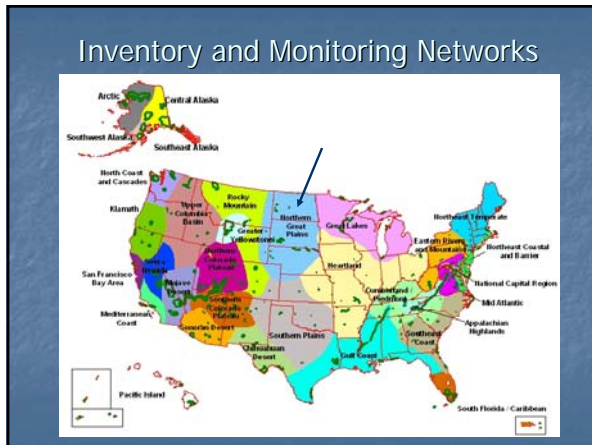
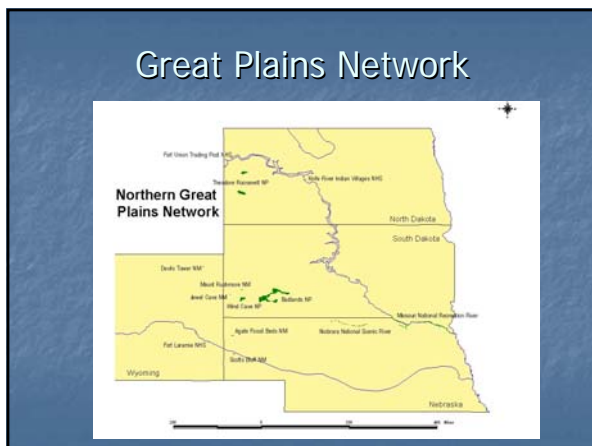




- ### Inventory and Monitoring
- Started to define natural populations in National Parks
  - Establish "Vital Signs" for each park
    - Physical, chemical, and biological
  - Macroinvertebrates ranked high as vital sign for parks
  - Ecological Health
  - Develop monitoring plan for each park



- ### Objectives
- Provide descriptions of macroinvertebrate communities within aquatic habitats of the Northern Great Plains Network
  - Estimate metrics toward development of invertebrate IBI's



- ### Sites
- 
- All 13 National Parks assessed
    - 58 sites
    - Includes 5 stock dams, 10 small- to medium-sized streams, 10 large rivers, 8 springs
      - 1-3 reaches on each system
  - Sampled 3 times June-Aug 2004 and May-June 2005

## Methods

- Modified EMAP protocols
  - Quantitative methods
- Physical, Chemical, Biological
  - Habitat Assessment
  - Chemical Analysis
  - Macroinvertebrate sweepnets
- Invertebrate sorting and analysis procedures followed EPA's Rapid Bioassessment Protocols



Chemical Parameters	Habitat Parameters	Biological Parameters
Nitrate, Ammonia, TKN	Weather	Macroinvertebrate Collection
Total Phosphorus	Flow	Fecal Coliform Bacteria
Dissolved Oxygen	Bank Slope	
Conductivity	Shoreline Vegetation	
pH	Canopy Cover	
Total Suspended Solids	Substrate Size	
Total Dissolved Solids	Embeddedness	
Alkalinity	Bank Erosion	
Turbidity	Snag Counts	

## Chemical & Physical Overview - Streams

Parameter	Mean	Min.	Max.
D.O. (mg/L)	8.7	0.2	18.4
pH	8.24	5.55	9.67
Conductivity (uS/cm)	504	62	5158
H <sub>2</sub> O Temp (°C)	16.7	9.5	26.7
Alkalinity (mg/L)	147	8	420
Turbidity (NTU)	87.8	0.1	2380
TSS (mg/L)	68	1	1418
TDS (mg/L)	454.2	40.0	3353.0
Fecal Coliforms (#/100ml)	643	<10	8500
Total Phosphorus (mg/L)	0.72	<0.25	18.80
TKN (mg/L)	0.66	<0.23	10.60
NO <sub>3</sub> (mg/L)	0.49	<0.10	2.40
NH <sub>3</sub> (mg/L)	0.017	<0.02	0.26

## Chemical and Physical Overview - Rivers

Parameter	Mean	Min.	Max.
D.O. (mg/L)	9.2	5.7	14.3
pH	8.26	7.52	9.42
Conductivity (uS/cm)	823	167	1861
H <sub>2</sub> O Temp (°C)	20.7	11.7	29.2
Alkalinity (mg/L)	181	42	620
Turbidity (NTU)	1998	1.43	116000
TSS (mg/L)	59	1	534
TDS (mg/L)	533	19	1517
Fecal coliforms (#/100mL)	184	<10	2300
Total Phosphorus (mg/L)	0.30	<0.25	4.65
TKN (mg/L)	0.78	<0.23	8.90
NO <sub>2</sub> (mg/L)	0.66	<0.10	3.70
NH <sub>3</sub> (mg/L)	0.02	<0.02	0.13

## Chemical and Physical Overview - Springs

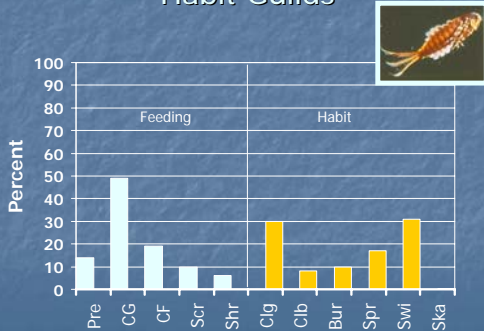
Parameter	Mean	Min.	Max.
D.O. (mg/L)	9.0	5.3	13.8
pH	7.61	6.88	9.02
Conductivity (uS/cm)	1098	175	2926
H <sub>2</sub> O Temp (°C)	11.9	7.2	17.0
Alkalinity (mg/L)	242	5	570
Turbidity (NTU)	37	0.34	346
TSS (mg/L)	47	1	185
TDS (mg/L)	765.6	160.0	2635.0
Fecal coliforms (#/100mL)	6050	<10	160000
Total Phosphorus (mg/L)	0.113	<0.25	0.855
TKN (mg/L)	0.285	<0.23	0.770
NO <sub>3</sub> (mg/L)	1.48	<0.10	3.00
NH <sub>3</sub> (mg/L)	0.020	<0.02	0.020

## Chemical and Physical Overview – Stock Ponds

Parameter	Mean	Min.	Max.
D.O. (mg/L)	7.8	0.7	14.3
pH	8.02	6.56	10.02
Conductivity (uS/cm)	848	115	3246
H <sub>2</sub> O Temp (°C)	26.5	15.3	19.6
Alkalinity (mg/L)	115	48	416
Turbidity (NTU)	161.2	5.6	586.0
TSS (mg/L)	94.28	5.20	228.00
TDS (mg/L)	796.5	56.00	3051.0
Fecal coliforms (#/100mL)	179	<10	810
Total Phosphorus (mg/L)	0.60	<0.25	1.67
TKN (mg/L)	3.73	<0.23	25.20
NO <sub>3</sub> (mg/L)	0.82	<0.10	5.90
NH <sub>3</sub> (mg/L)	0.11	<0.02	0.30



### % Stream Functional Feeding and Habit Guilds



### Large River Metrics

Metric	Min.	Max.	Mean	Total
Richness	1	25	9	168
Abundance	1	8303	92	25312
% Dominant	29	100	50	
% EPT	0	100	31	
% Chir Taxa	0	100	30	
<b>Tolerance</b>	<b>0</b>	<b>10</b>	<b>5</b>	



### % River Functional Feeding and Habit Guilds

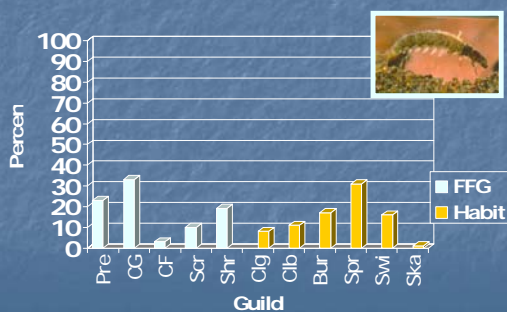


### Spring Metrics

Metric	Min.	Max.	Median	Total
Richness	1	9	4	74
Abundance	2	344	39	902
% Dominant	23	100	55	
% EPT	0	97	30	
% Chir Taxa	0	100	20	
<b>Tolerance</b>	<b>1</b>	<b>10</b>	<b>5</b>	

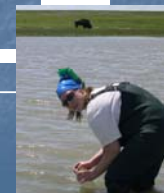


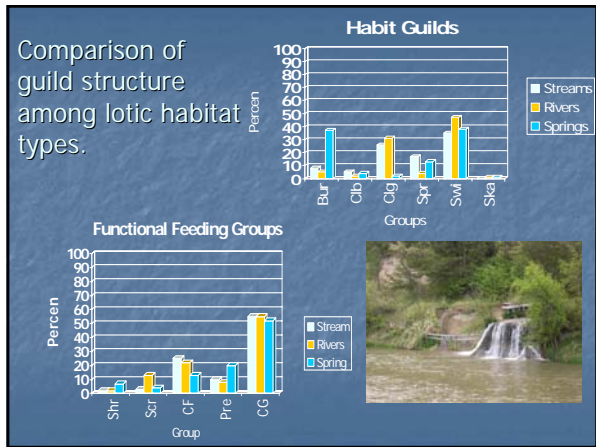
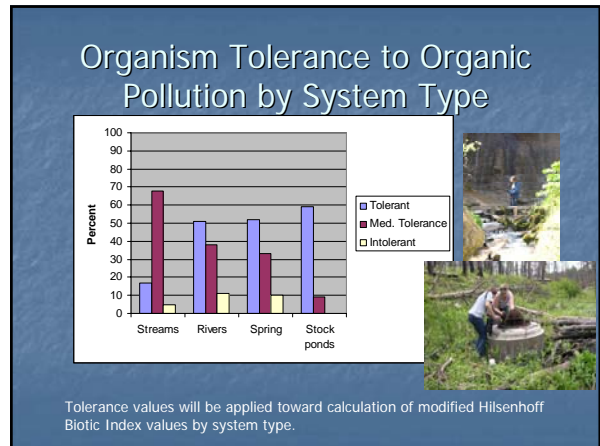
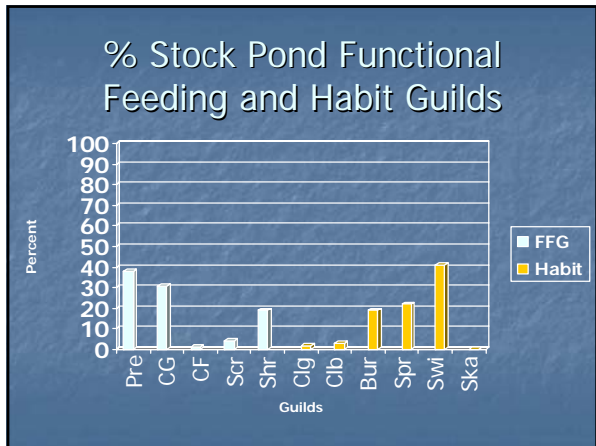
### % Spring Functional Feeding and Habit Guilds



### Stock Pond Metrics

Metric	Min.	Max.	Mean	Total
Richness	0	11	7	52
Abundance	0	1166	153	
% Dominance	28	67	46	
% Ephemeroptera	0	55	13	
% Chir Taxa	0	44	21	
<b>Tolerance</b>	<b>4</b>	<b>10</b>	<b>6</b>	

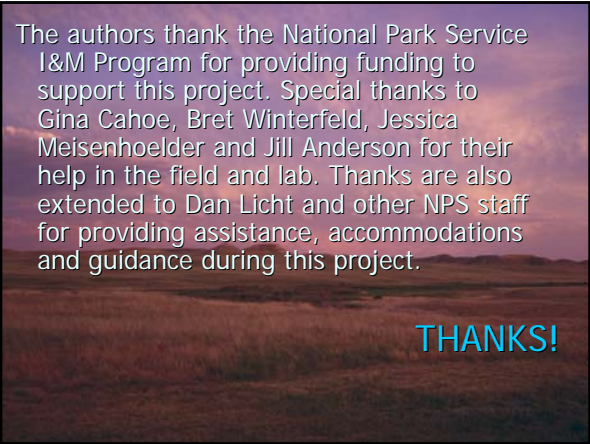




- ### Conclusions
- Diverse systems with rare taxa
    - 309 genera and species found
    - 80% of genera and species in <10% of samples
  - Feeding guilds and River Continuum Concept
    - Low Scrapers and Shredders
      - Riparian Condition? – lower amount of CPOM
    - High Collectors
      - CF – Suspended FPOM
      - CG – Depositional FPOM
  - Habit Guilds
    - Swimmers high
      - Stock Ponds – *Neoplea sp.* and *Hyallella azteca* – 60%
    - Clingers
      - Rivers and Streams

- ### Conclusions
- National Parks could be considered one of the least human impacted areas in the regions where they are found
    - Regional reference conditions?
  - Macroinvertebrates ranked in the top ten of 120 vital signs considered by park staff, state, federal agencies, and academic institutions
  - Macroinvertebrate monitoring by parks would contribute data for several partners

- ### Conclusions
- Next steps include:
    - Metric optimization
      - High discriminatory power
      - Low within park variability
    - Generation of IBI values
  - Long-term monitoring using optimized metrics by park and system type



The authors thank the National Park Service I&M Program for providing funding to support this project. Special thanks to Gina Cahoe, Bret Winterfeld, Jessica Meisenhoelder and Jill Anderson for their help in the field and lab. Thanks are also extended to Dan Licht and other NPS staff for providing assistance, accommodations and guidance during this project.

**THANKS!**