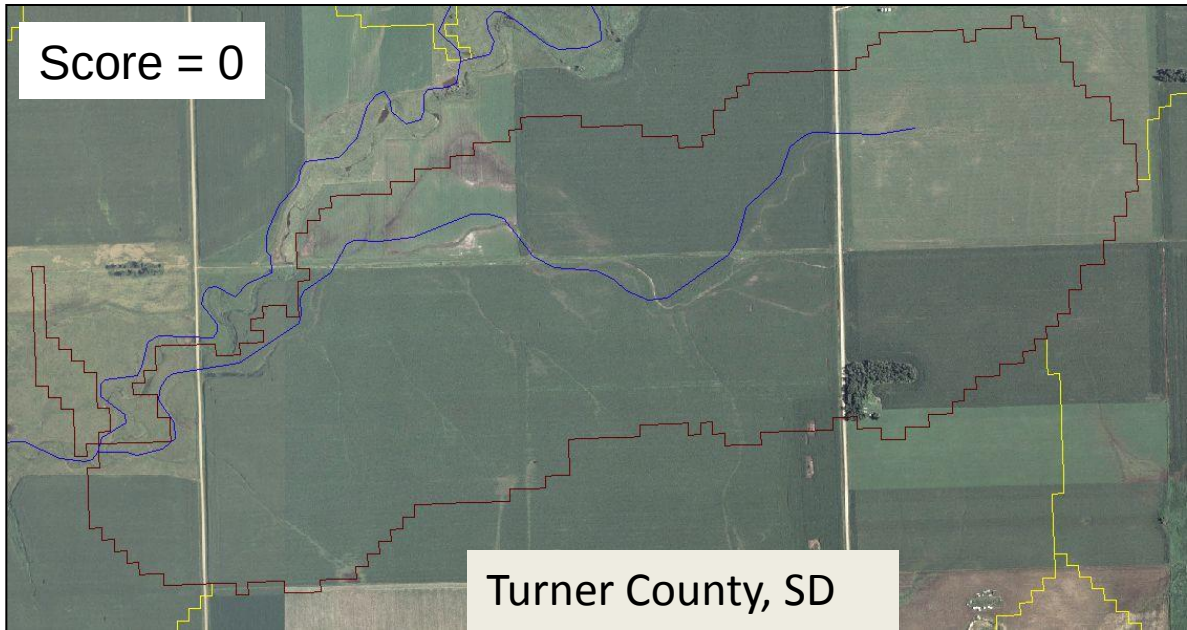
Field

- Site Classes
  - Random Sites (n=10)
    - Random within target population
  - Targeted Sites (n=5G, 5B)
    - Paired in major LIV ecoregions
  - Reference Sites (n=40)
    - Random within top 15% of each LIV



A watershed in the northern portion of the study area which scored in the upper 5th percentile of watershed condition. Note the absence of tillage and well wooded riparian zone.

A watershed in the southern portion of the study area which scored in the lowest 5th percentile of watershed condition. Note the high degree of tillage practices up to and through the channel.

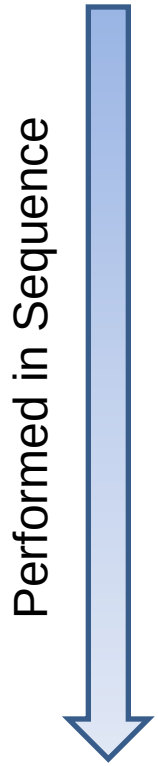


Field and Lab Methods

- Peck et al. (2006); Fritz (2006)
- Stream reach (40x channel width)
- 11 cross-section transects equally spaced
- Bucket sampler and petite net (500 um)
- Reach-wide composite sample
- Monthly (April – August) or until stream dried
- Identification generally to genus (EPA 2004)
- Voucher specimens submitted to state collection

Generation of IBI Scores

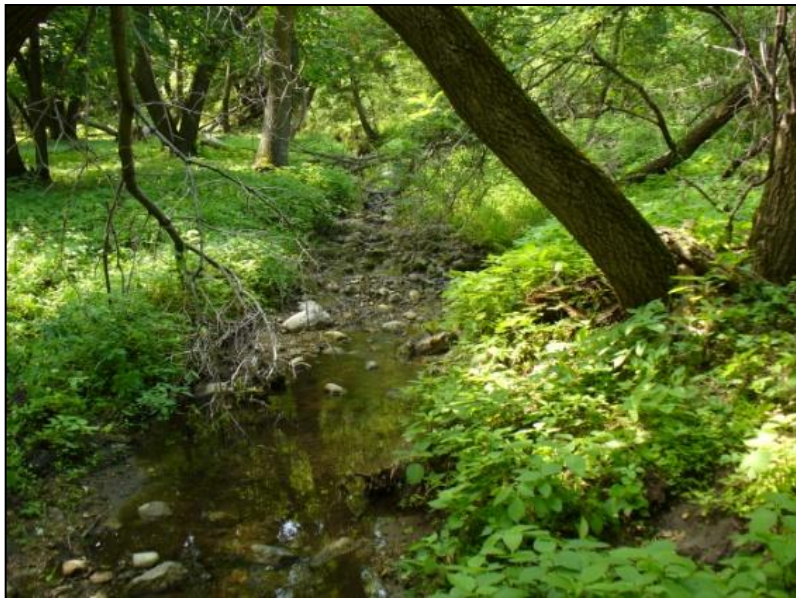
- Started with 72 metrics of community condition
- Metric screening/scoring (Whittier et al. 2007):
  - Range test – 37.5% omitted
  - Signal:noise ratio test – 2.8% omitted
  - Natural gradients test – no metrics adjusted
  - Responsiveness test – 37.5% omitted
  - Redundancy test – 13.9% omitted
  - Score range test – 2.8% omitted
  - Flow condition test – 3 of 4 metrics adjusted
- Final IBI scores linearly interpolated and rescaled to range between 0 to 100



Analysis Procedures

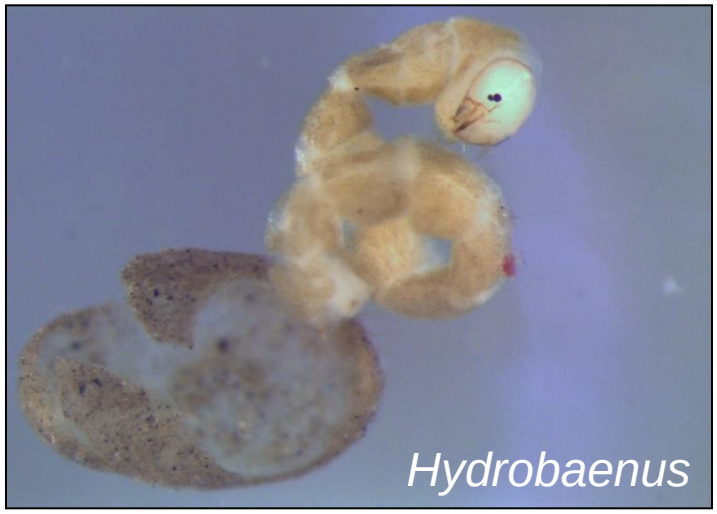
- Kruskal-Wallis ANOVA
  - Does IBI vary by LIV Ecoregion?
  - Does IBI vary by stream class?
- Linear Regression
  - What is the relationship between IBI and watershed condition scores?


Paraleptophlebia



Community Composition

Invertebrate Community Breakdown:



10 classes

- Insecta=46%
- Clitellata=21%

20 orders

- Diptera=38%
- Haplotaxida=21%

75 families

- Chironomidae=29%
- Tubificidae=11%
- Enchytraeidae=10%

199 genera

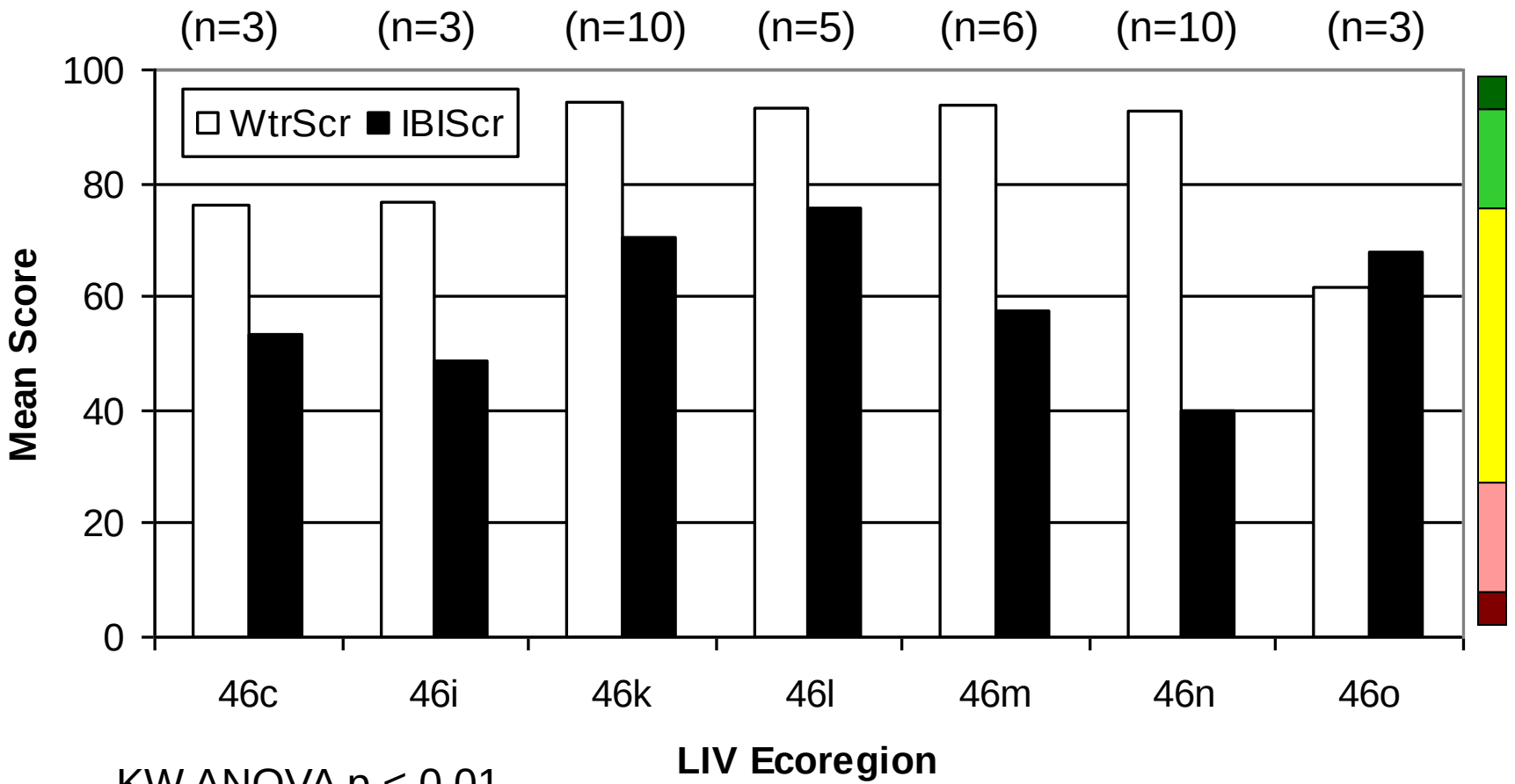
- *Aedes* (Culicidae)
- *Pseudosuccinea* (Lymnaeidae)
- *Paraleptophlebia* (Leptophlebiidae)

Invertebrate Community Characteristics

Metric	Random	Target Gd	Target Bd	Reference
Abundance	3300	2891	2698	2235
% Three Dominant	77	72	86	75
Total Richness	20	24	10	20
EPT Richness	0.8	0.6	0.0	0.7
% Shredders	2.6	1.5	3.7	2.8
% Clingers	9.9	12.7	6.2	5.7
HBI	7.3	7.6	6.9	6.8
Insecta Richness	**15**	**19**	**6**	**15**
Coleoptera Richness	**2**	**3**	**1**	**2**
Shredder Richness	**1**	**2**	**0.3**	**2**
Swimmer Richness	**3**	**4**	**2**	**3**

*Median values observed for each metric – IBI metrics shaded green

Watershed Condition by Ecoregion

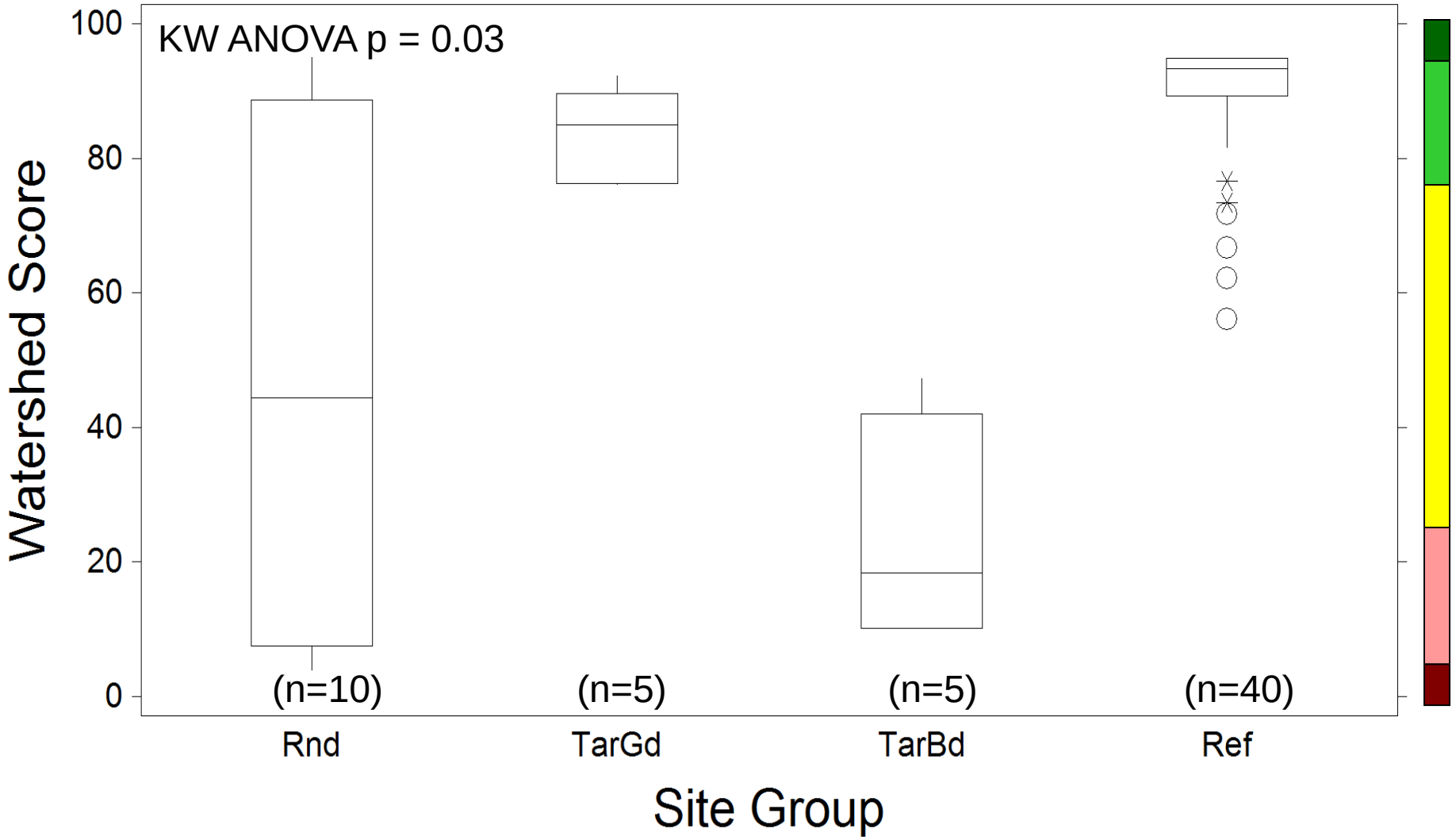


KW ANOVA $p < 0.01$

Reference Sites Only

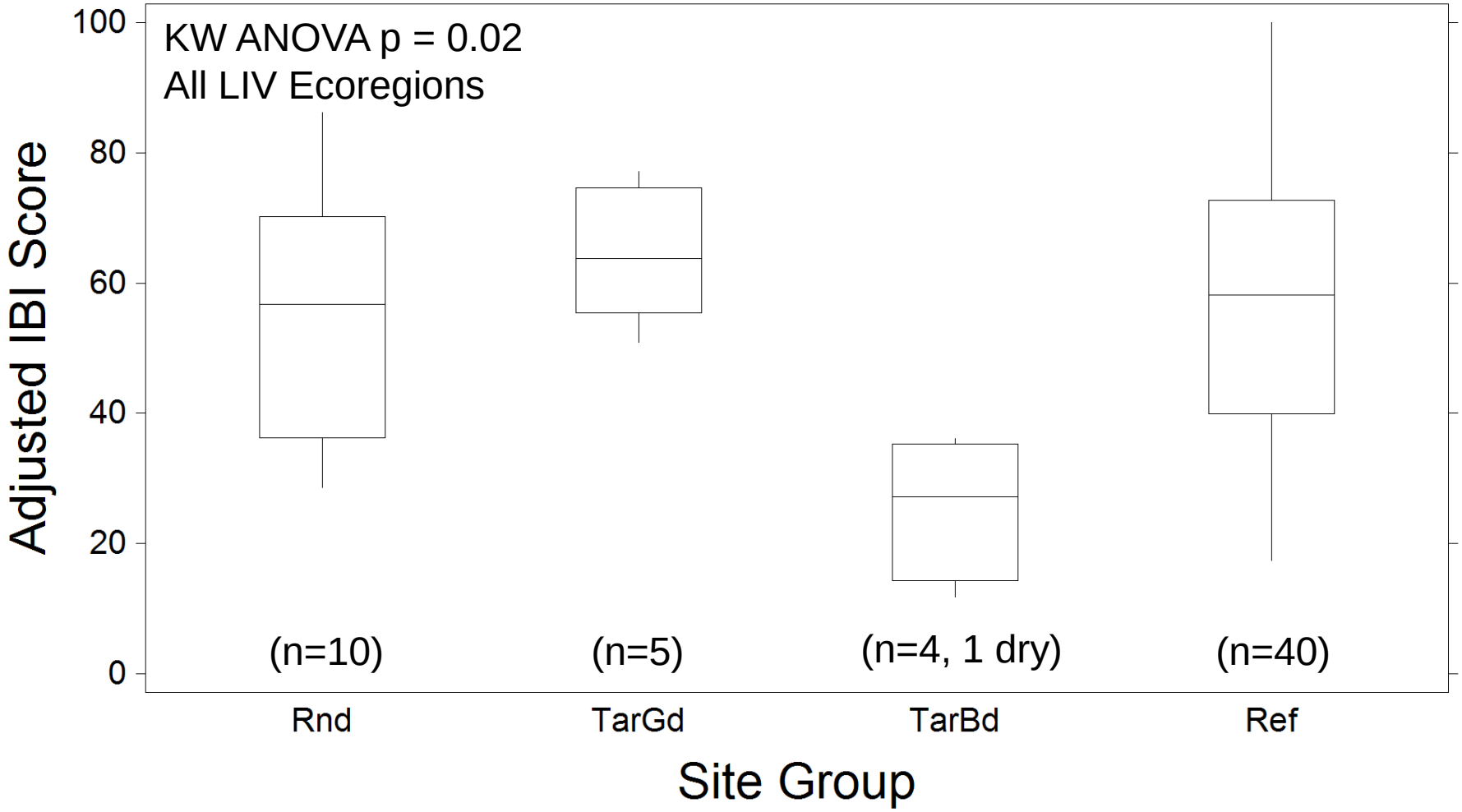
Q1: Do minimally impacted watershed/IBI scores vary by LIV ecoregion?

Watershed Condition by Stream Group



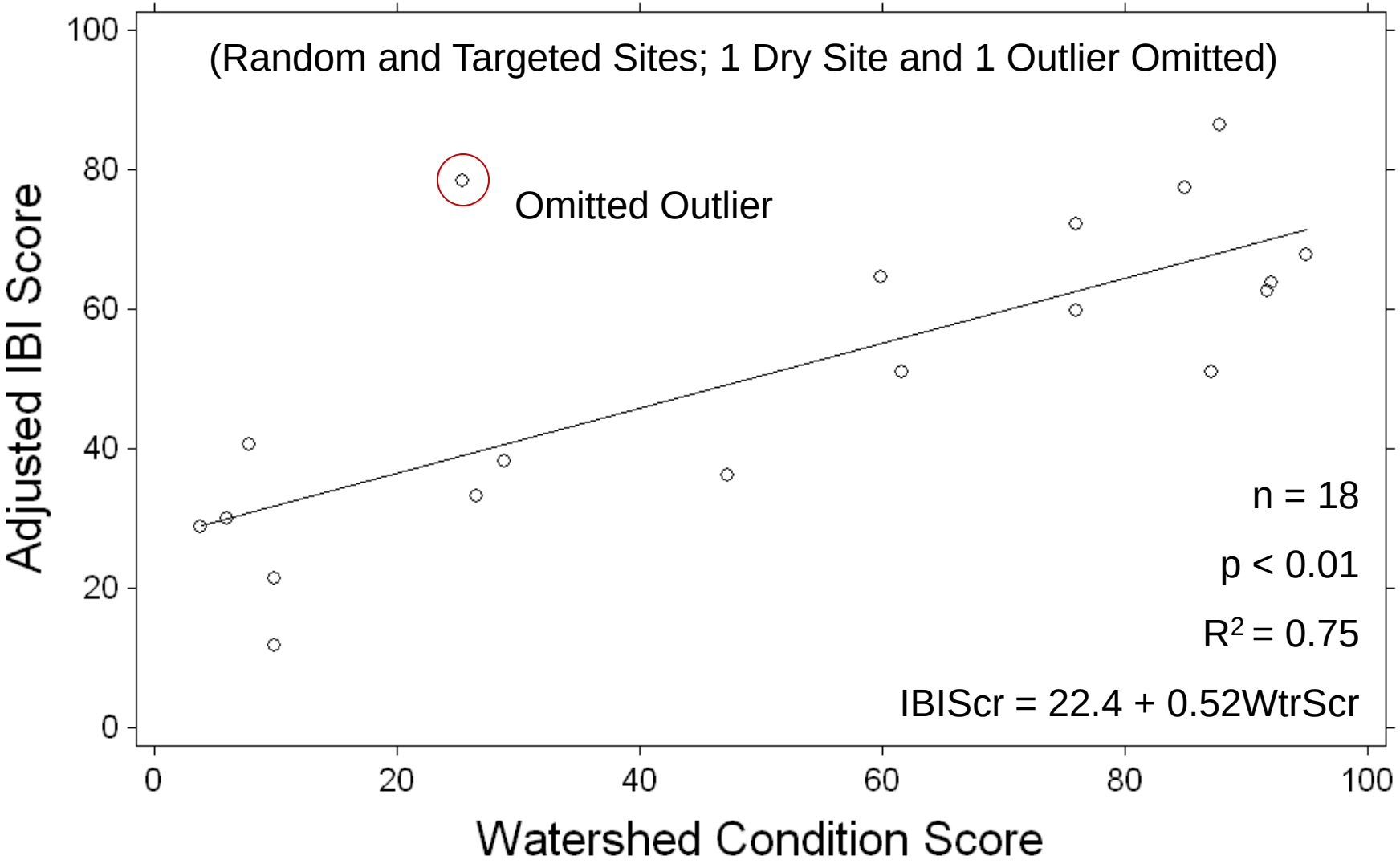
Q2: Do watershed scores differ among stream classes?

Invertebrate IBI by Stream Group



Q3: Do invertebrate IBI scores differ among stream classes?

IBI vs Watershed Condition



Q4: Do watershed scores explain significant variance in IBI scores?

Conclusions

- Invertebrate composition and guild structure of prairie headwaters are very diverse
- Most IBI metrics eliminated due to low value ranges, low responsiveness and high redundancy, leaving only a few for IBI development
- LIV ecoregion stratification appears necessary – even in Great Plains streams
- Our headwater stream IBI successfully discriminated targeted poor sites
- ATtILA watershed condition appears to be a good predictor of invertebrate IBI within the NGP

Acknowledgments

This project was supported with funding from the United States Environmental Protection Agency, South Dakota Department of Environment and Natural Resources and the South Dakota Agriculture Experiment Station. Thanks are extended to Kendall Vande Kamp, Christine Neuhart, Jake Billings, Katie Smith, Colleen Smith, Emily Johnson, Evan Washechek, Jennie Maag and Paige Turbes for assistance in the field and laboratory. Thanks are extended to the Natural Resource Conservation Service and East Dakota Water Development District for assistance in selecting targeted sites. Finally, we extend special thanks to the private landowners of the Northern Glaciated Plains ecoregion for property access and interest in our project.