Macroinvertebrate Communities in Lake and Wetlands in the Nebraska Sandhills



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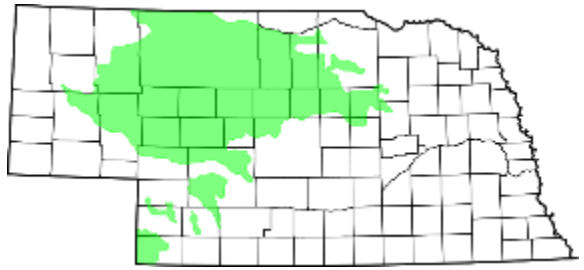
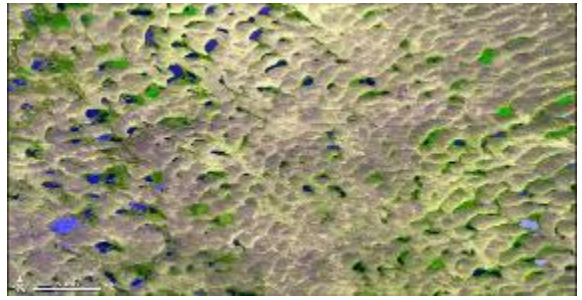
Nebraska Sandhills

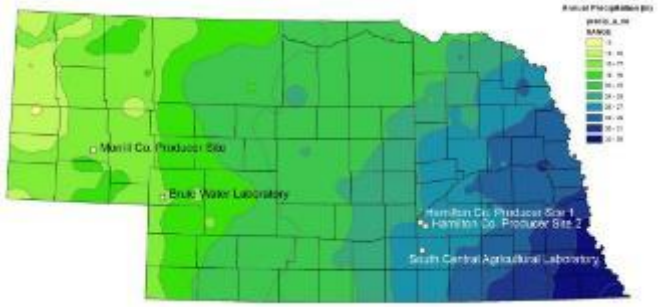
- Largest grass-stabilized dune system in the western hemisphere



- ~4000 km^2 of groundwater-fed wetland habitat and thousands of permanent and semi-permanent aquatic habitats



- Transitions from semi-arid climate in the west to mesic climate in the east



- Importance ecological resource

Biologically Unique Landscapes

- Sandhills Aklaline Lakes
- Cherry County Wetlands
- Dismal River Headwaters
- Elkhorn River Headwaters

Overall Project Objectives

- Characterize the ecological condition of Sandhill wetlands
- Determine the effects of invasive carp in sandhill wetlands and lakes
- Focus on macroinvertebrates

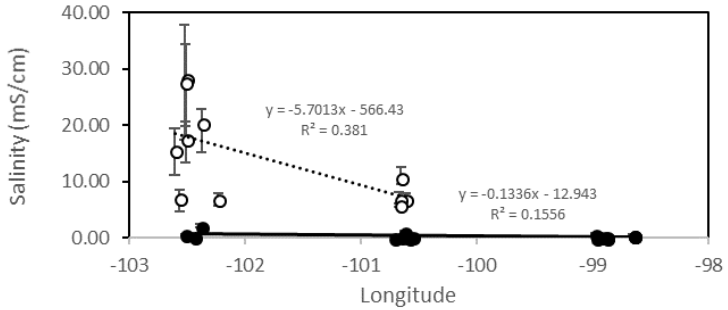
Macroinvertebrates

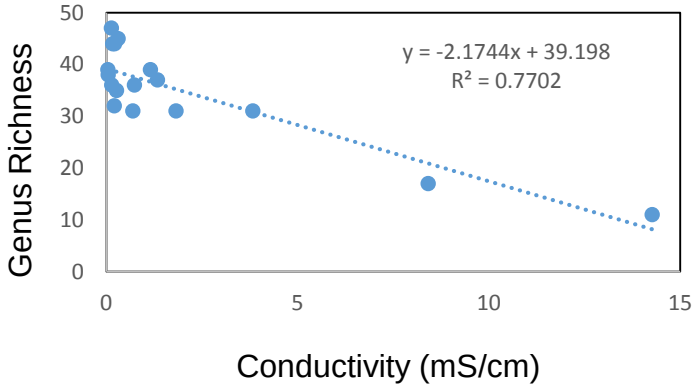
- Often used in bioassessment studies
- Respond to environmental change
- Influence ecosystem function

- Provide important nutritional resources for waterbirds

Project Objectives

- Characterize the ecological condition of Sandhill wetlands



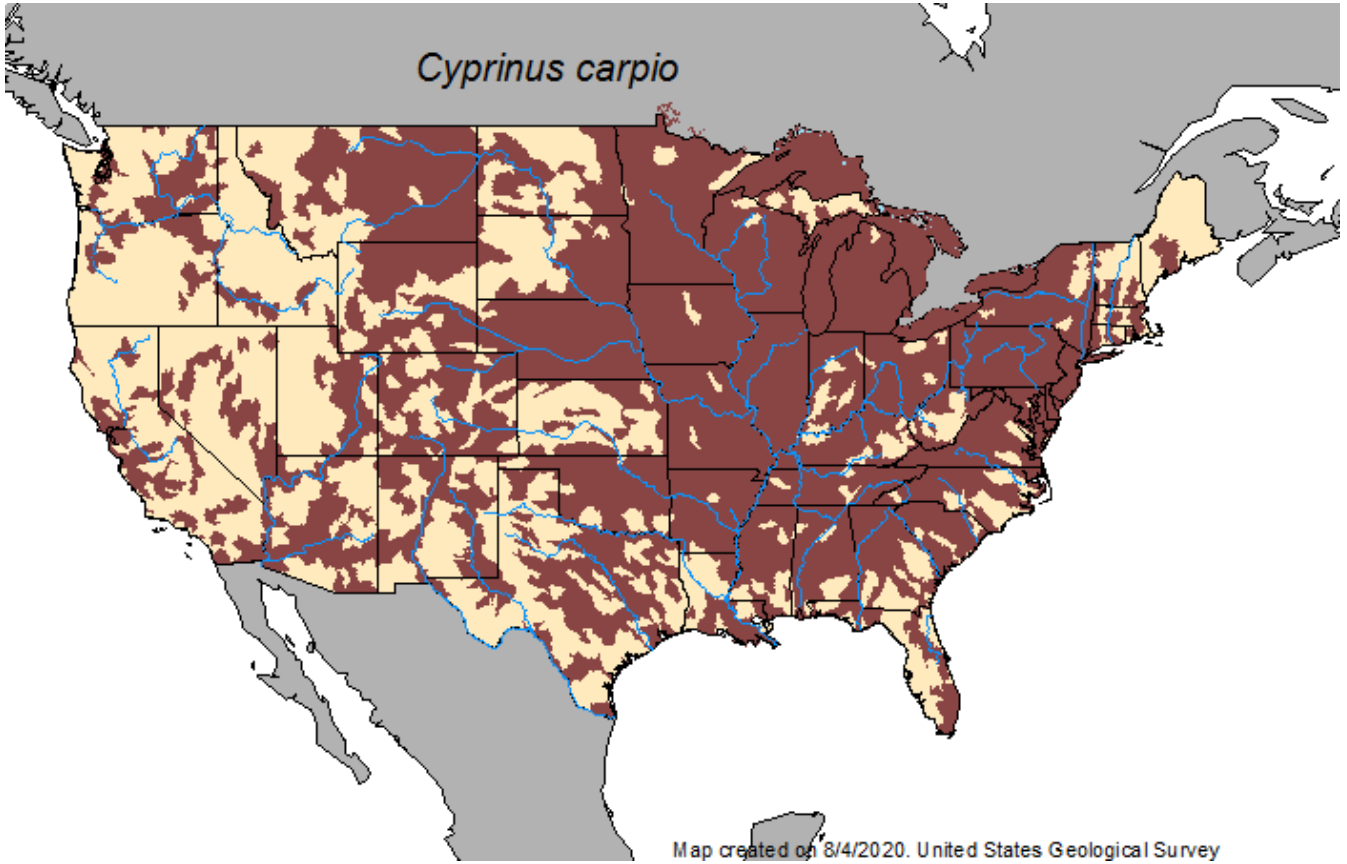


Overall Project Objectives

- Determine the effects of invasive carp in sandhill wetlands and lakes

Common Carp *Cyprinus carpio*

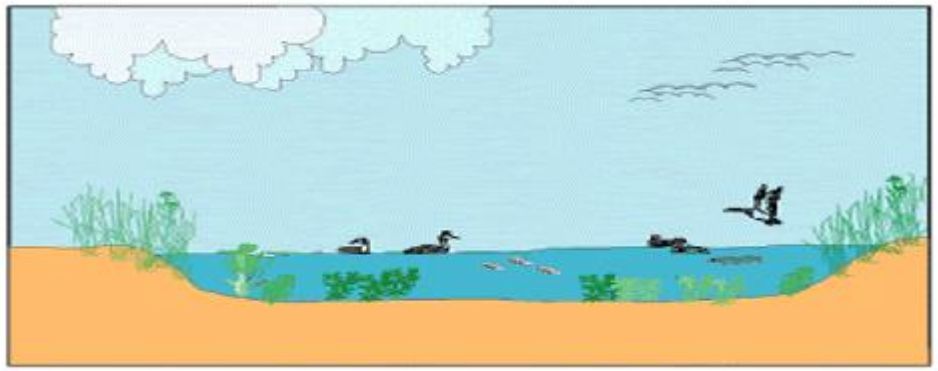
- Native to eastern Europe and Asia
- One of the most widely distributed fish species in the world
- Introduced in 1877 by U.S. Fis Commission as food source
- Fast growth, maturation, and reproduction
- Ecosystem engineers



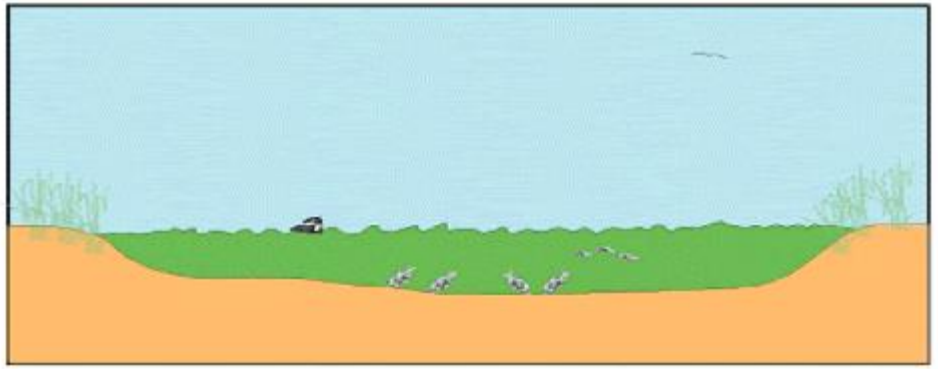
Impact of Carp on Shallow Lakes

Carp have the potential to alter the stable state of aquatic systems:

1. **Clear water state:**



2. **Turbid state:**



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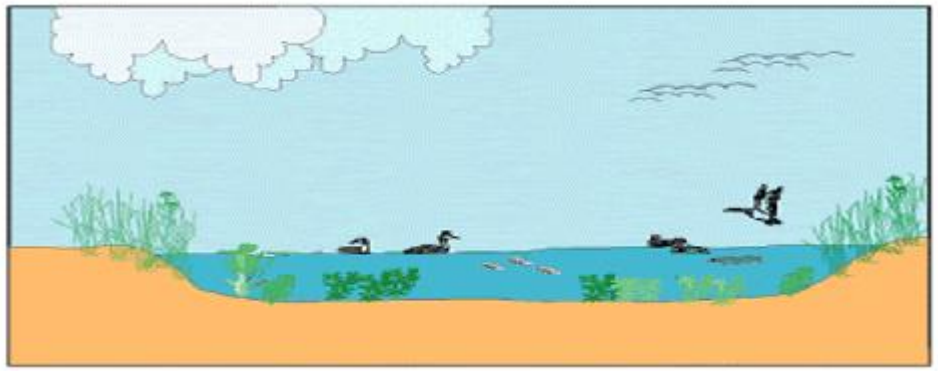
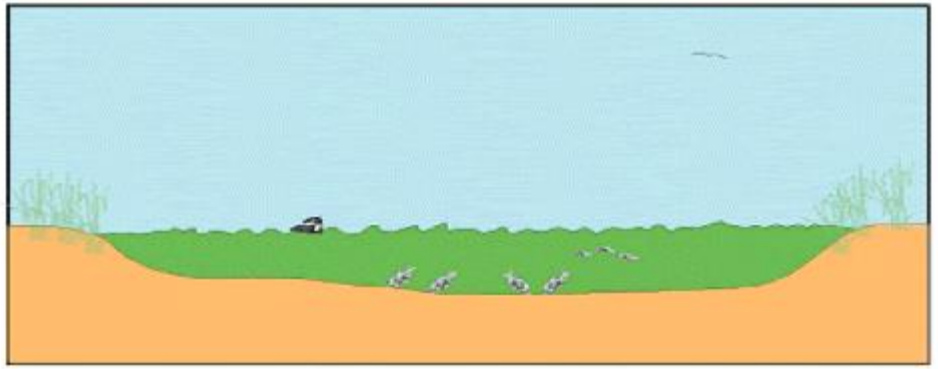


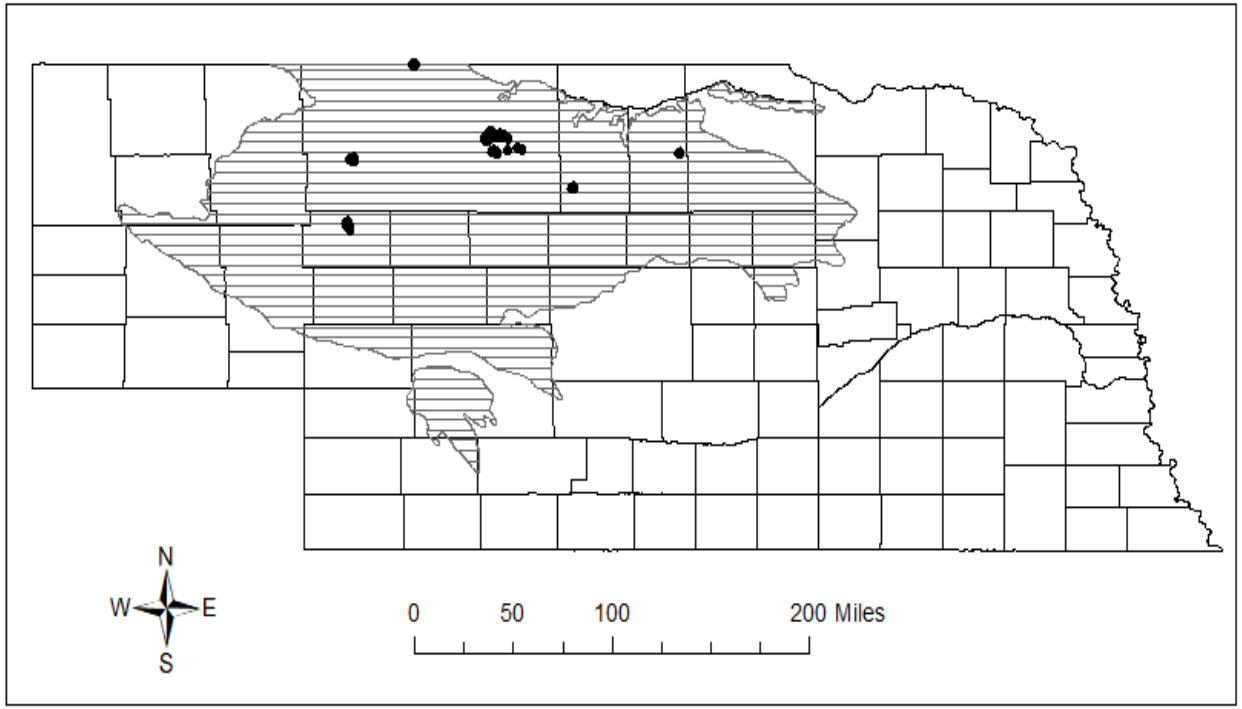
- Clear
- Dense vegetation
- Low nutrients and chl
- High macroinvertebrate richness and abundances

2. **Turbid state:**

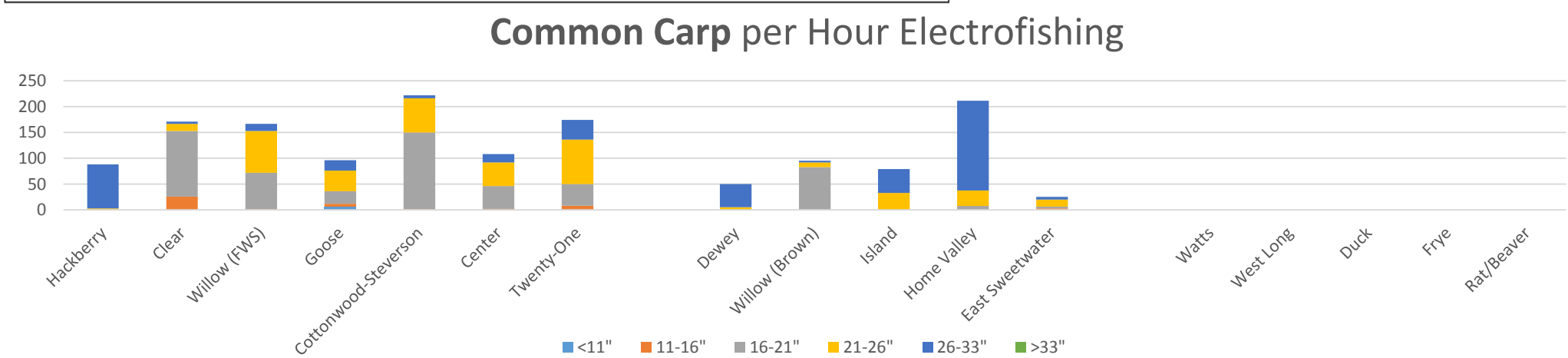


- Turbid
- Sparse vegetation
- High nutrients and chl
- Low macroinvertebrate richness and abundances

Sample Lakes



10 Lakes = No Carp
3 Lake – “Mid” Carp
8 Lakes – “High” Carp
*Sites selected by Nebraska Game and Parks (NGP)



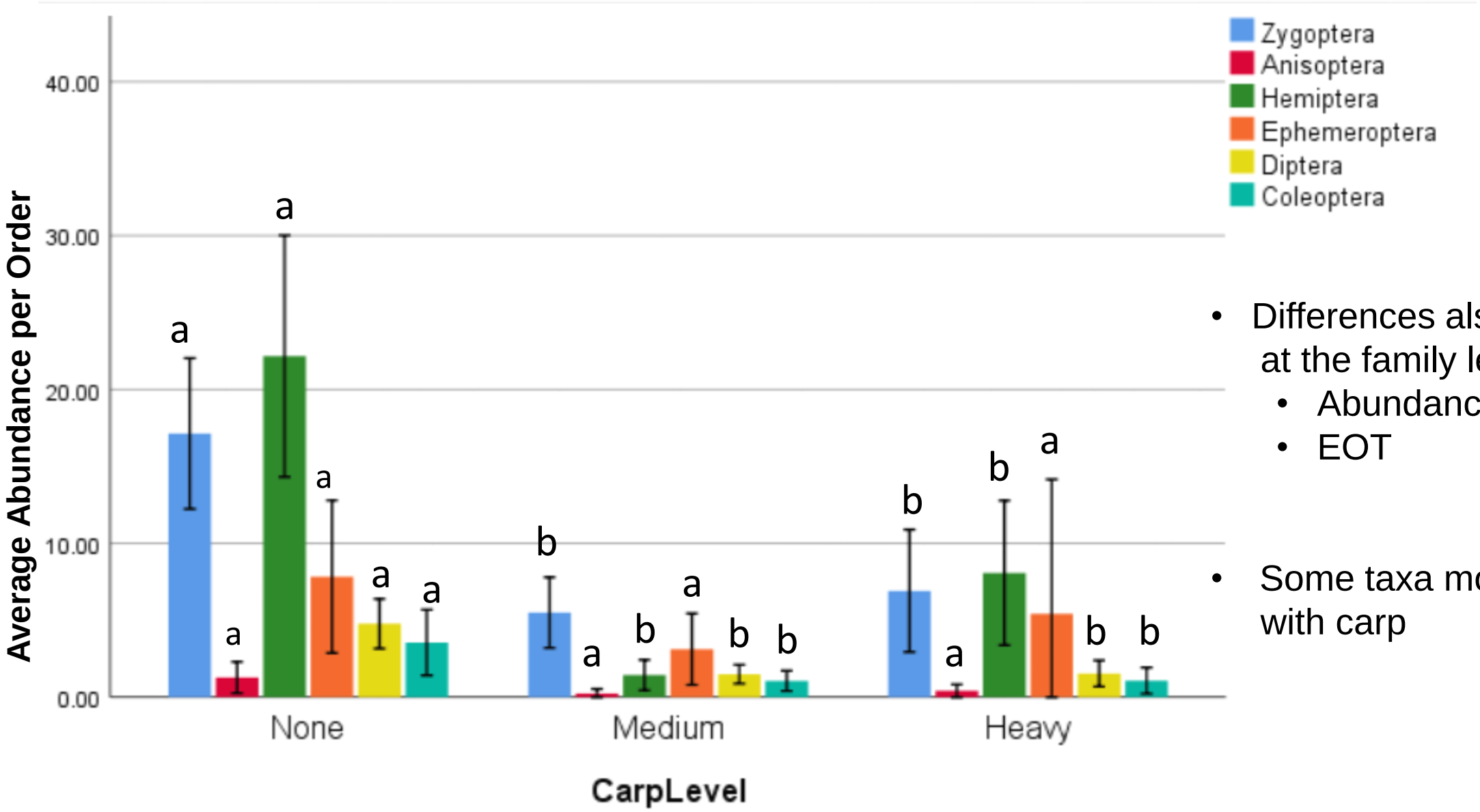
Data Collection

- Macroinvertebrates
  - Littoral
  - Benthic
- Vegetation
- Water quality
  - Turbidity
  - Salinity
  - Phosphorus
  - Chlorophyll a

- **>14,500 Macroinvertebrates collected**
- **>10,000 Littoral**
- **>4,000 Benthic**

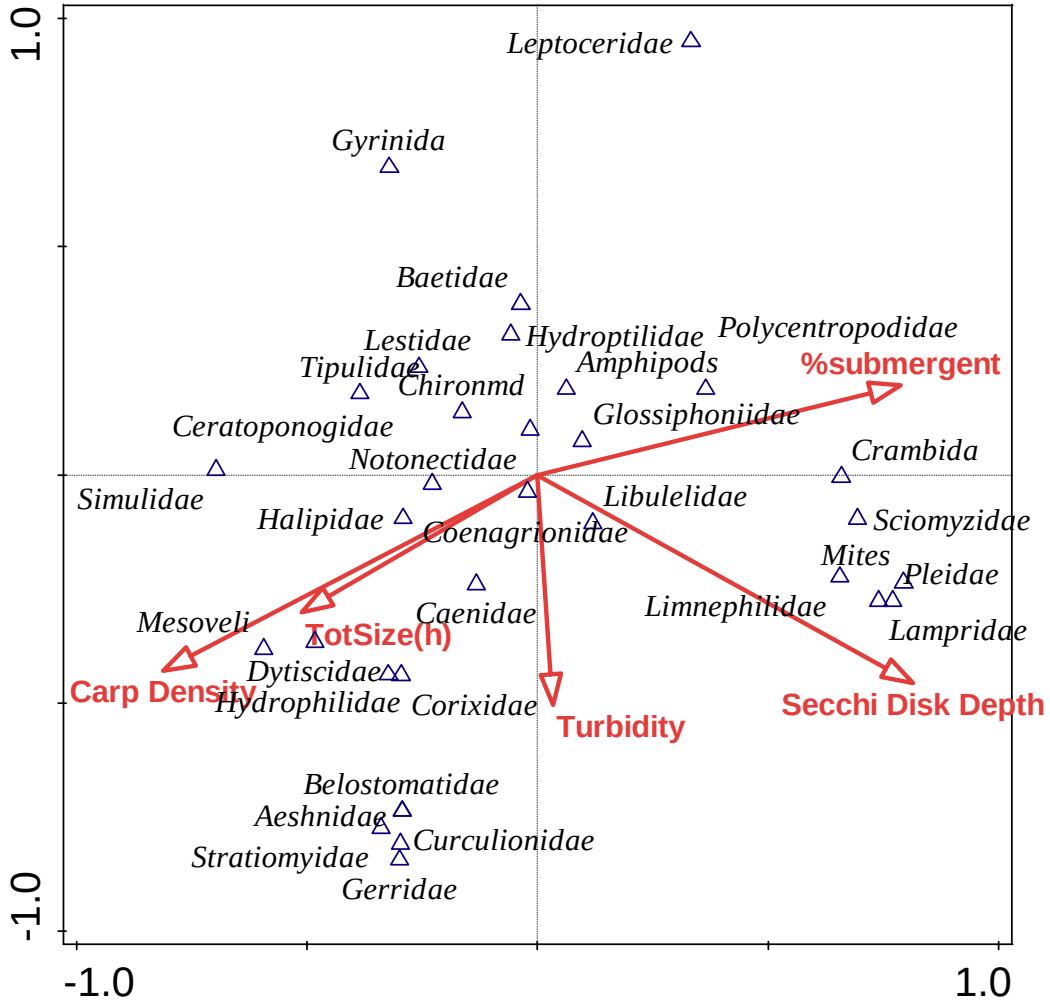
- **44 Families**
- **42 littoral**
- **22 benthic**

Effects of Carp on Macorinvertebrates



- Differences also observed at the family level
  - Abundance
  - EOT
- Some taxa more abundant with carp

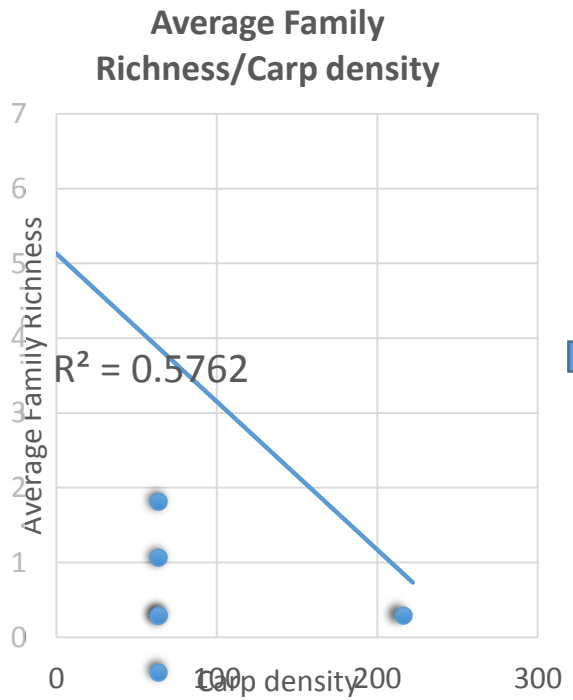
Effects of Carp on Macorinvertebrate Community Structure



- Carp Density
- Secchi Disk
- Submerged vegetation
- Total Size
- Turbidity

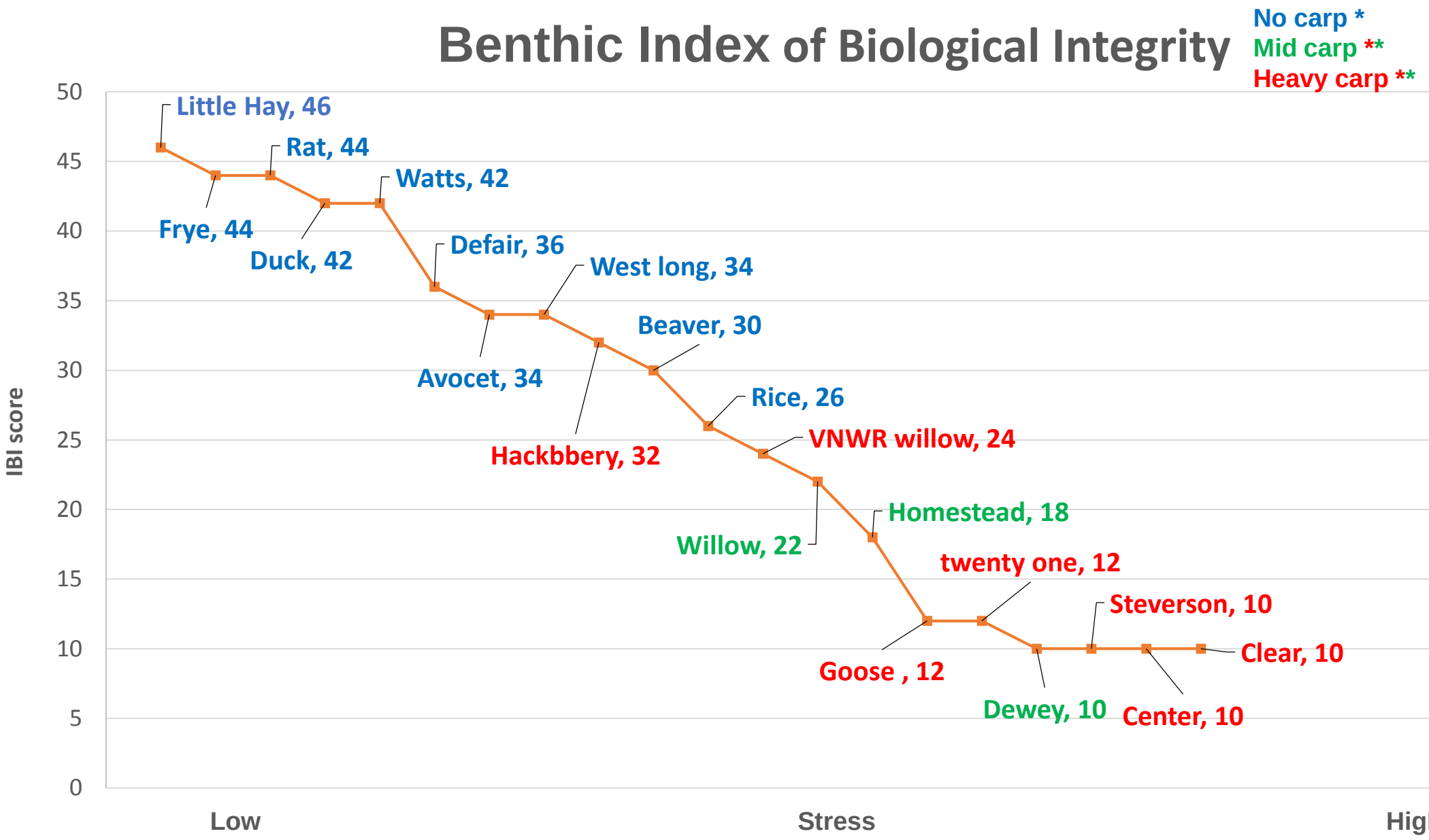
Index of Biological Integrity

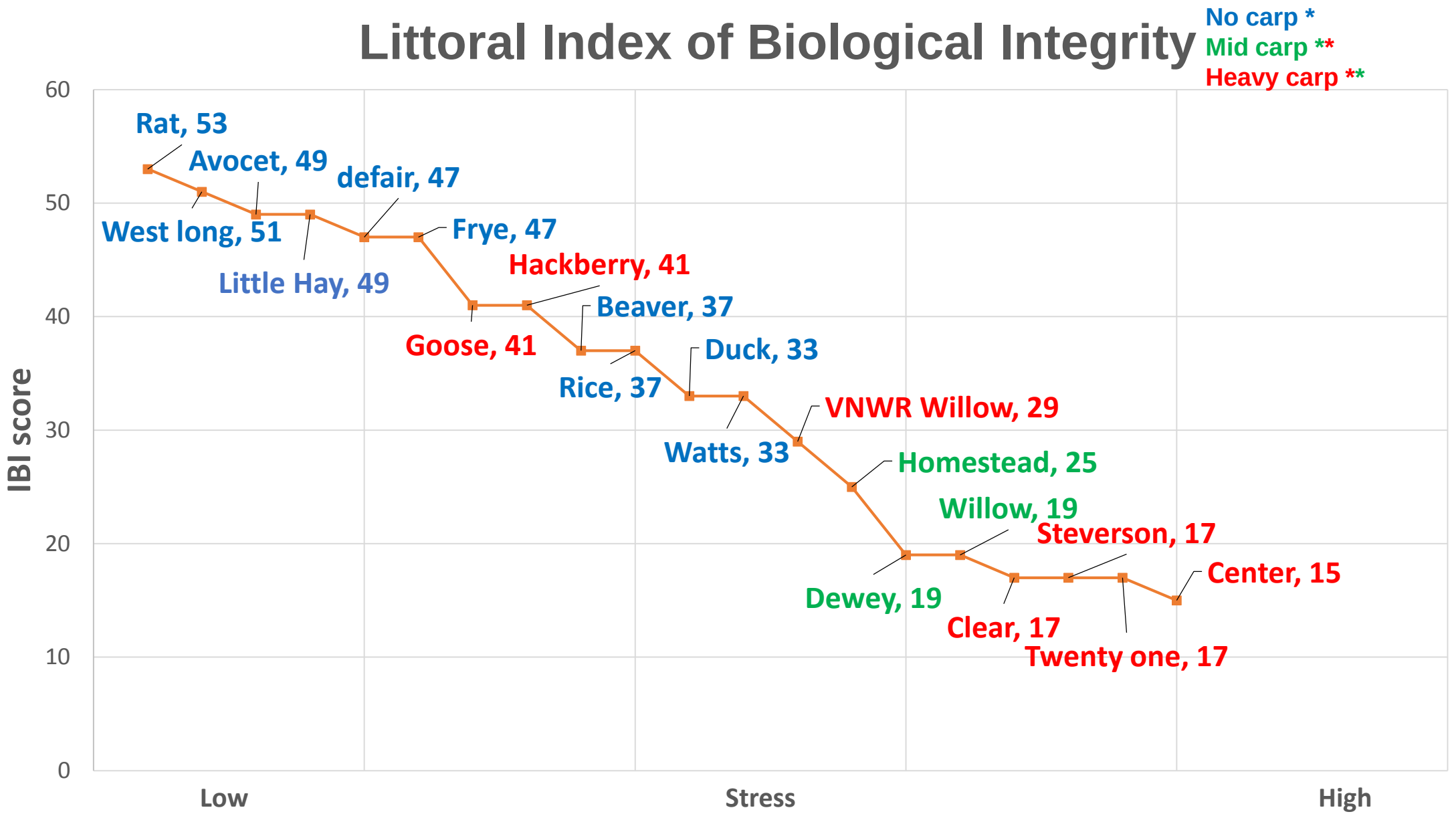
- Family Richness
- Total number of taxa
- Ginni Simpson Index
- Hilsenhoff biotic index (HBI)
- Predator richness
- Shannon diversity index
- Shreddar richness
- Chironomidae abundance
- % Amphipoda
- % baetidae
- % corixidae
- % gatherer
- % Odonata
- Total Odonata
- Total Ephemeroptera
- %Oligochaeta
- % Trichoptera
- % 2 dominant taxa
- EOT richness
- % EOT
- Gatherer Richness



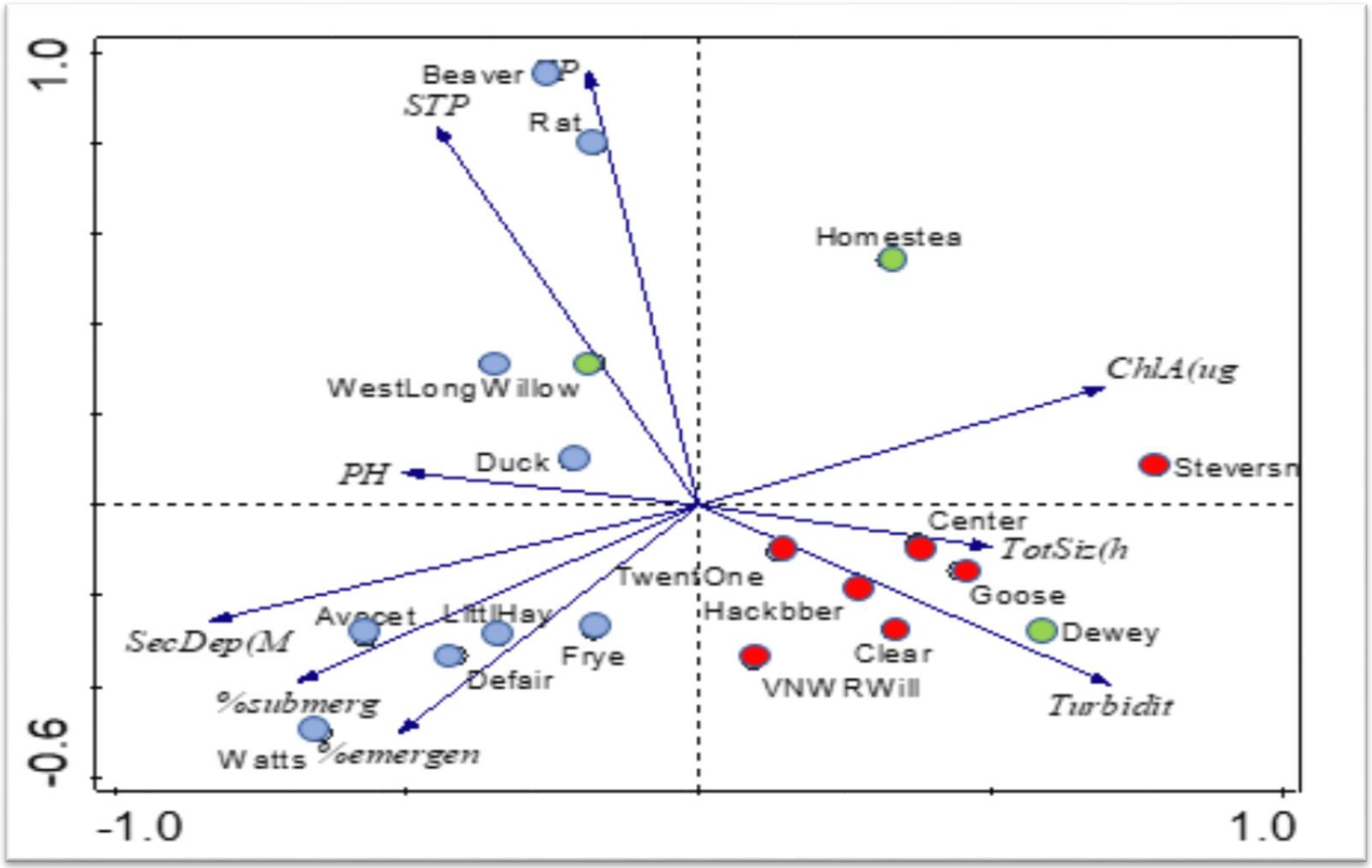
	# of families	% corixidae	% filter	% gatherer	% pred	%2 dom	%eot	%shreddar	eot richness	gather richness	gini simpson	hbi	total taxa	predator richness	shannon	shreddar richness	total odonata
# of families	1																
% corixidae	-0.3176	1															
% filter	0.0899	-0.3156	1														
% gatherer	0.13864	-0.3102	0.96821	1													
% pred	0.69324	-0.169	-0.0147	0.03227	1												
%2 dom	0.12647	-0.3339	0.0045	-0.0496	0.07112	1											
%eot	0.37153	-0.6551	0.57376	0.54795	0.03948	0.16447	1										
%shreddar	-0.1313	0.80579	-0.4176	-0.4021	-0.1404	0.08763	-0.6105	1									
eot richness	0.77319	-0.4781	0.43648	0.45196	0.29685	0.16171	0.74354	-0.3109	1								
gather richness	0.66578	-0.4231	0.45198	0.50731	0.24253	0.00653	0.70877	-0.3052	0.88042	1							
gini simpson	0.81159	-0.2811	-0.0475	-0.0679	0.56876	0.31257	0.35684	-0.0316	0.66905	0.50451	1						
hbi	0.36721	-0.3655	-0.4531	-0.4899	0.28447	0.73686	0.02669	0.03605	0.19344	0.02567	0.52626	1					
N total taxa	0.65951	-0.171	0.24548	0.33073	0.61455	0.07686	0.27042	-0.0468	0.45858	0.48996	0.42239	0.1483	1				
predator richness	0.92114	-0.1334	0.045	0.11285	0.8008	0.01241	0.17824	-0.0822	0.58843	0.47171	0.65621	0.22875	0.61796	1			
shannon	0.89715	-0.3198	0.14074	0.14955	0.69918	0.30523	0.44793	-0.0783	0.75787	0.67295	0.89329	0.42502	0.53832	0.79068	1		
shreddar richness	0.79974	-0.2671	0.13259	0.18371	0.53758	-0.0024	0.34828	0.00851	0.70213	0.65001	0.72482	0.24605	0.68278	0.63826	0.76521	1	
total odonata	0.69804	-0.209	-0.0141	0.0848	0.6545	-0.0221	0.28458	-0.1163	0.48563	0.47321	0.55618	0.19218	0.54141	0.73442	0.62496	0.65172	1
correlation = >.7																	

Littoral				Benthic			
Metric	Scoring Criteria			Metric	Scoring Criteria		
Abundance	5	3	1	Abundance	5	3	1
1. # of families	>10.5	7.5-10.5	0-7.5	1. # of families	>4.5	2.5-4.5	<2.5
2.Simpson's index	>.85	.53-.85	<.53	2. Simpson's index	>.4	.2-.4	<.2
3. Total taxa N	>193	103-193	13.4-103	3. Total Taxa N	>75	39-75	<39
4. Shannon diversity Index	>1.5	1.25-1.5	<1.25	4. Shannon diversity Index	>.83	.45-.83	<.45
Taxon composition				Taxon composition			
5. % Corixidae	<10%	10%-20%	>20%	5. % EOT	>34%	17%-34%	<17%
6. % EOT	>50%	31%-50%	<31%	6. Trichoptera abundance*	>17.8	7.8-17.8	<1.3
Sensitivity				Sensitivity			
7. %2 Dominant Taxa	<63%	63%-79%	>79%	7. %2 dominant taxa	<80%	80%-90%	>90%
8. Hilsenhoff Biotic index (HBI)	<5.7	5.7-6.6	>6.6	8. Hilsenhoff biotic index (HBI)	<6.34	6.34-7.17	>7.17
Functional feeding group				Functional feeding group			
9. % Gatherer	>38%	20%-38%	<20%	9. Chironomidae abundance*	>50	26-50	<26
10. % Predator	>34%	24%-34%	<24%	10. % Shreddar	>19%	2%-19%	<%2
11. % shreddar	>20%	10% 20%	<10%				

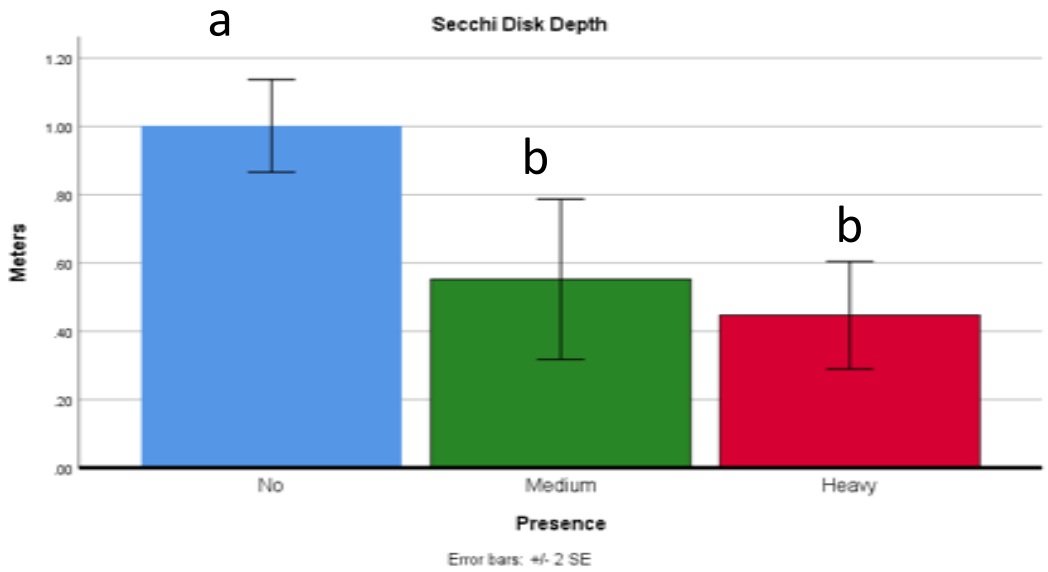

Benthic Index of Biological Integrity
No carp *
Mid carp **
Heavy carp **
IBI score
50
45
40
35
30
25
20
15
10
5
0
Little Hay, 46
Rat, 44
Watts, 42
Frye, 44
Duck, 42
Defair, 36
West long, 34
Beaver, 30
Avocet, 34
Rice, 26
Hackbbery, 32
VNWR willow, 24
Homestead, 18
Willow, 22
twenty one, 12
Steverson, 10
Clear, 10
Goose , 12
Dewey, 10
Center, 10
Low
Stress
High

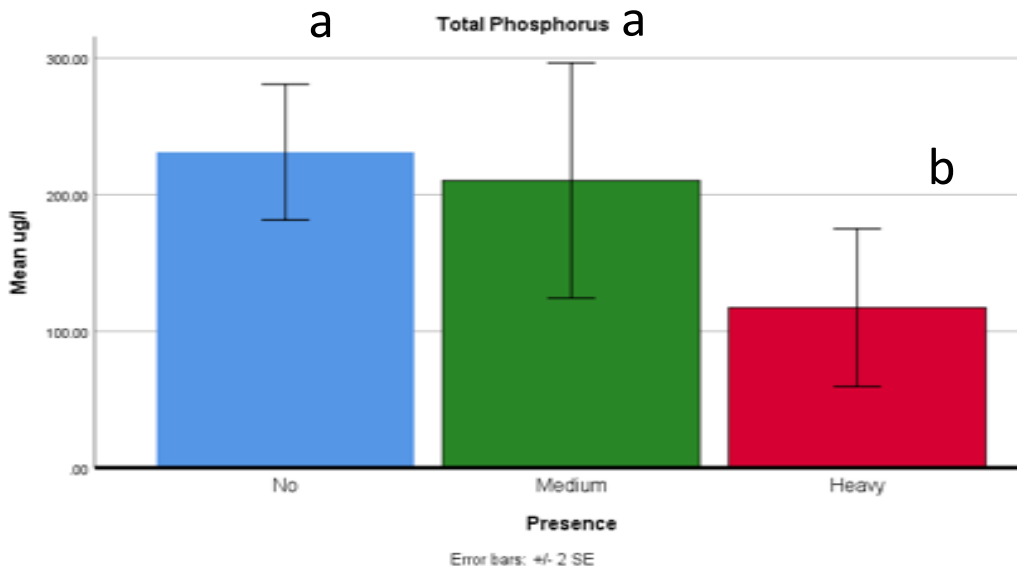

Littoral Index of Biological Integrity
No carp *
Mid carp **
Heavy carp **
IBI score
60
50
40
30
20
10
0
Low
Stress
High
Rat, 53
Avocet, 49
defair, 47
West long, 51
Little Hay, 49
Frye, 47
Hackberry, 41
Goose, 41
Beaver, 37
Rice, 37
Duck, 33
Watts, 33
VNWR Willow, 29
Homestead, 25
Willow, 19
Steverson, 17
Center, 15
Dewey, 19
Clear, 17
Twenty one, 17

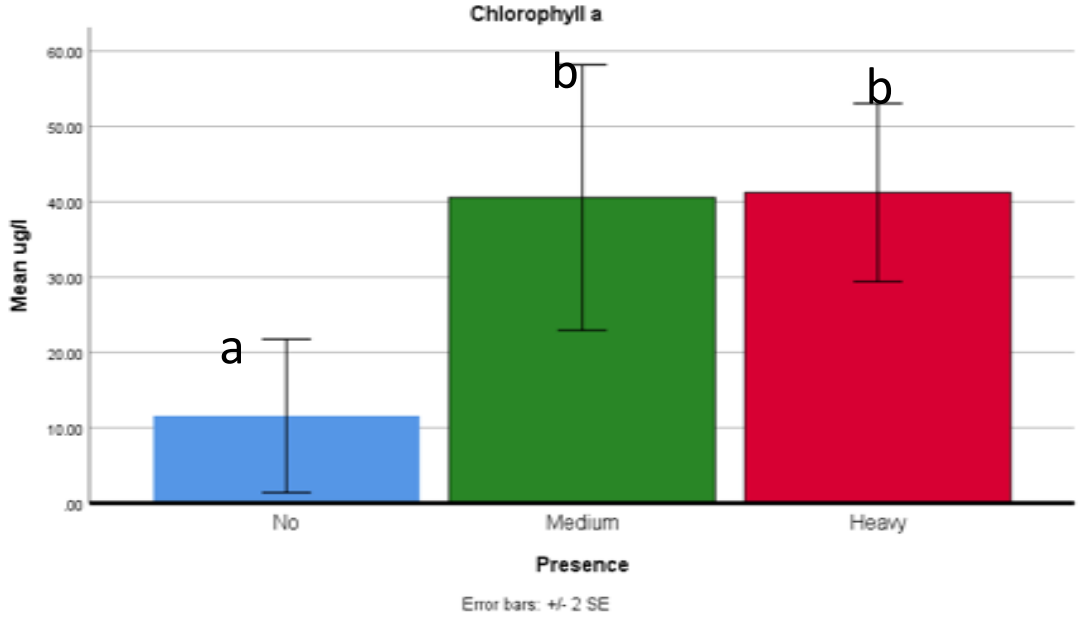
Effects of Carp on Water Quality

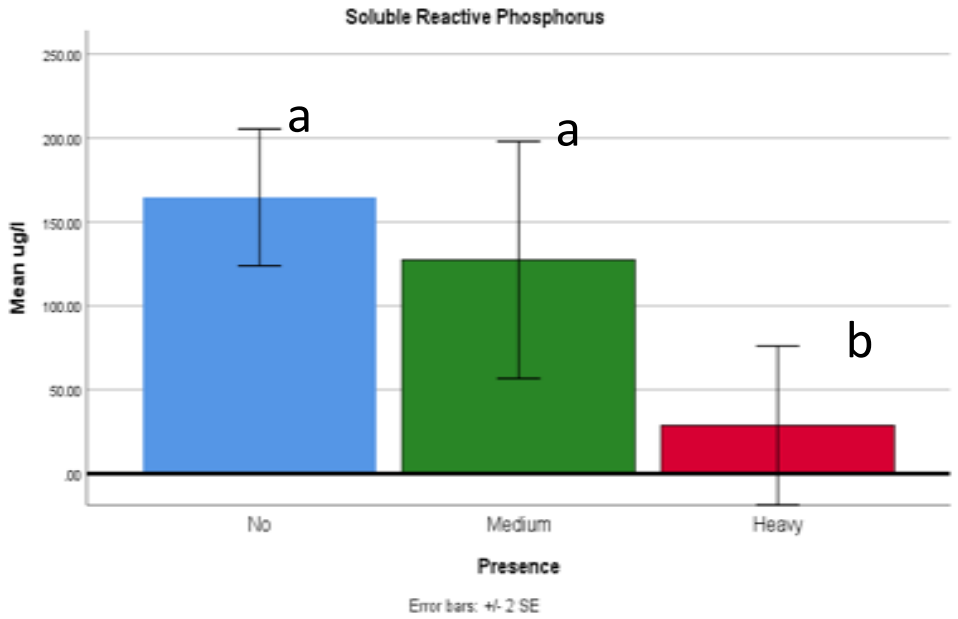


- Heavy Carp
  - Turbidity ↑
  - chl a ↑
- No Carp
  - Vegetation ↑
  - Secchi Dish ↑
  - Phosphorus ↑


a
Secchi Disk Depth
Meters
1.20
1.00
.80
.60
.40
.20
.00
b
b
No
Medium
Heavy
Presence
Error bars: +/- 2 SE


a
Total Phosphorus
a
Mean ug/l
300.00
200.00
100.00
.00
b
No
Medium
Heavy
Presence
Error bars: +/- 2 SE


Chlorophyll a
Mean ug/l
60.00
50.00
40.00
30.00
20.00
10.00
.00
b
b
a
No
Medium
Heavy
Presence
Error bars: +/- 2 SE


Soluble Reactive Phosphorus
Mean ug/l
250.00
200.00
150.00
100.00
50.00
.00
a
a
b
No
Medium
Heavy
Presence
Error bars: +/- 2 SE

Effects of Carp on Vegetation

Heavy Carp

No Carp

Conclusions

- Invasive carp have the potential to shift the stable state of shallow water ecosystems in the Sandhills
  - Macroinvertebrates
  - Water Quality
  - Vegetation
- IBI can be used to assess success of future carp renovations

- Carp will continue to disperse through the region

Acknowledgements

- US Environmental Protection Agency
- Nebraska Game and Parks Commission
- Valentine and Crescent Lake NW Reserves
- Association of State Wetland Managers

Questions?