Fish assemblages in the Powder River Basin in relation to coalbed natural gas development

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Outline

What are the concerns for fisheries?

Objectives

Study design

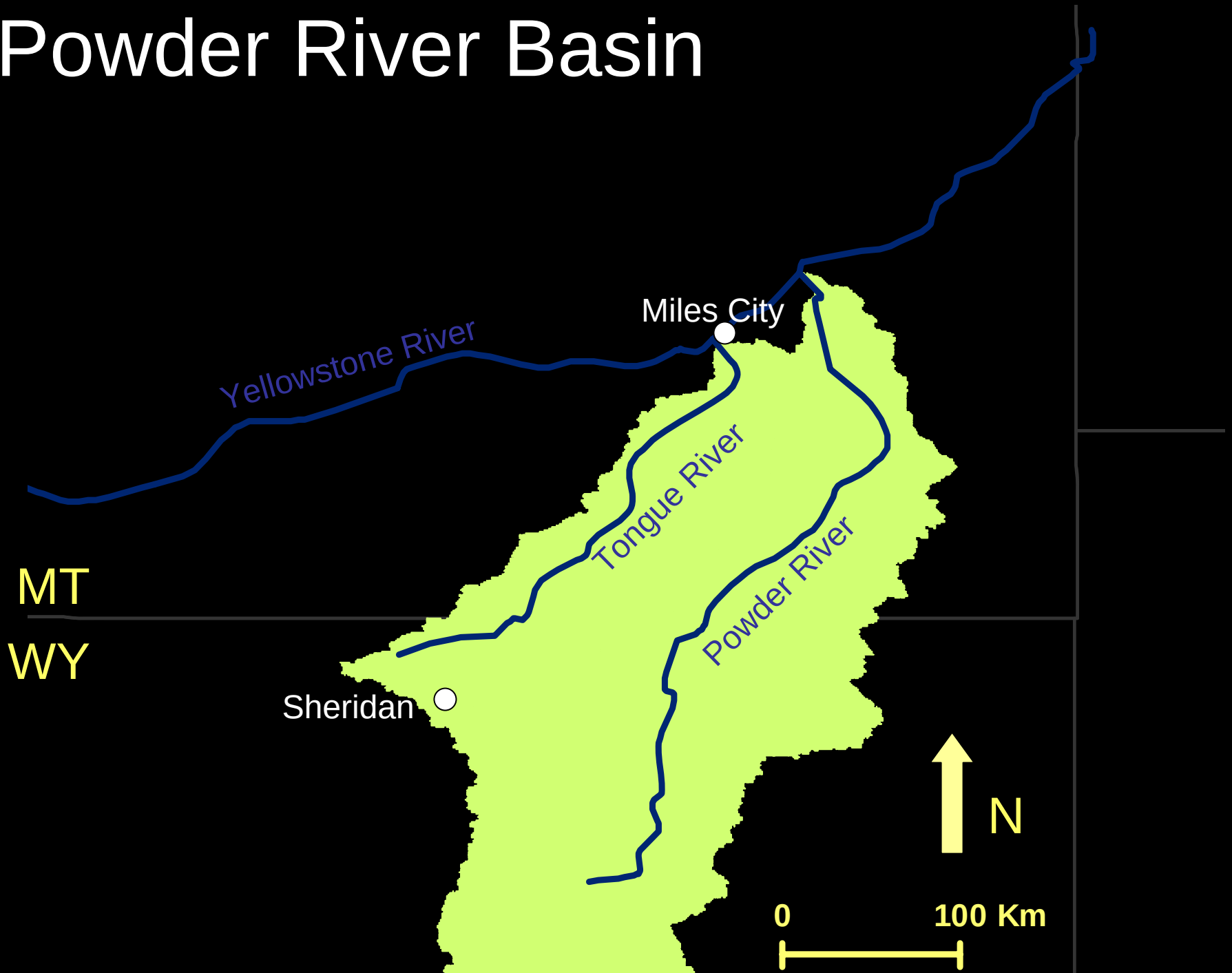
Methods

Results

Challenges

Discussion

Powder River Basin



Fish of the Powder River Basin

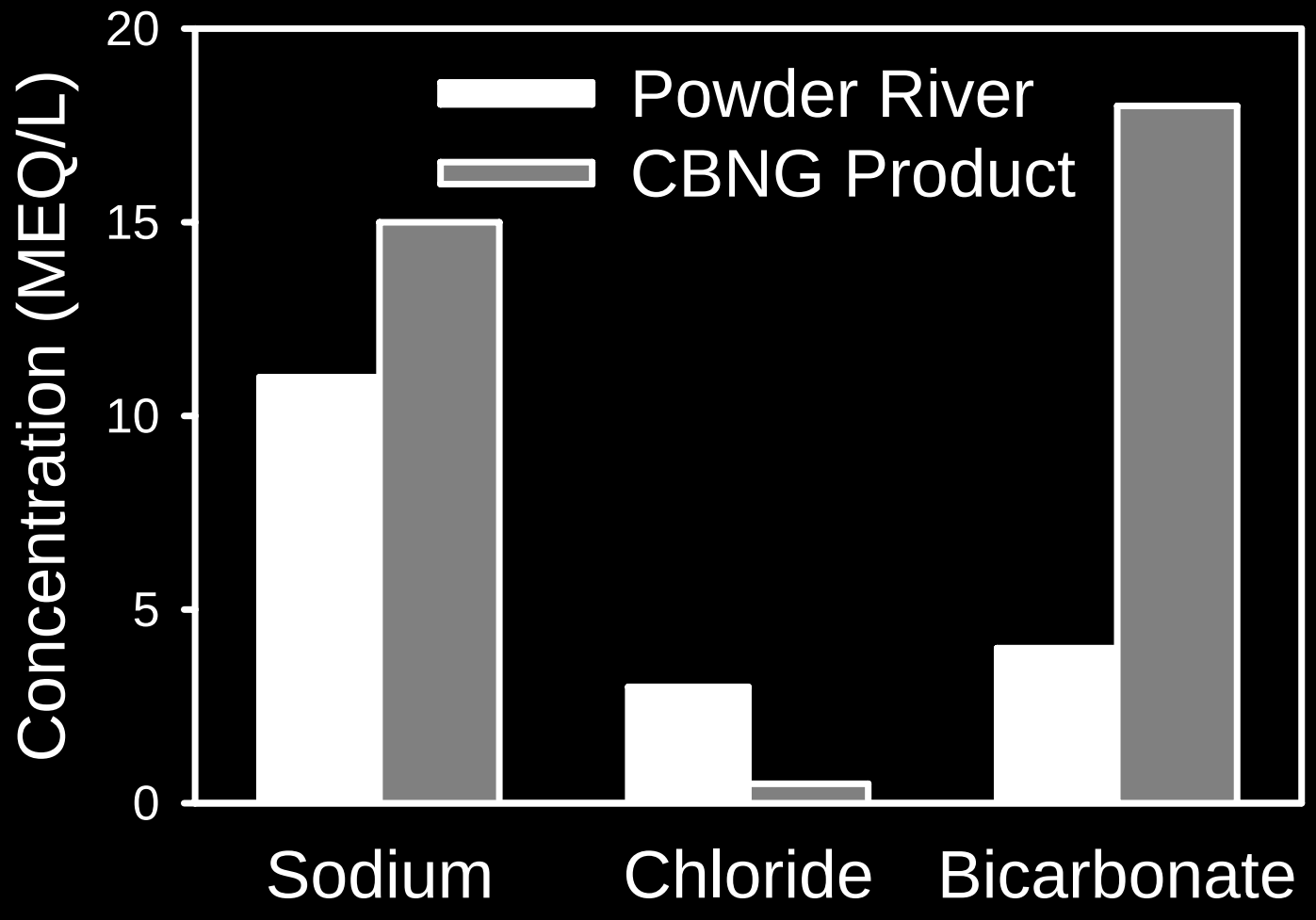
- Unique assemblage of 52 fish species
  - predominately suckers and minnows
- Includes 9 species of concern

Potential effects to fish

- Changes in <u>water quality</u>
- Changes in <u>water quantity</u>

Water quality

Surface vs. product



(Clark et al. 2001)

Water quantity

- Groundwater pumping $\longrightarrow$ reduced flow

Water quantity

- Groundwater pumping $\longrightarrow$ reduced flow
- Direct discharge $\longrightarrow$ increased flow

Research goal

Determine if CBNG development has affected fish assemblages in tributary streams of the Tongue and Powder rivers.

Field study objectives

Has CBNG affected fish assemblages ...

Field study objectives

Has CBNG affected fish assemblages …

1. In streams with and without CBNG?

Field study objectives

Has CBNG affected fish assemblages …

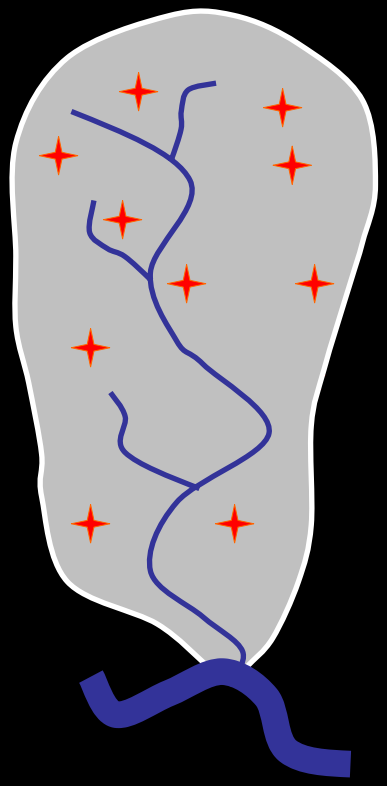
1. In streams with and without CBNG?
2. Compared to historical surveys conducted before CBNG?

Field study design

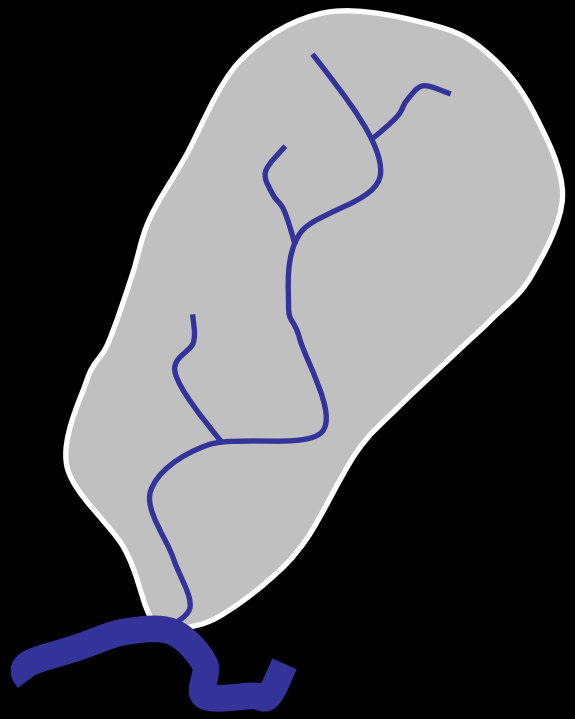
1. Treatment vs. control
2. Historical comparisons

Treatment vs. control

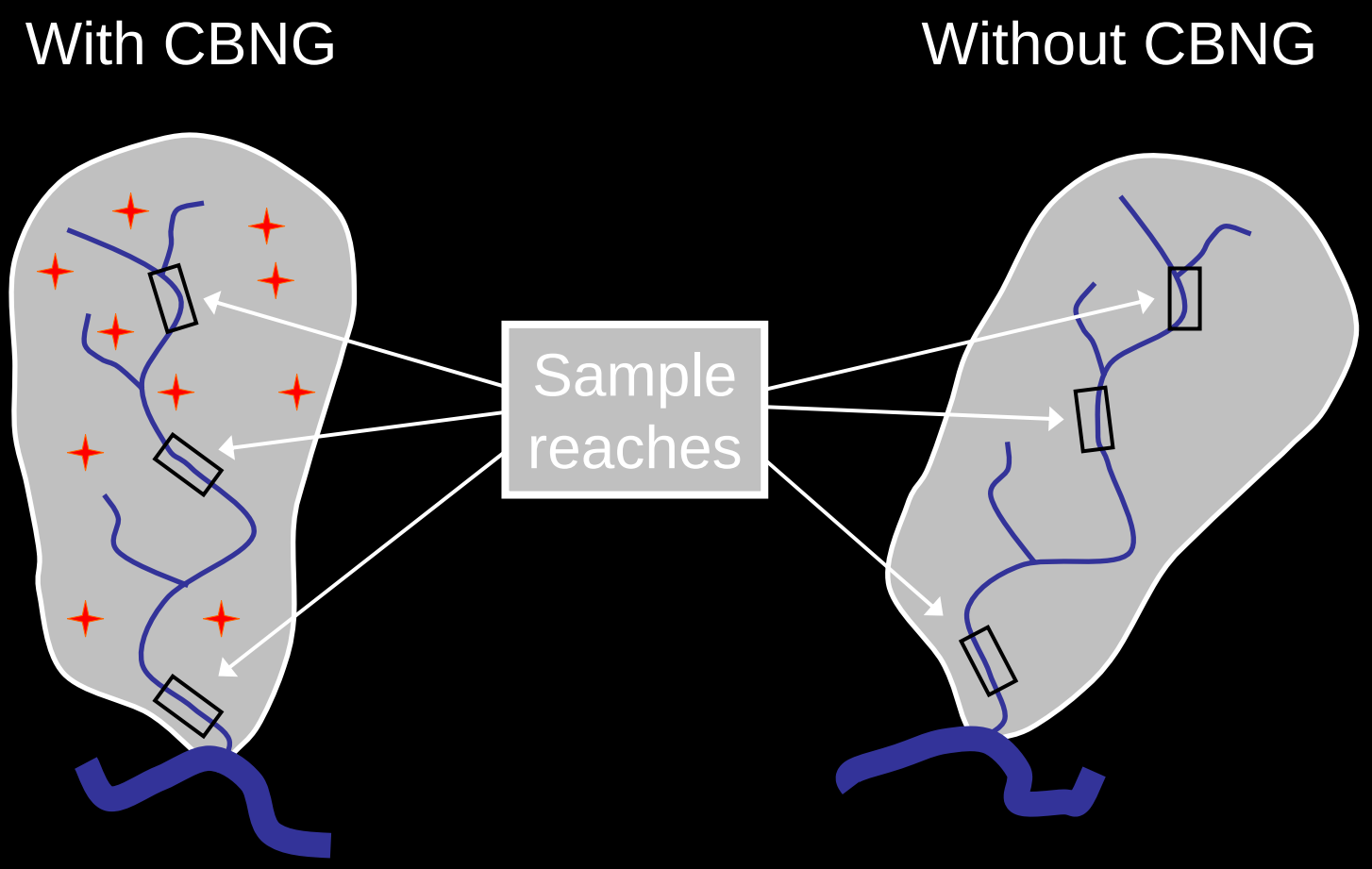
With CBNG



Without CBNG



Treatment vs. control



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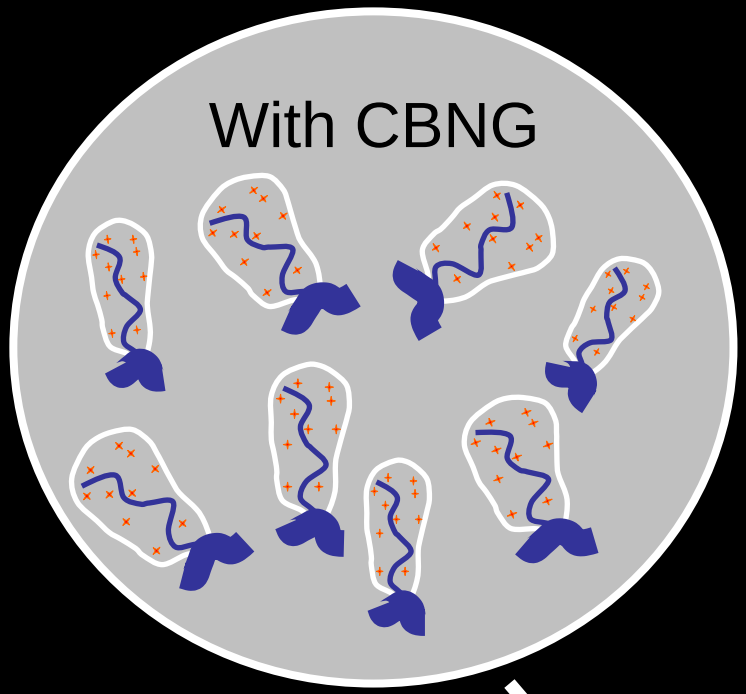
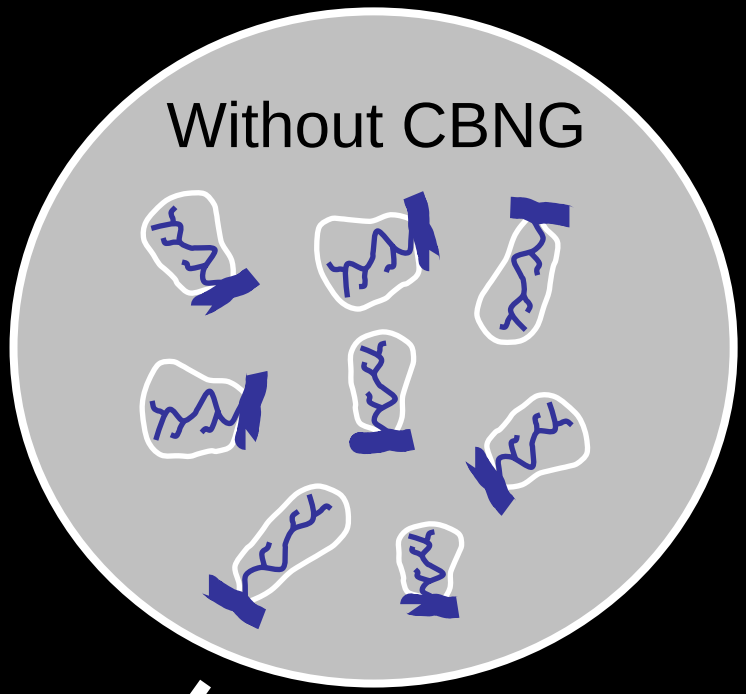
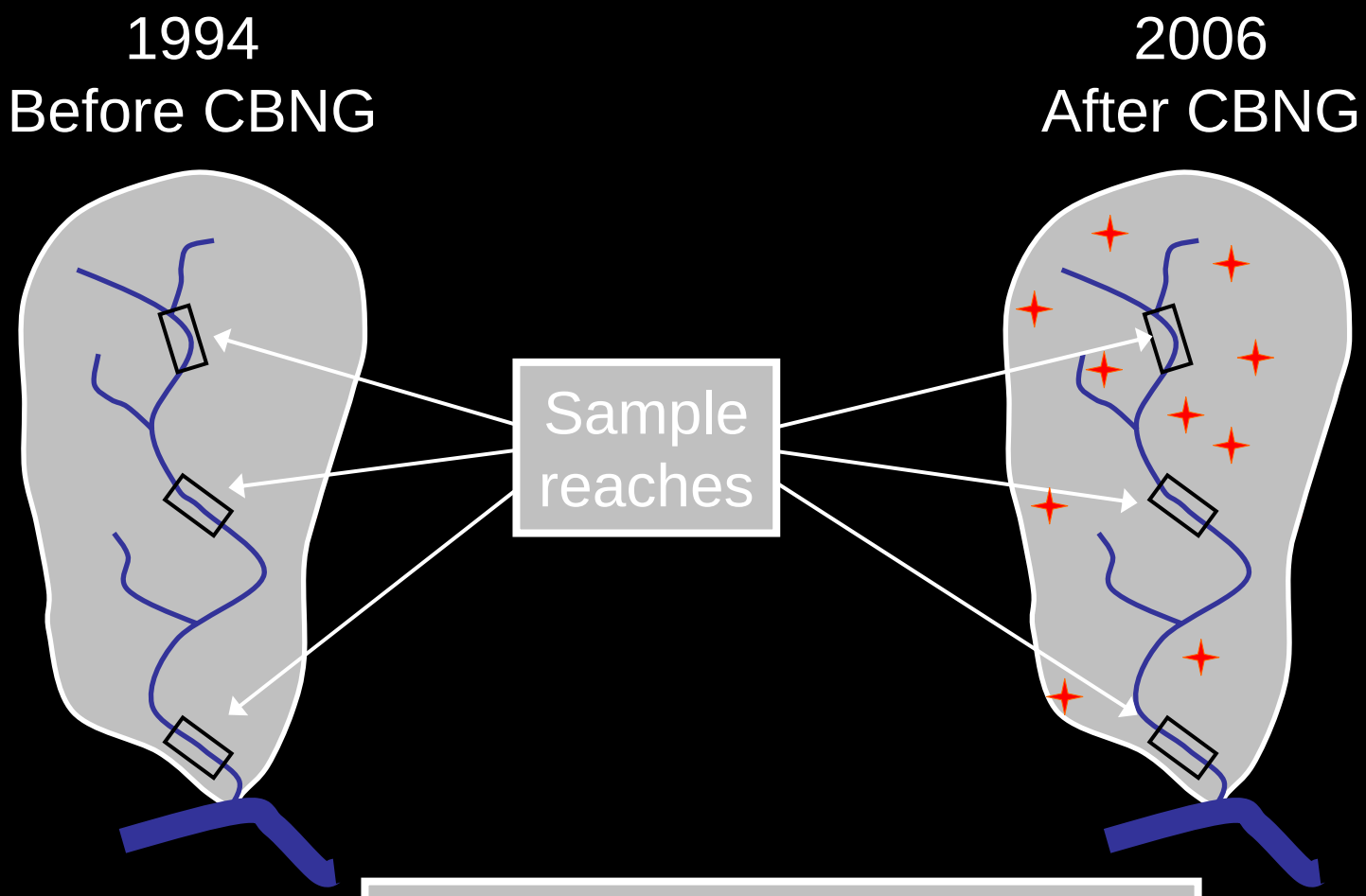




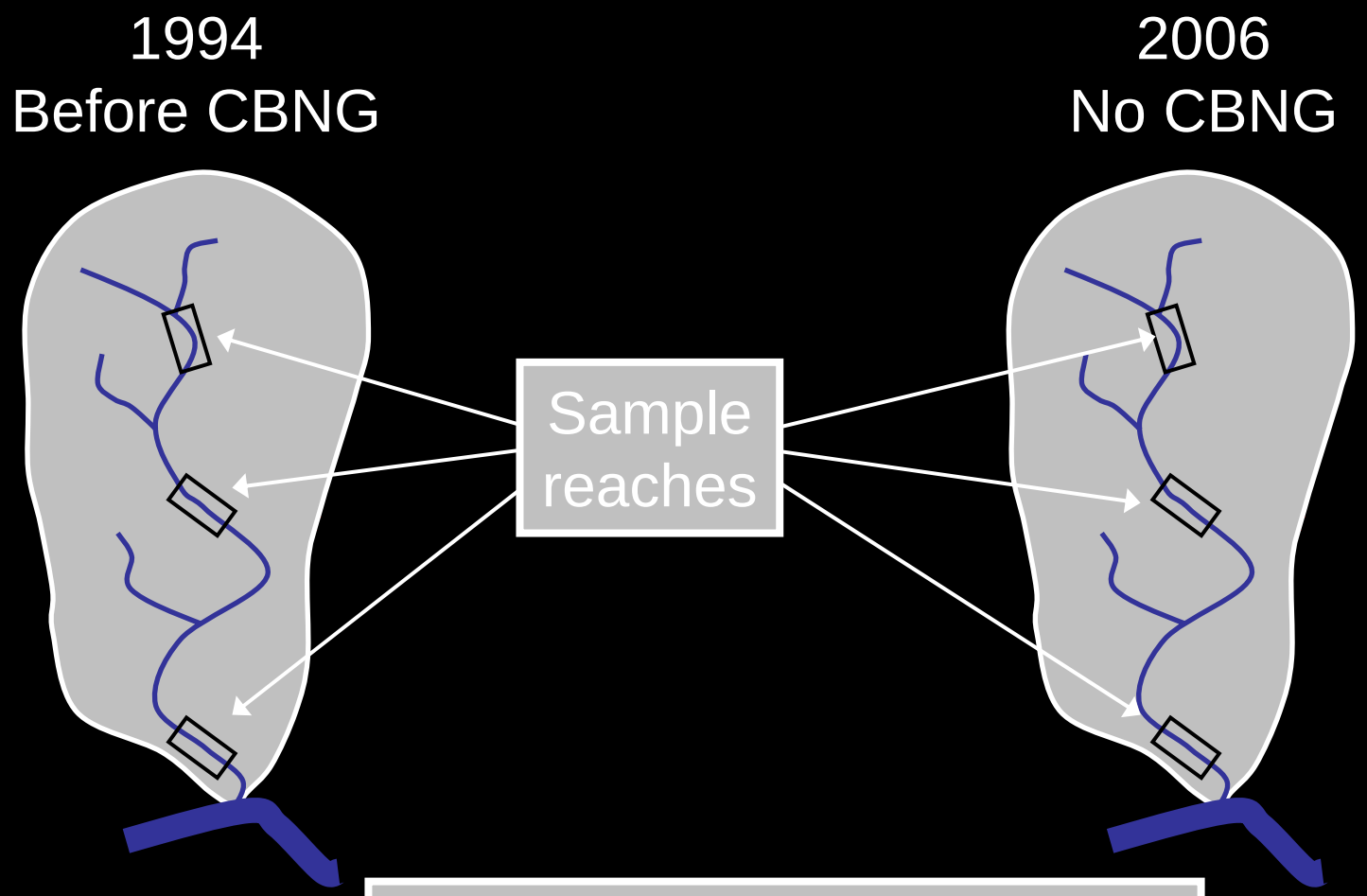
- Abundance
- Species richness
- IBI scores

Historical comparisons



- Species presence/absence
- IBI scores

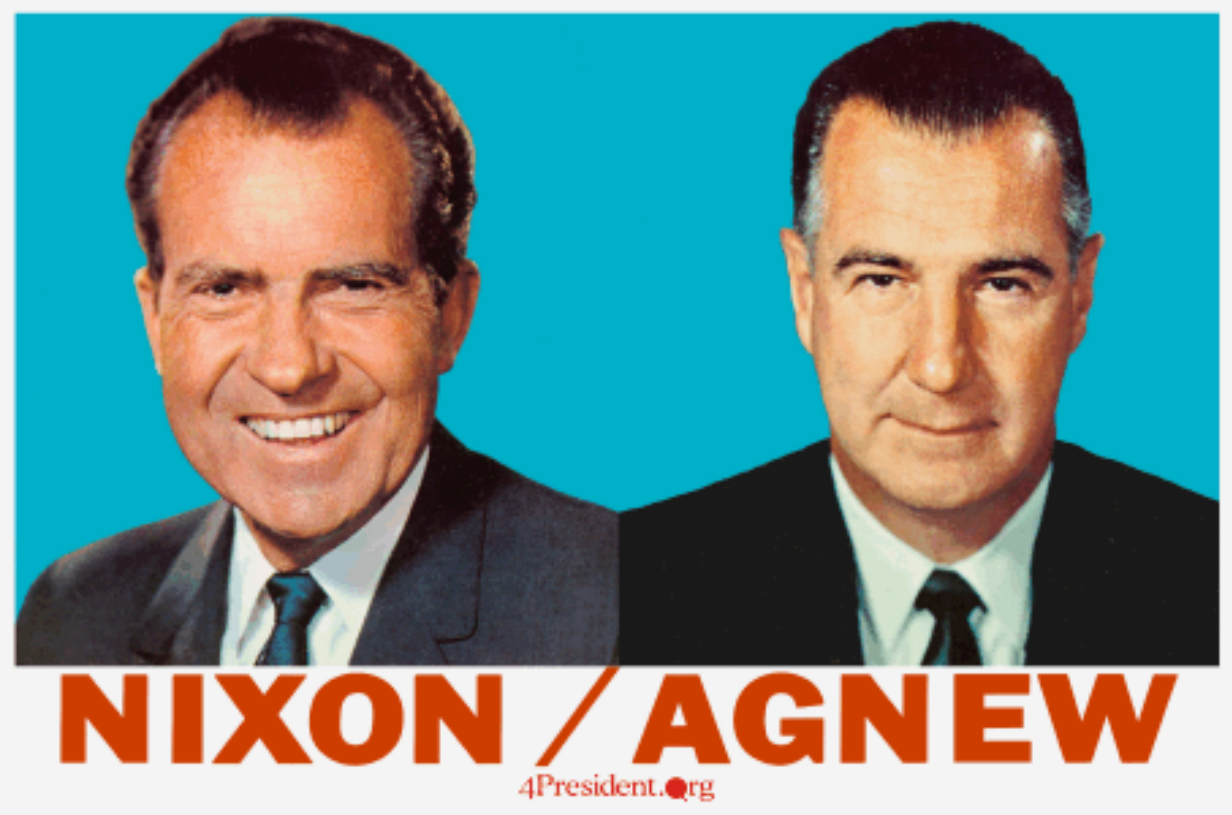
Historical comparisons



- Species presence/absence
- IBI scores

Concept of biological integrity

- Clean Water Act 1972
  - “restore and maintain the chemical, physical, and ***biological*** integrity of the Nation’s waters”



Concept of biological integrity

"a … community of organisms … comparable to that found in natural habitats of the region"

Index of Biotic Integrity (IBI)

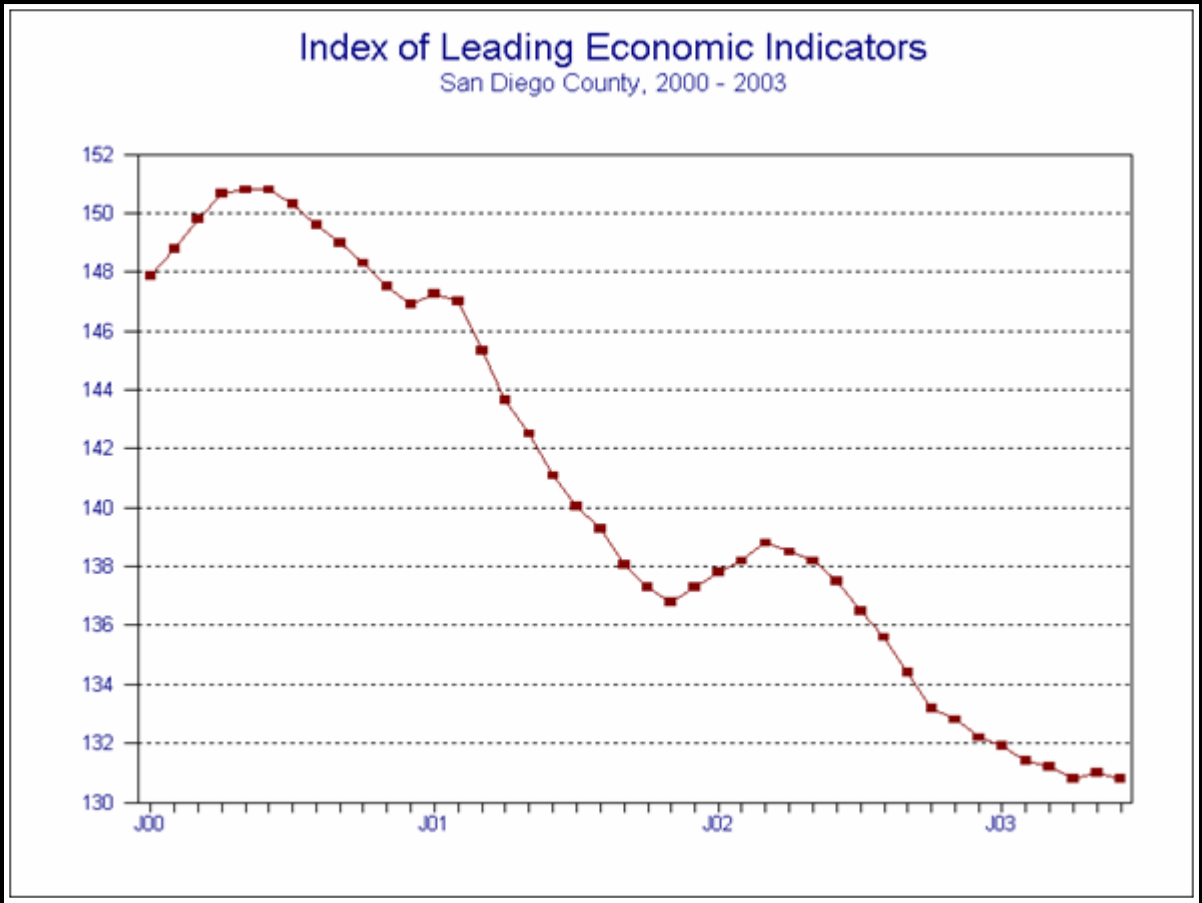
Began in 1981

- Karr (1981) used fish assemblages to evaluate the biotic integrity of Midwestern streams

Index of Biotic Integrity (IBI)

Analogous to index of leading economic indicators

- Combines many measures to assess the “health” of the economy



Index of Biotic Integrity (IBI)

A metric is essentially a hypothesis predicting how a biological attribute will change with increasing anthropogenic stress

- The number of native fish species will decline
- The proportion of tolerant species (e.g. common carp, fathead minnow) will increase
- The proportion of invertivorous species will decrease

IBIs have been applied in many environments:

streams, rivers

lakes, reservoirs

wetlands, estuaries

terrestrial environments

IBI scoring example
“good stream”

white sucker	241
longnose dace	122
flathead chub	55
lake chub	20
shorthead redhorse	7
stonecat	6
fathead minnow	3
longnose sucker	2
mountain sucker	1

Metric	Raw metric value	Metric score
No. native spp.	9	10
No. native families	3	9
No. sucker and catfish spp.	5	10
% tolerant	53.4	4
% invert. minnows	43.1	6
No. benthic invert.	3	10
% rock spawners	82.9	10
% tolerant repro.	0.7	10
% native	100.0	10
No. long-lived	6	10
Total IBI score		89

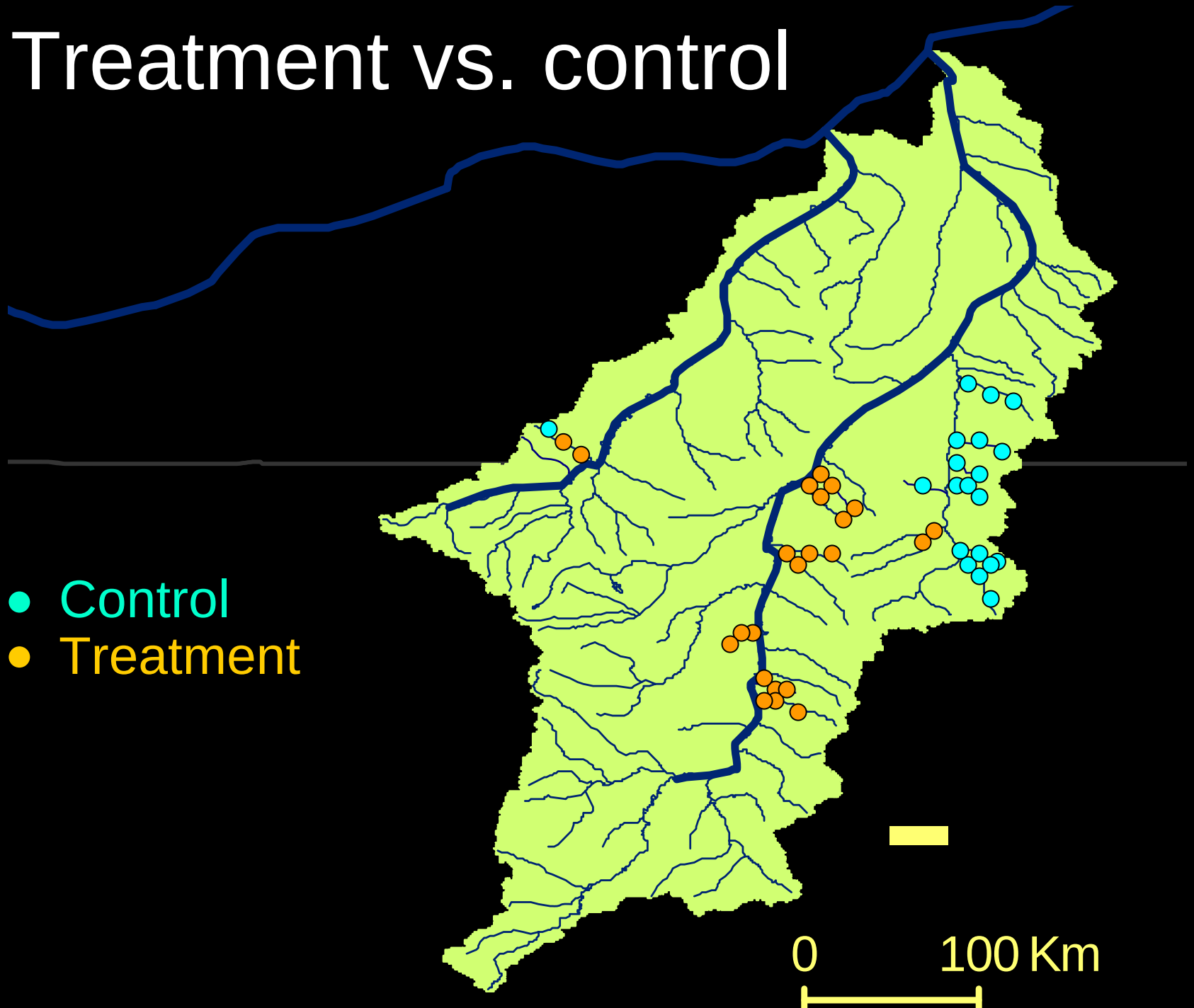
IBI scoring example "poor stream"

plains killifish	33
fathead minnow	1

Metric	Raw metric value	Metric score
No. native spp.	1	5
No. native families	1	4
No. sucker and catfish spp.	0	5
% tolerant	100.0	0
% invert. minnows	0.0	0
No. benthic invert.	0	6
% rock spawners	0.0	0
% tolerant repro.	2.9	10
% native	2.9	0
No. long-lived	0	6
Total IBI score		36

Field methods

Treatment vs. control



Water quality

	Control		Treatment		
Response	Mean	SE	Mean	SE	*p*-value
Temperature (°C)	22	0.5	23	0.9	0.160
pH	8.6	0.07	8.6	0.09	0.520
Turbidity (NTU)	35	9.5	28	10.1	0.637
Conductivity (µmhos/cm)	3133	462	4565	778	0.829

Water quality

	Control		Treatment		
Response	Mean	SE	Mean	SE	*p*-value
Alkalinity	305	24.7	636	89.7	<0.01
Chloride (mg/L)	319	128	17	3.15	<0.01
Sulfate	836	103	2028	495	0.158
Bicarbonate (mg/L)	362	28	621	61	0.033

Product water streams

8 species observed…

Green sunfish

Black bullhead

Plains killifish

River carpsucker

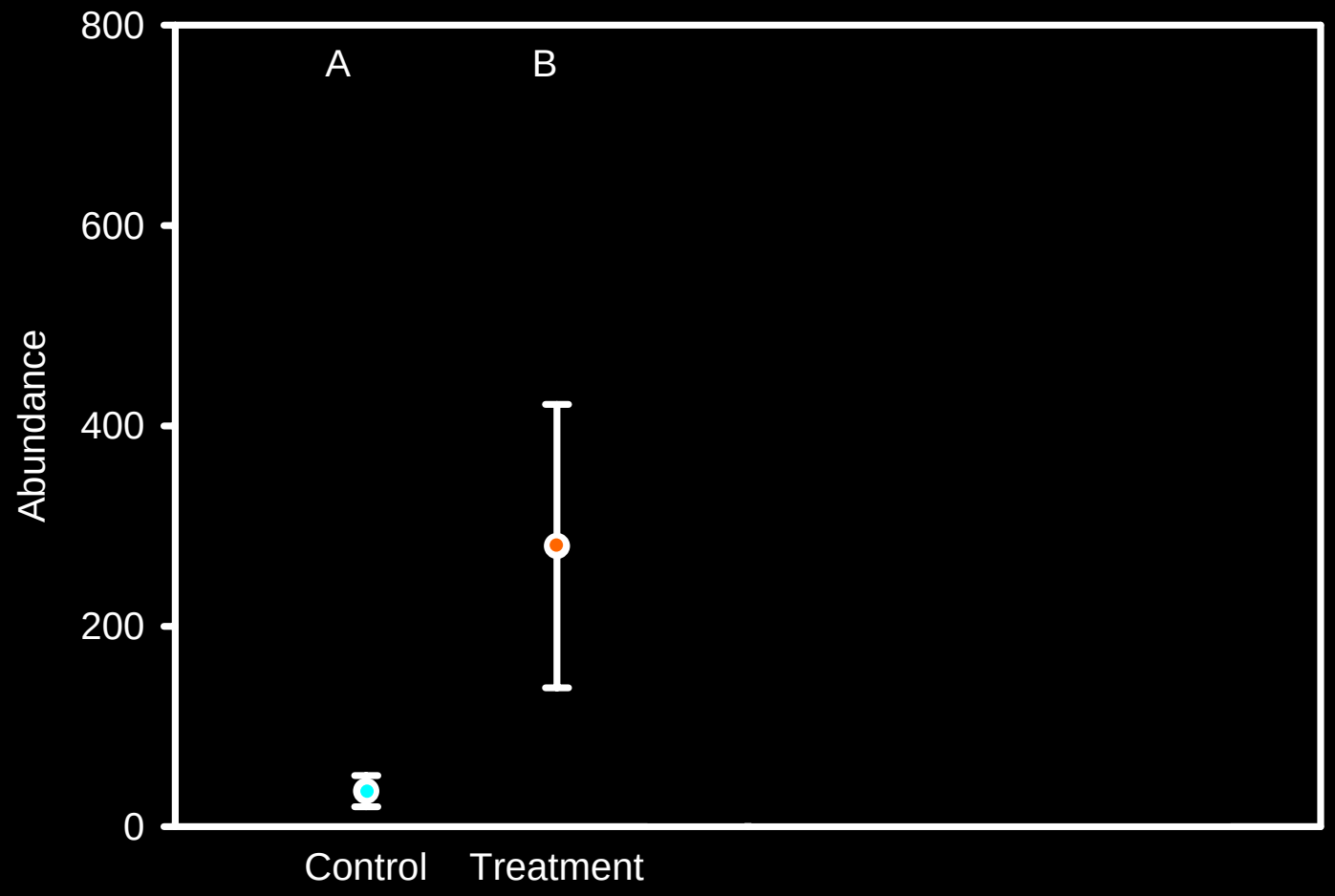
White sucker

Fathead minnow

Sand shiner

Flathead chub

Abundance



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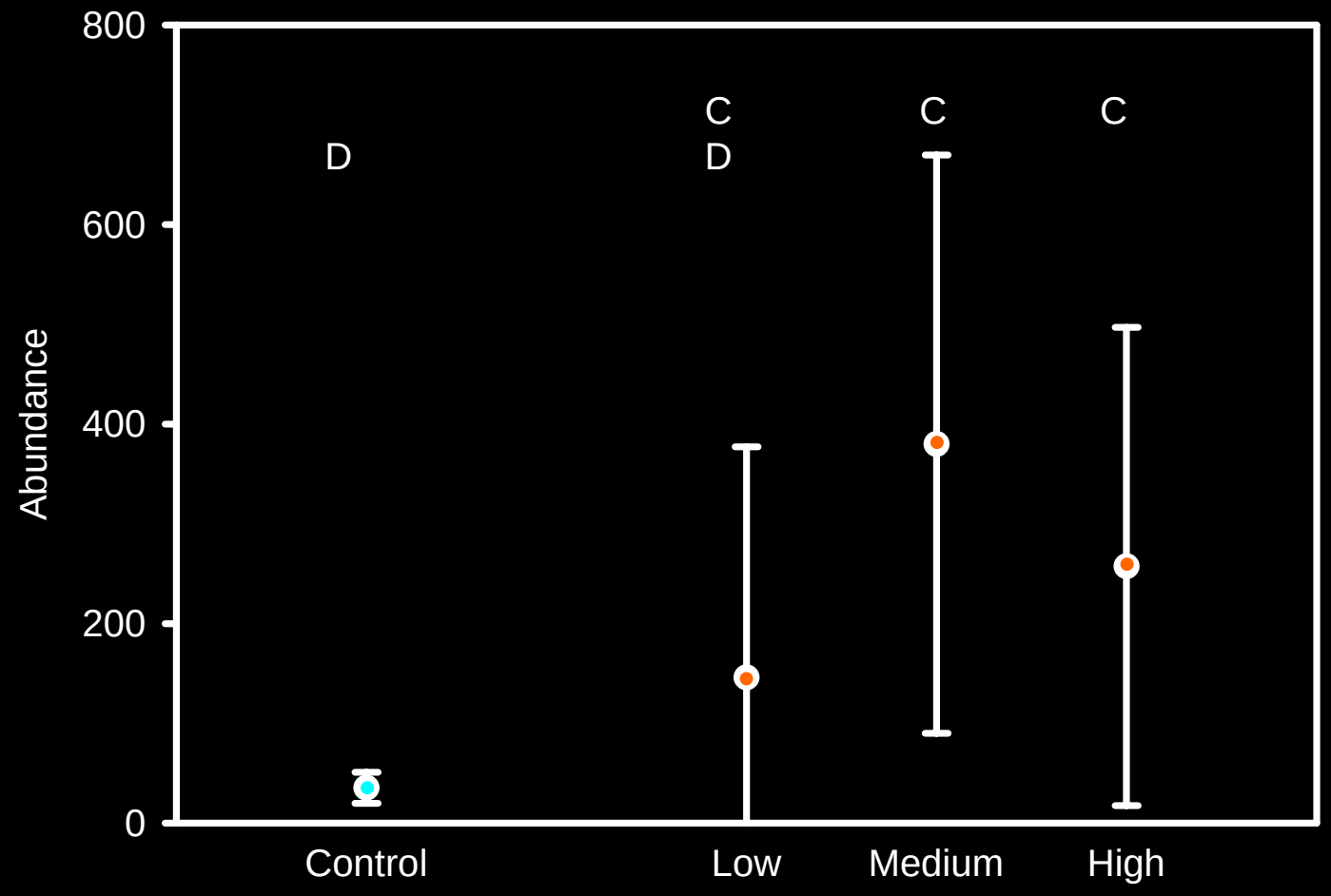
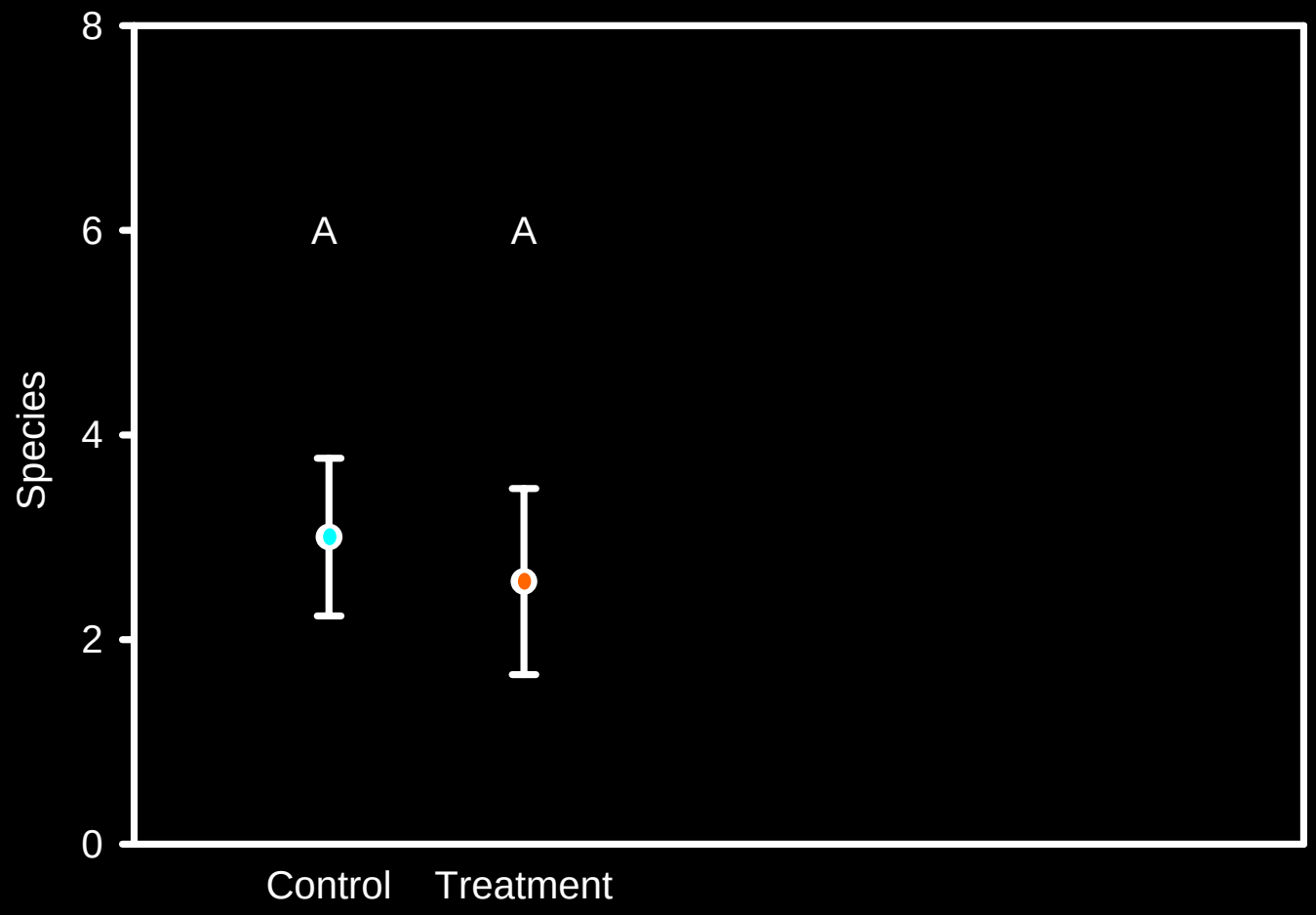


Species Richness



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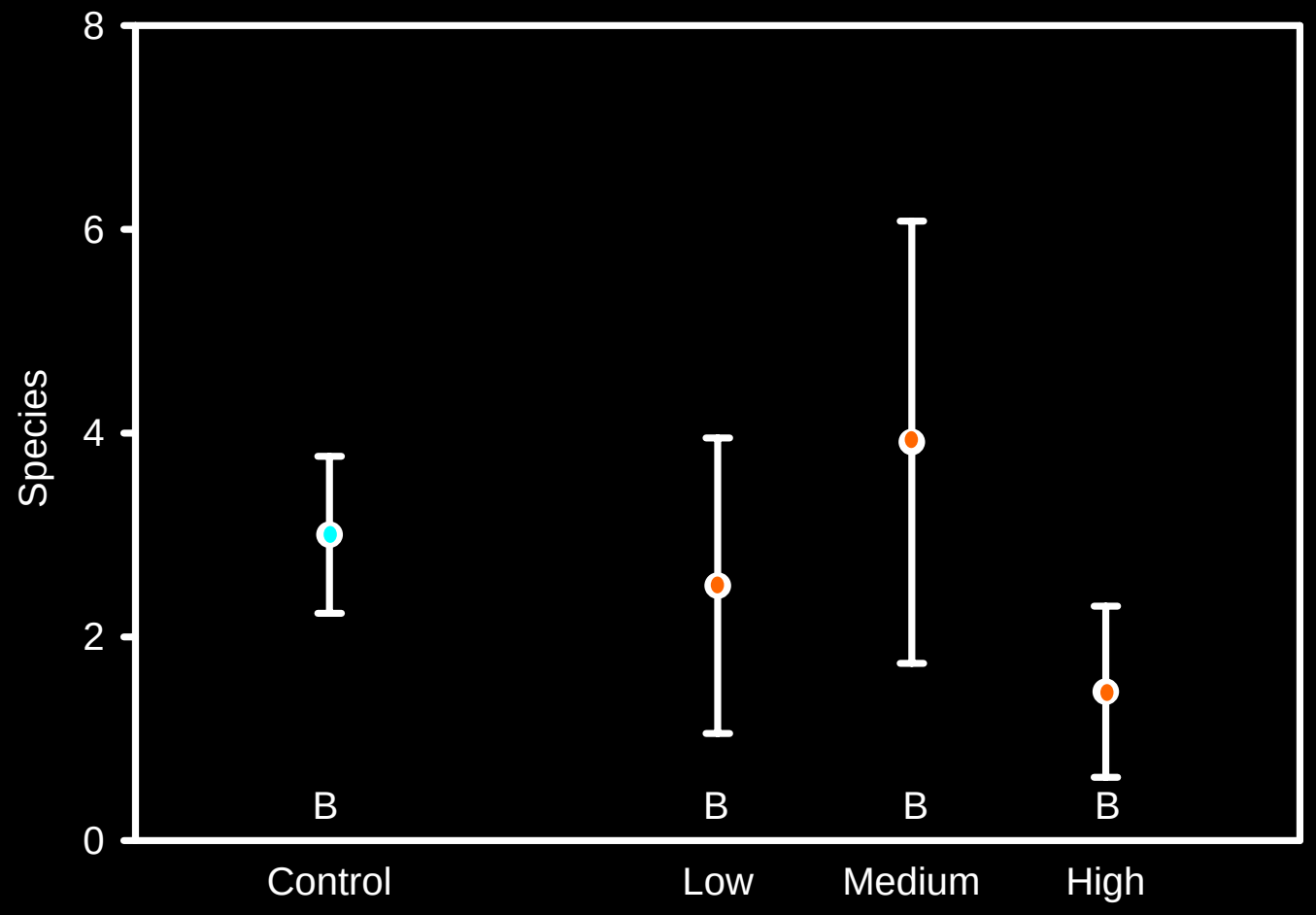
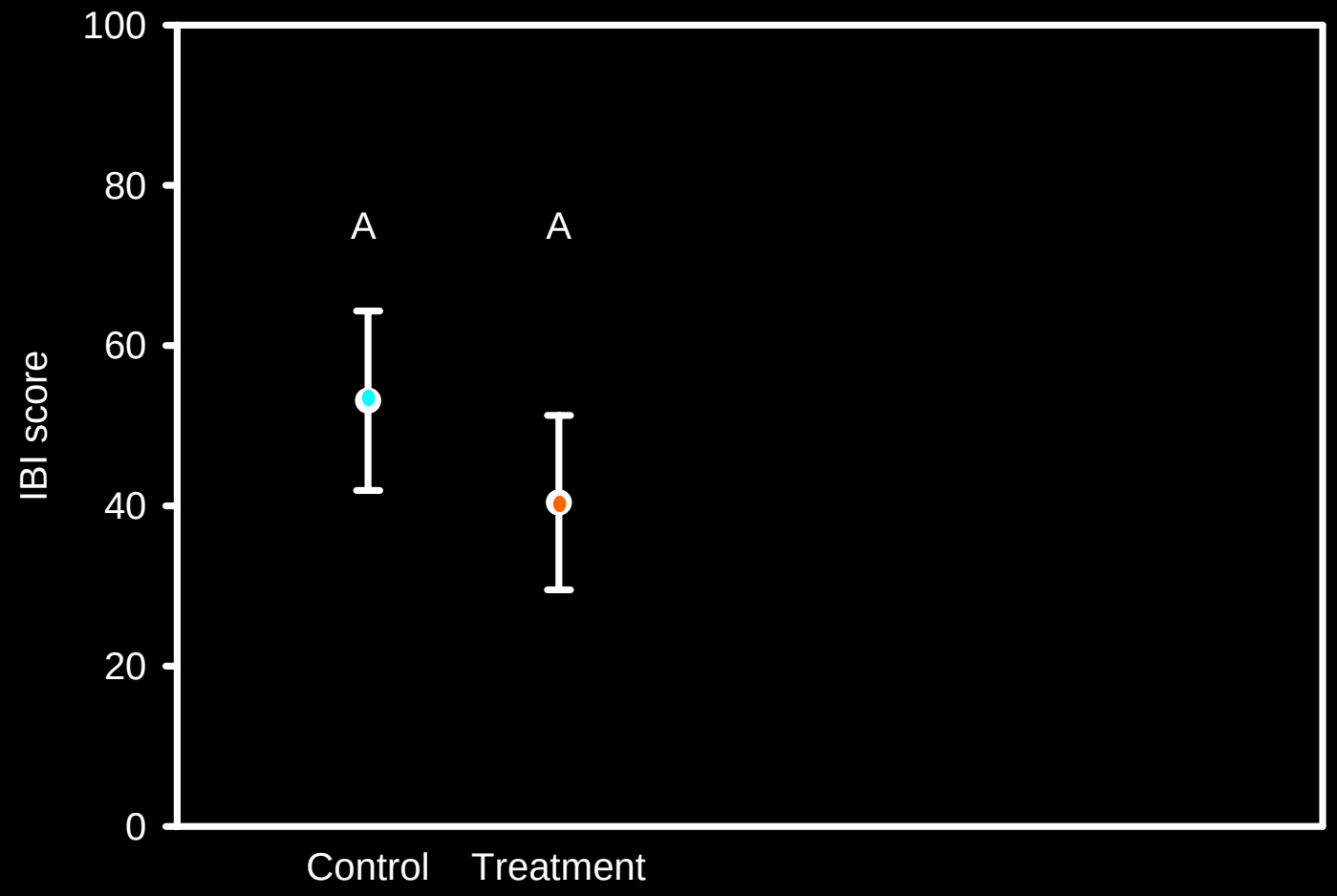


Biotic Integrity



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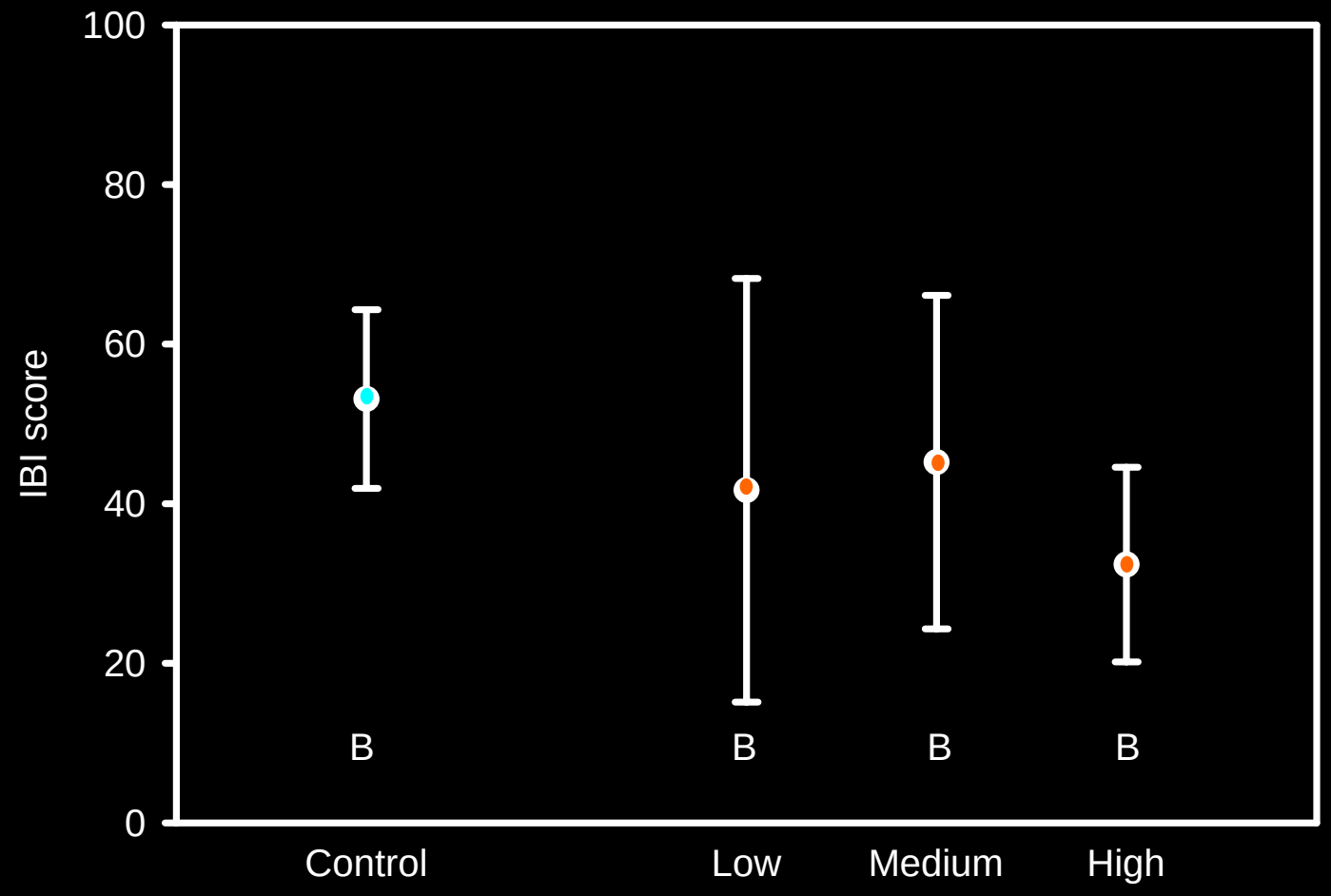

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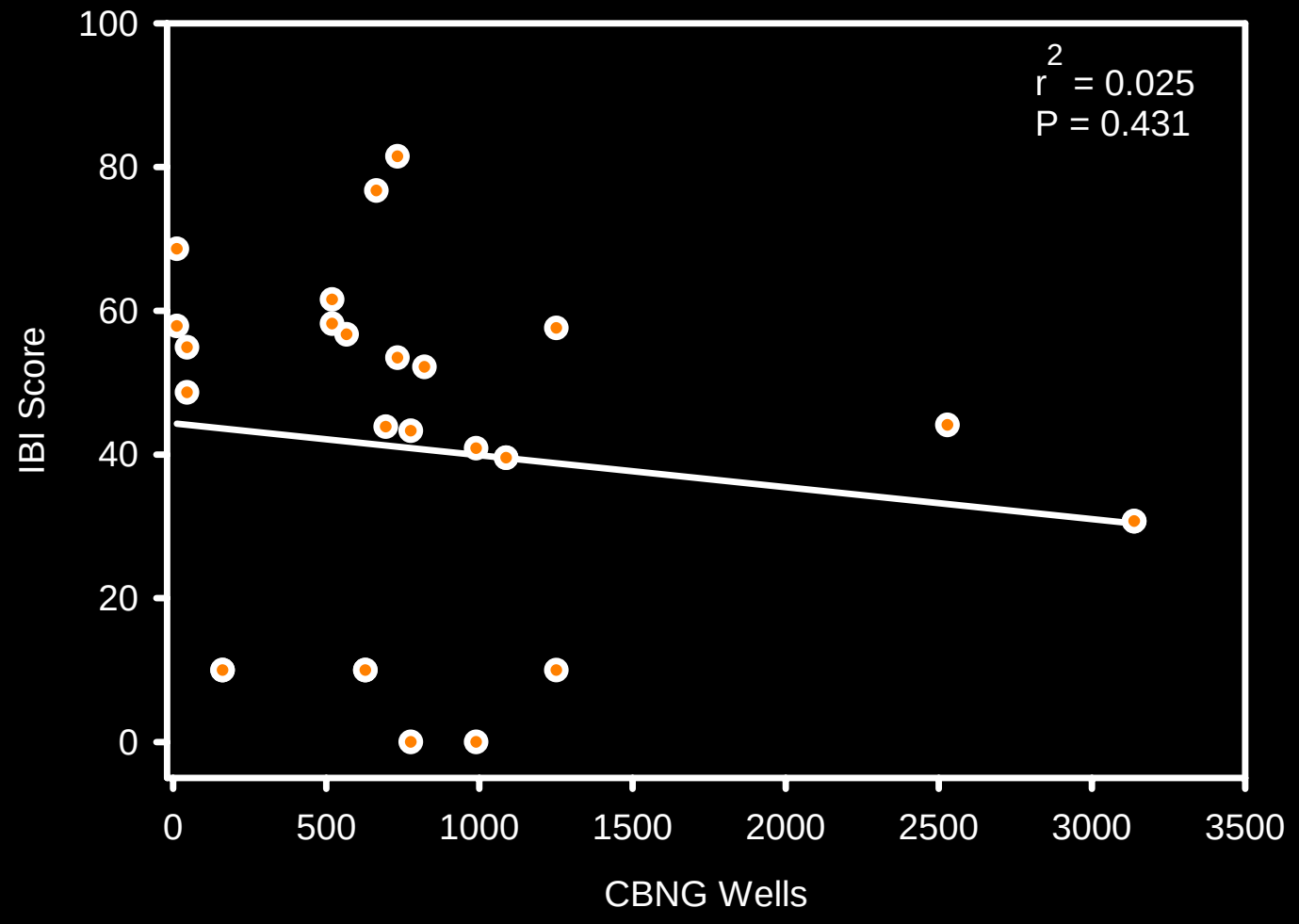

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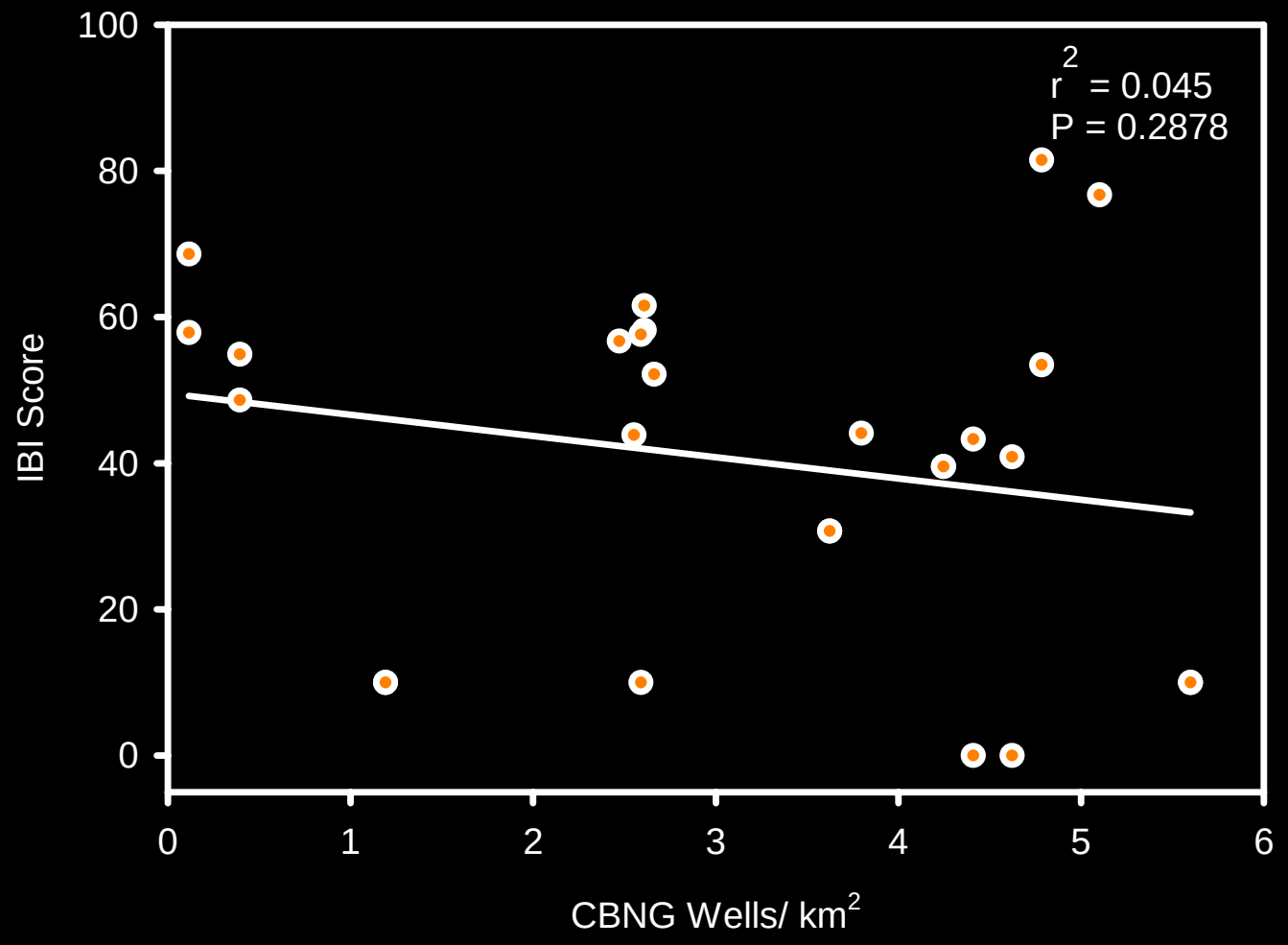
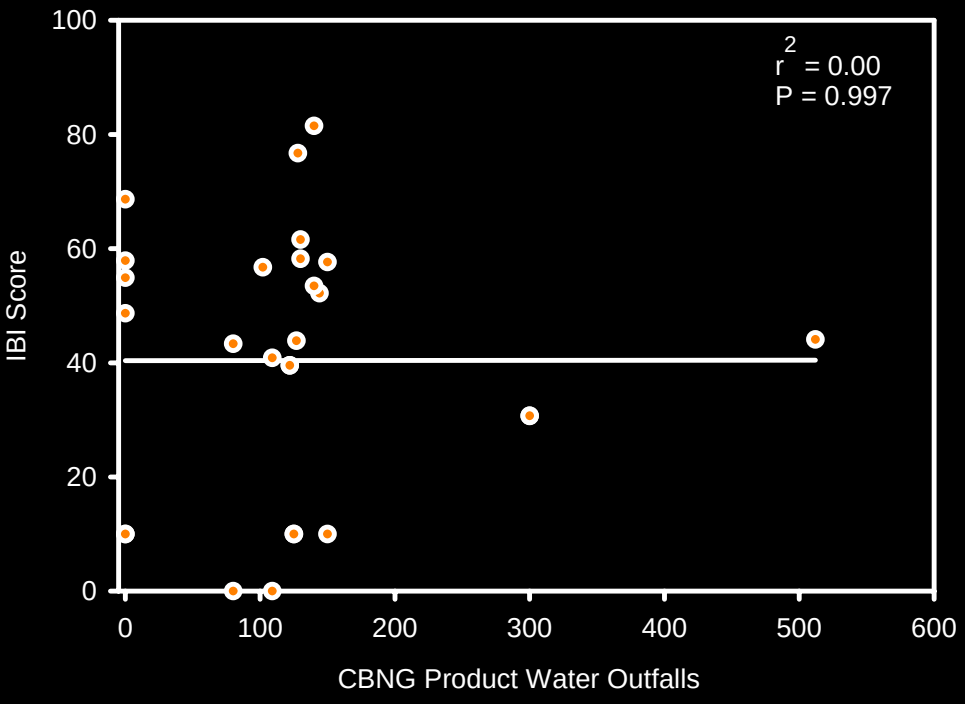
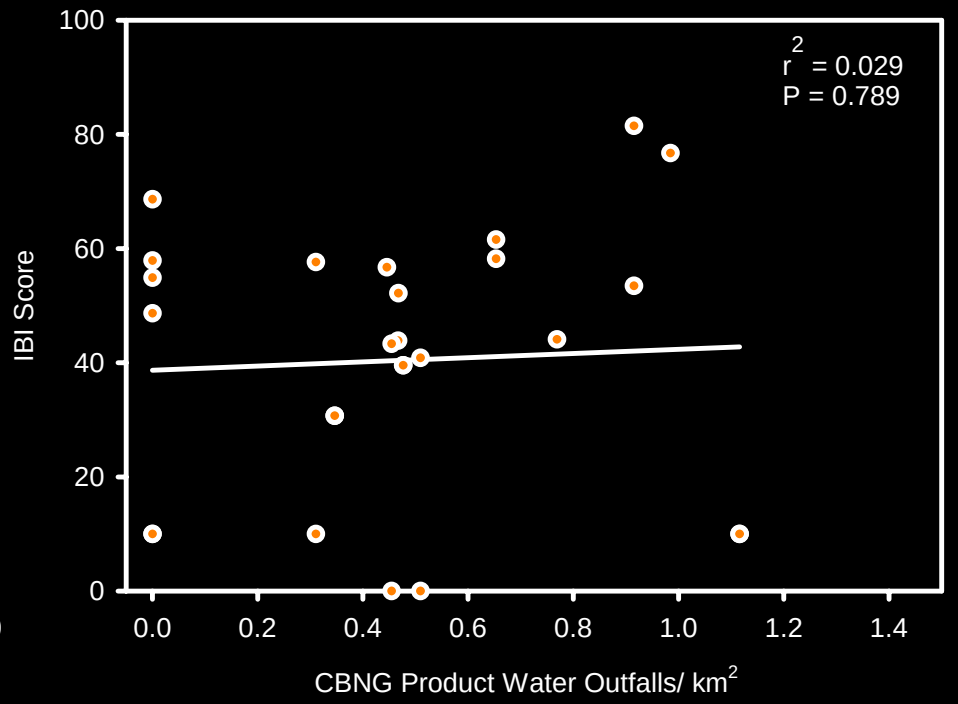


Biotic Integrity vs. Water Management





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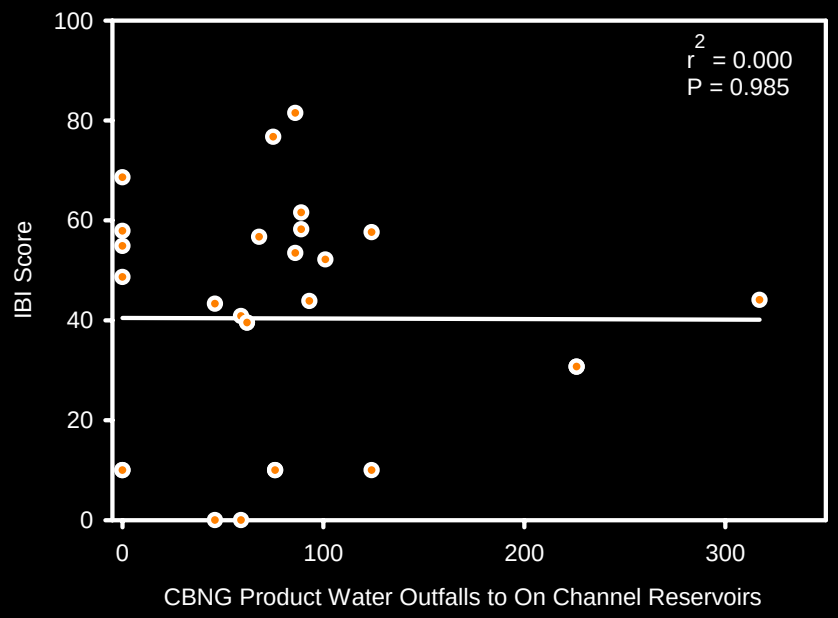
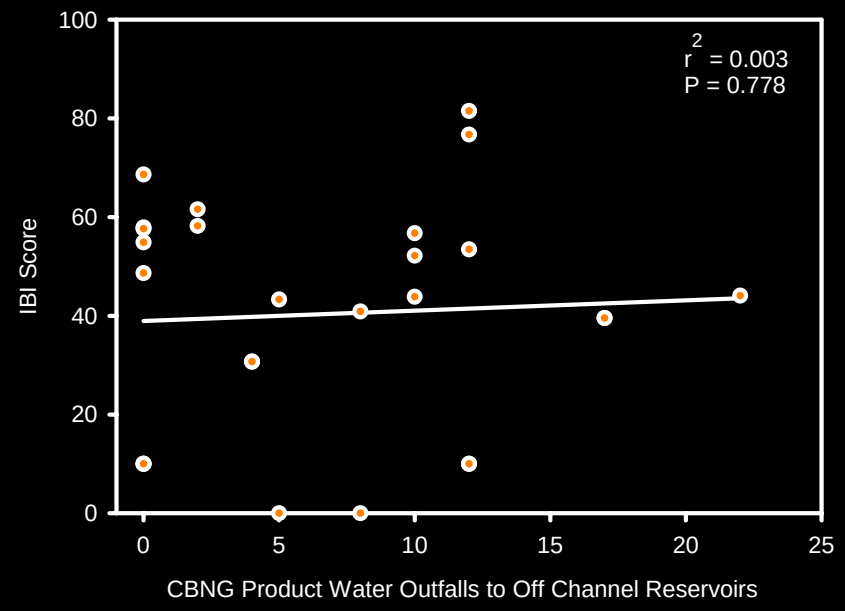
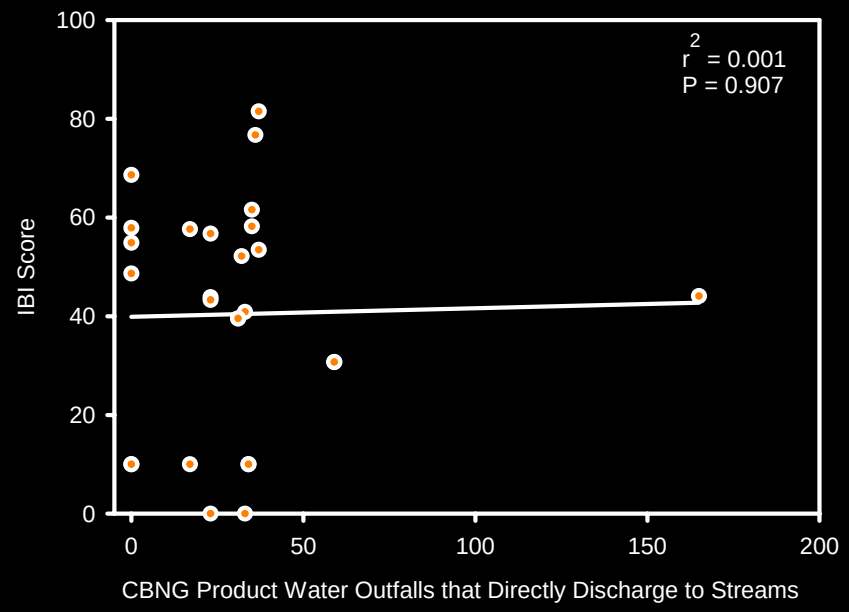
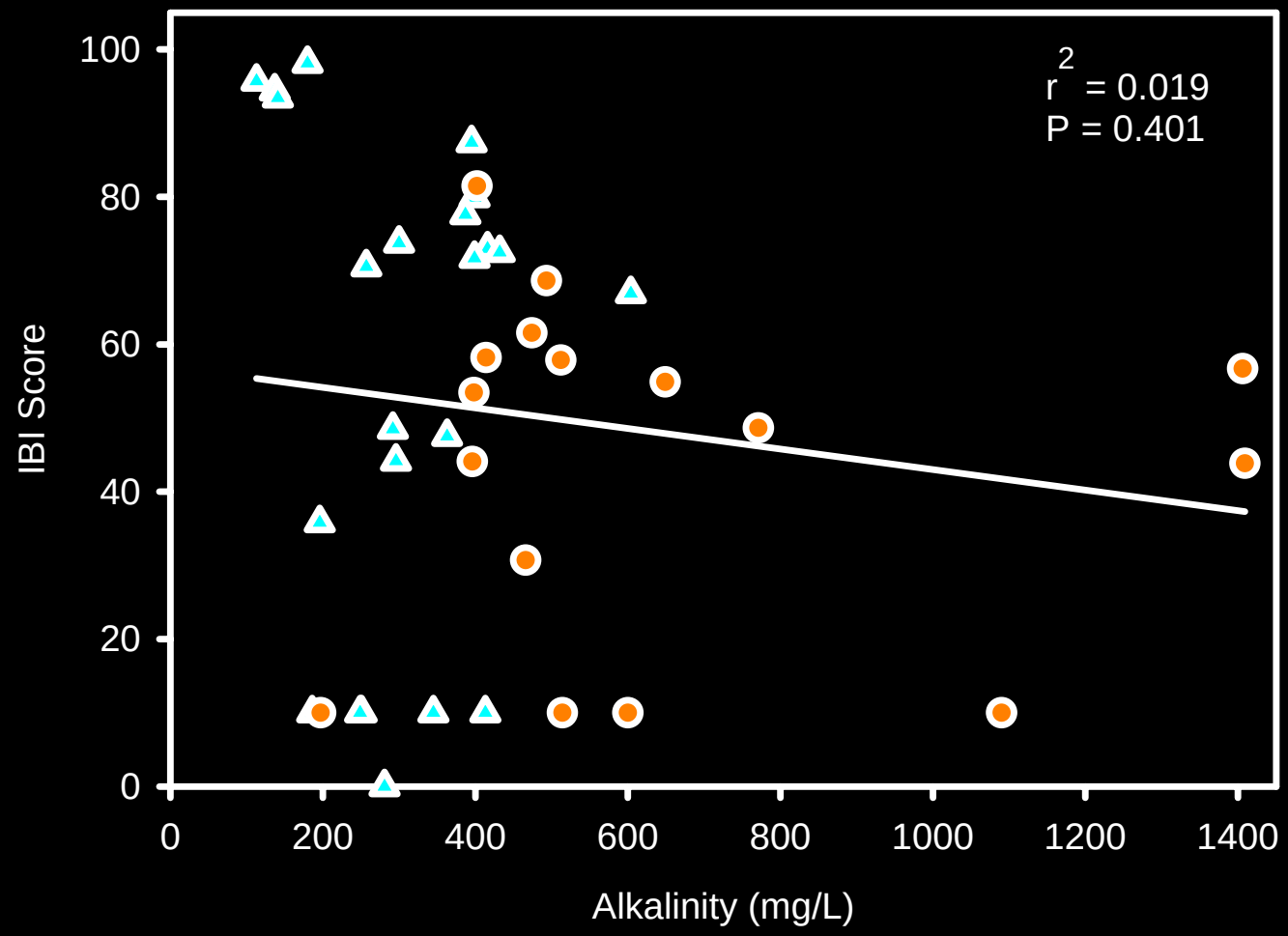






Biotic Integrity vs. Water Quality



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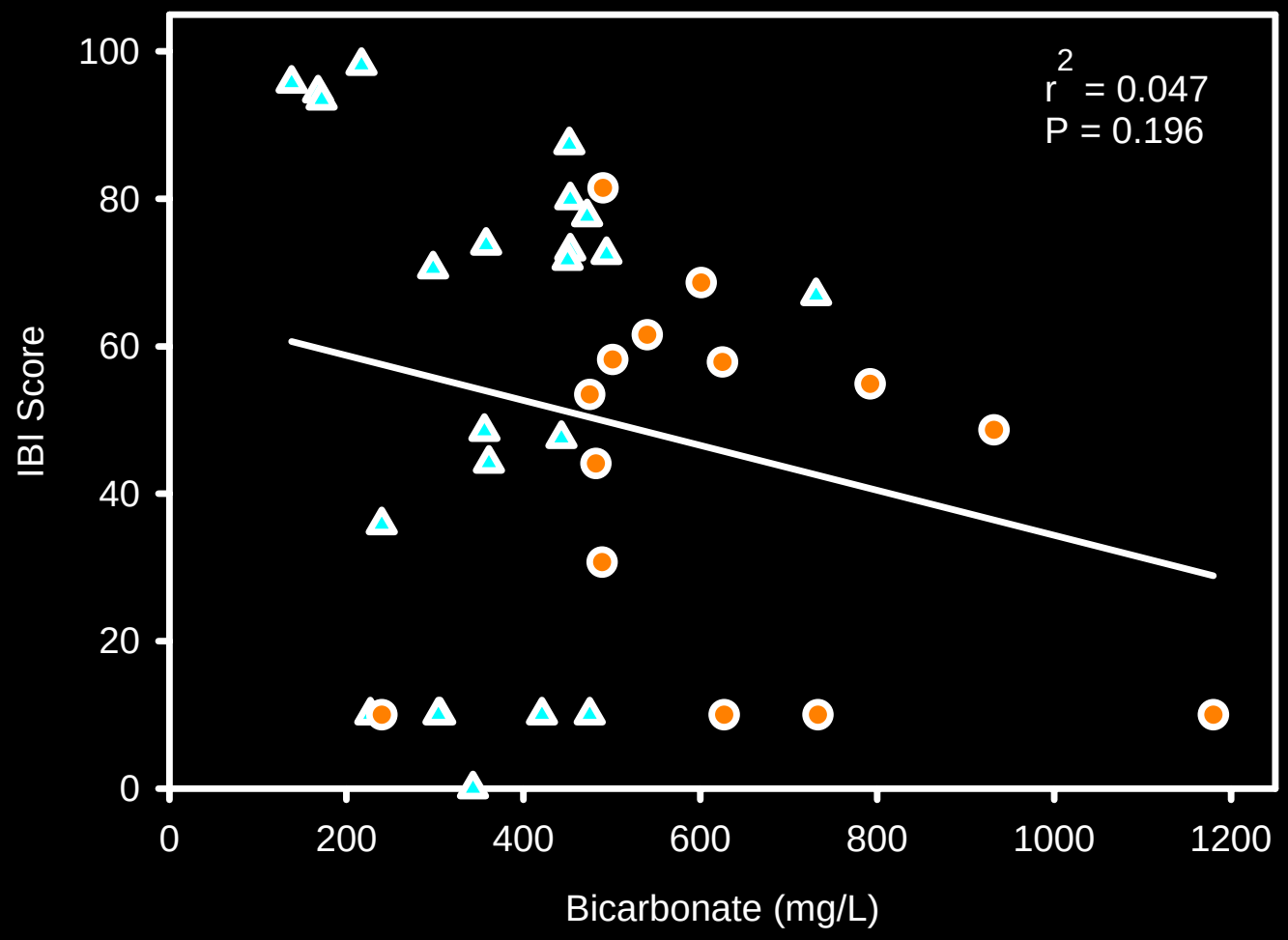
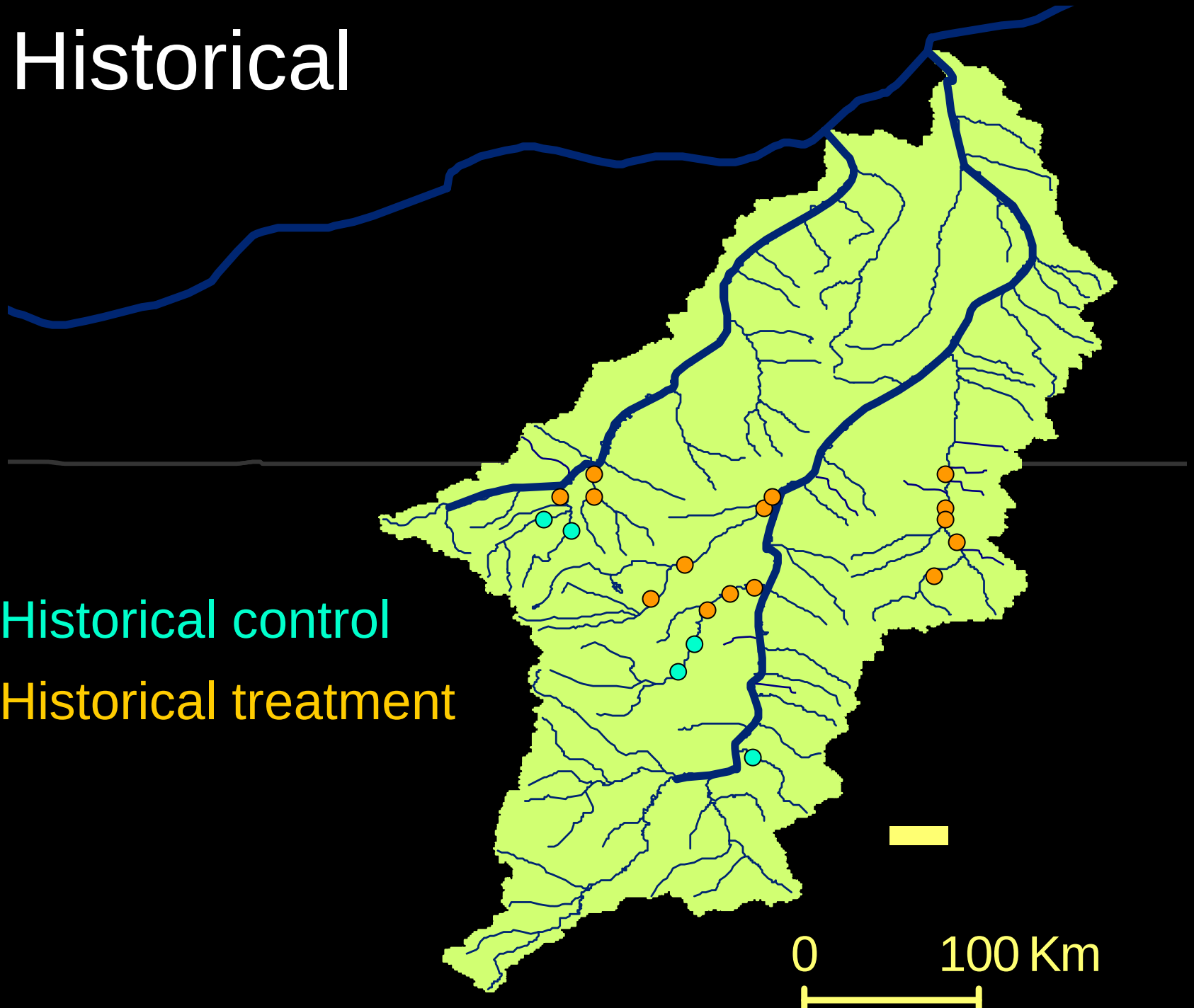


Historical



- Historical control
- Historical treatment

Changes

	Lost	Gained
Treatment	Lake chub Plains minnow Sturgeon chub Western silvery minnow	Black bullhead Brown trout Spottail shiner

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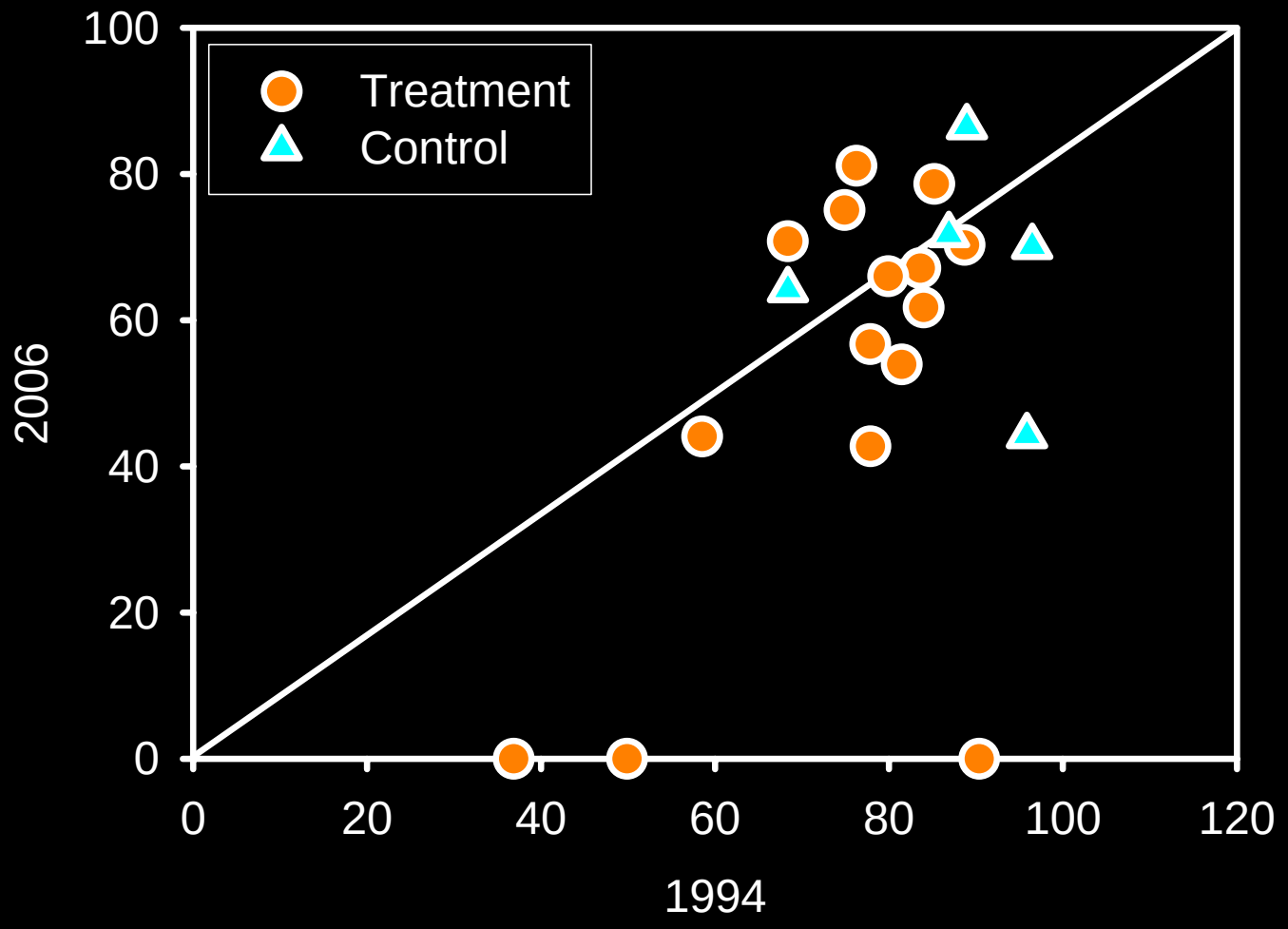
Control	Brassy minnow (2) Goldeye (2)	Channel catfish (1) Largemouth bass(1) Plains killifish (1) River carpsucker (1)

Biotic Integrity



Conclusions

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Research Challenges

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  No clear designation of the type of product water outfalls

  Difficult to assess quantity of product water entering the system at a given time

Research Limitations

- Most conservative model
- Short term data set
- Drought (2005-2006)

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BLM: Joe Platz, Larry Gerard
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Others: Ryan White, Tiffany Holland, Carol Endicott, Kristin Murphy (photos), Billie Kerans, Anadarko Co., Fidelity Inc., and all the cooperative landowners of the Powder River Basin.

WILD FISH HABITAT INITIATIVE

MONTANA University System WATER CENTER

Questions?