Macroinvertebrate Response to RSCs

March 2017 Results

Greg Pond and Kelly Krock

U.S. EPA, Region III

Wheeling , WV

Macroinvertebrates: 2 basic research questions

1. Do RSCs improve macroinvertebrate diversity and aquatic life use in MD's urban CP streams?

2. What abiotic factors drive macroinvertebrate diversity and assemblage structure among MD's restored and unrestored coastal plain streams?

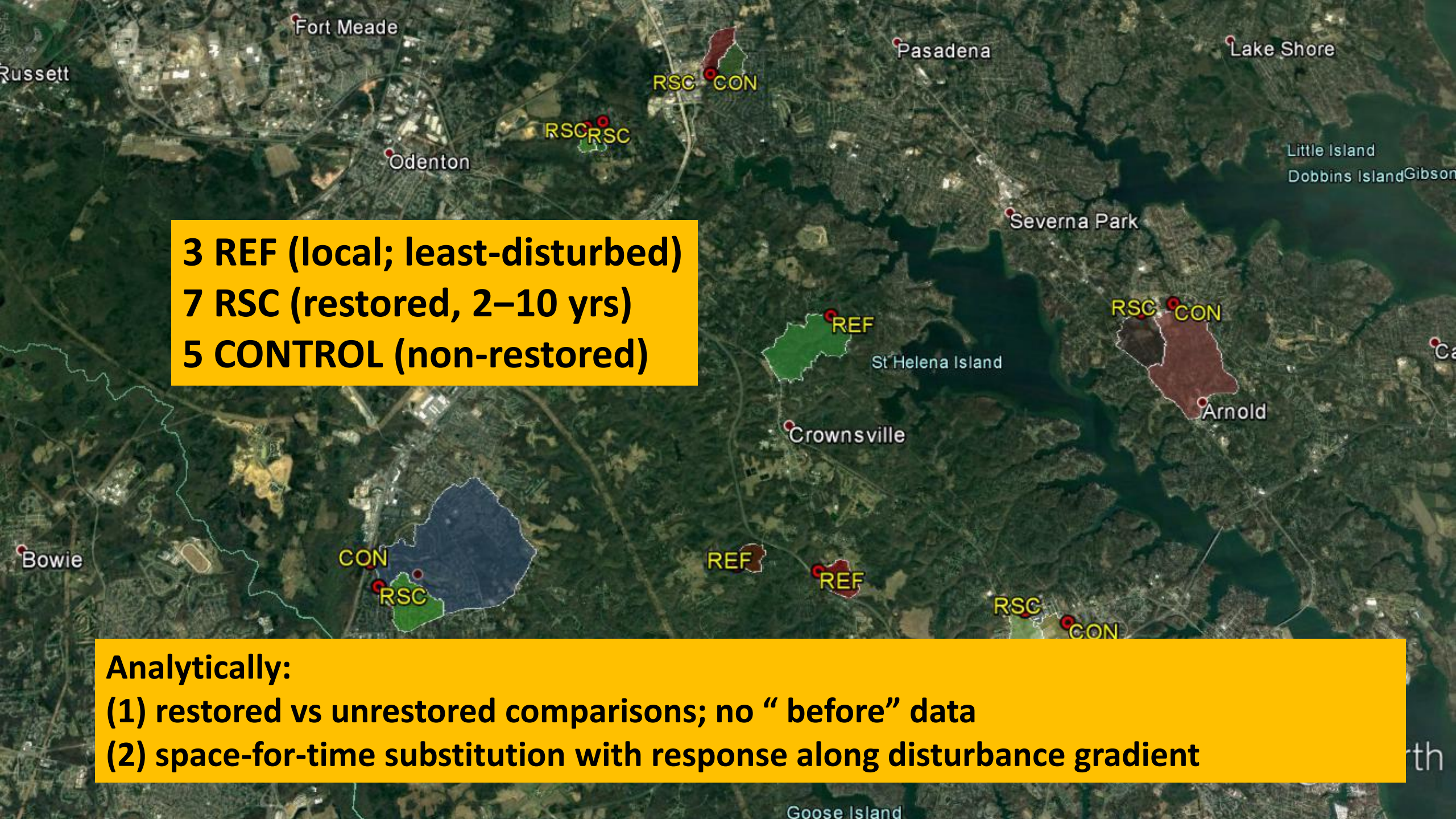
METHODS

- One-time baseflow sampling for biology, chemistry, habitat data (Mar 2017);
- Sampling performed in 75m riffle-run-pool complexes (not wetland complexes);
- Followed MBSS benthic sampling and processing protocols (120- count)
  - 20- $1ft^2$ jabs allocated among stable, flowing habitats
  - 200-count also analyzed to enhance estimates of biodiversity

Our predictions:

- *RSCs should exhibit biological "uplift" (i.e., increased benthic diversity and assessment scores) over non-restored sites*

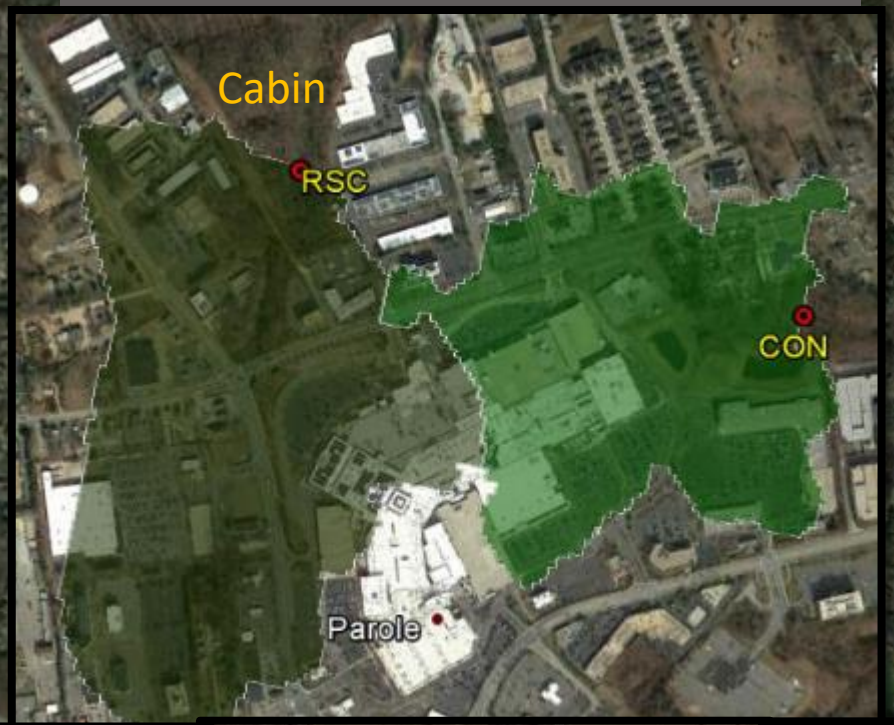
- *Urban land use (e.g., % impervious) would be a primary driver of overall benthic health. RSCs should moderate the urban impact (by design) via improvements in habitat and water quality.*



3 REF (local; least-disturbed)
7 RSC (restored, 2–10 yrs)
5 CONTROL (non-restored)

Analytically:
(1) restored vs unrestored comparisons; no " before" data
(2) space-for-time substitution with response along disturbance gradient

Example Pairs



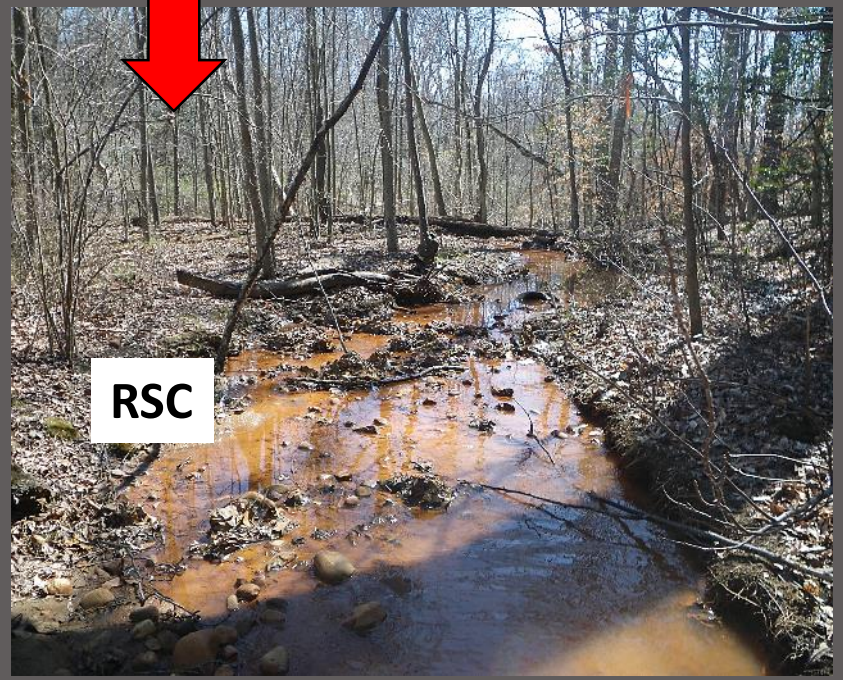
Local References

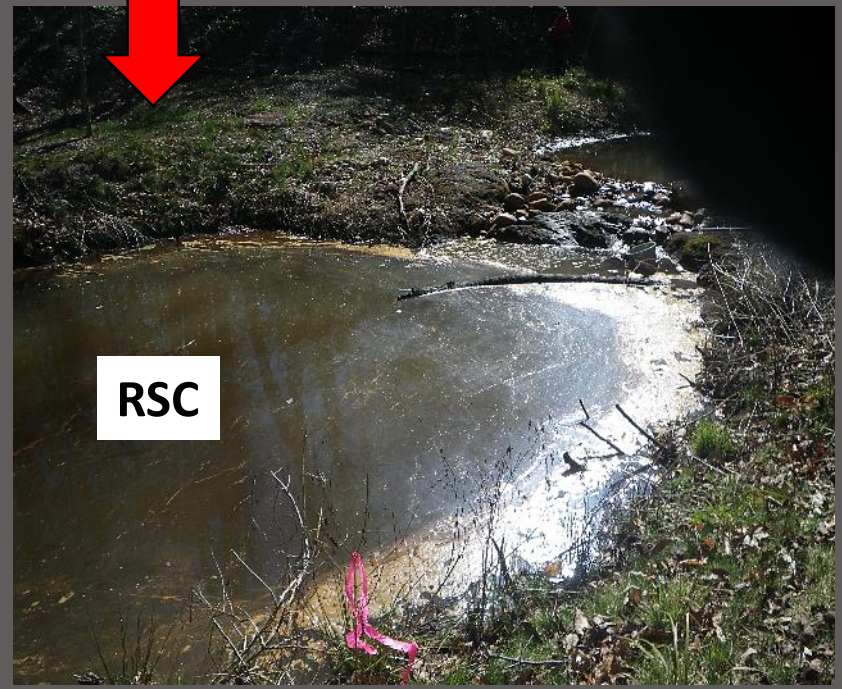
Control

Control

Control

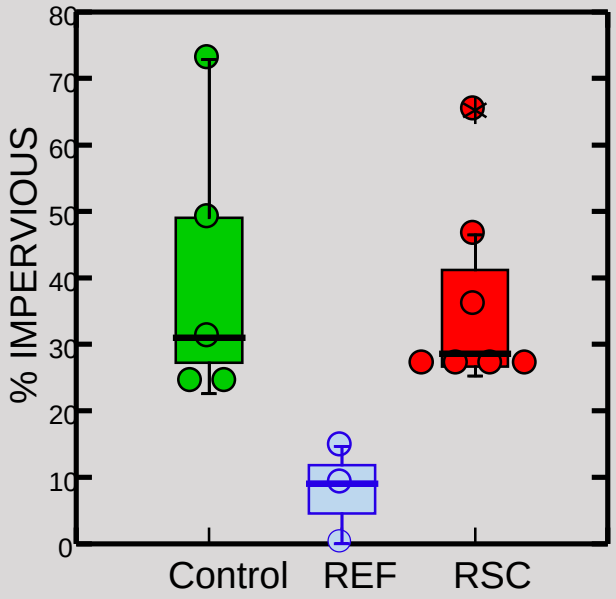
RSC

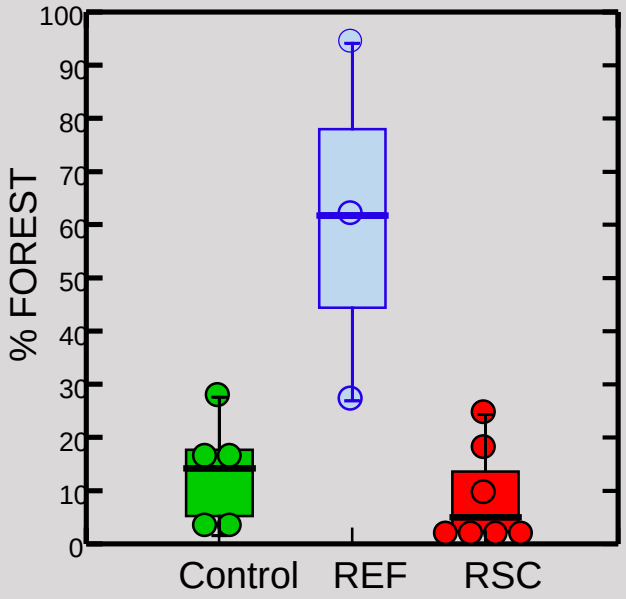

RSC

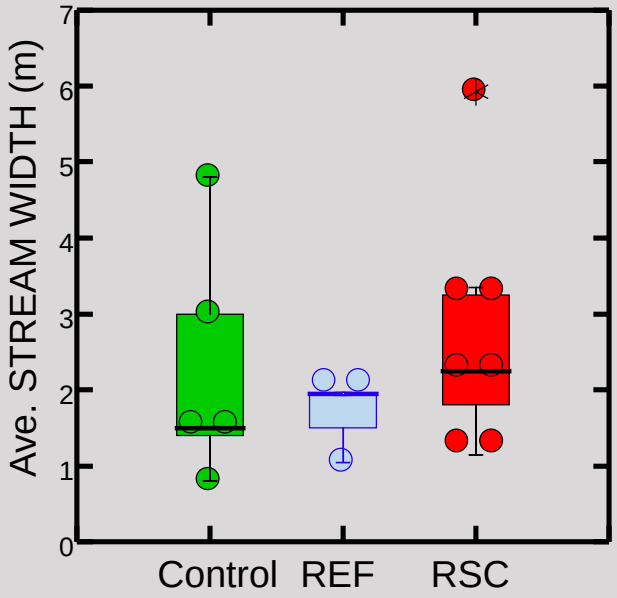

RSC

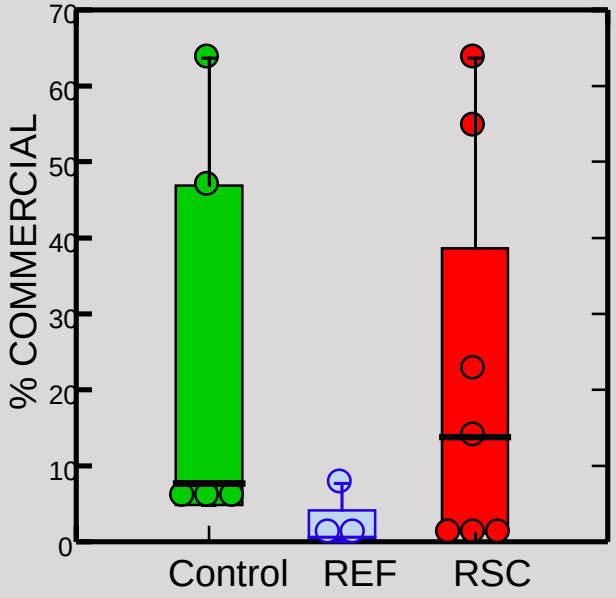
Site selection:
By design, land use and stream size between RSCs and Controls were roughly similar

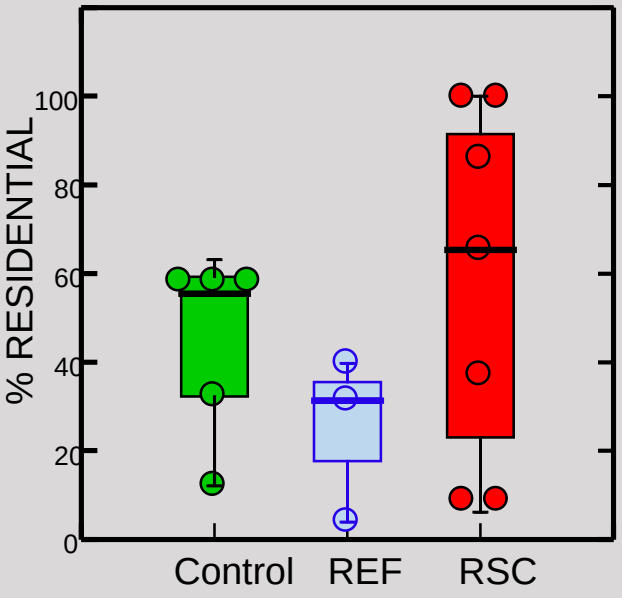
Land use data from 2014 Anne Arundel Co. layer











Benthic IBIs

MD B-IBI (1—5 scale)

Coastal Plain
Number of Taxa
Number of EPT
Number of Ephemeroptera
% Intolerant Urban
% Ephemeroptera
Number of Scrapers
% Climbers

CHESSIE B-IBI (0—100 scale)

SEP	GOLD
SEP	PCT_COTE
SEP	PCT_EPT_RICH_NO_TOL
SEP	RICH_EPHEMEROPTERA
SEP	RICH_TRICHOPTERA
SEP	RICH_COLLECT
SEP	RICH_FILTER
SEP	PCT_CLING
SEP	RICH_CLING
SEP	ASPT_MOD
SEP	HBI

The GOOD

MD B-IBI= 3.57

CHESSIE B-IBI= 74.1

The *really* BAD

MD B-IBI= 1.0

CHESSIE B-IBI= 0.0

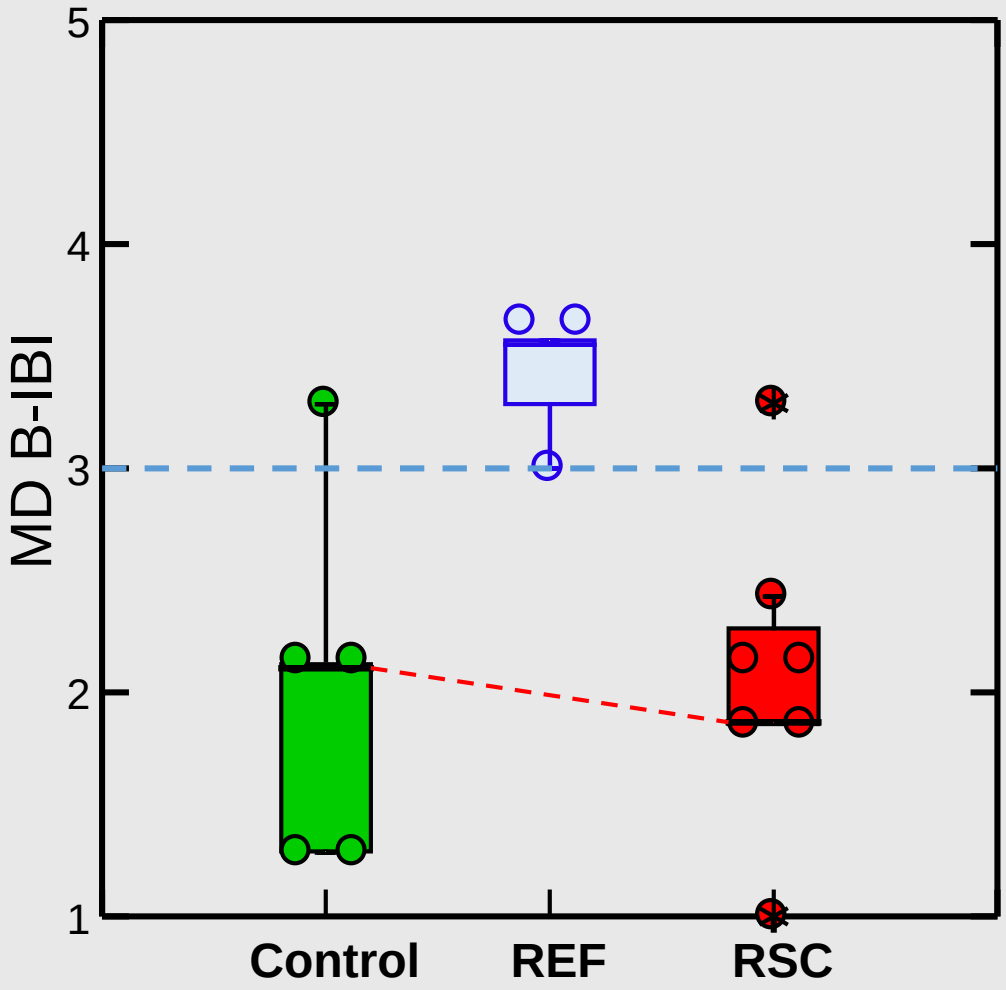
The UGLY

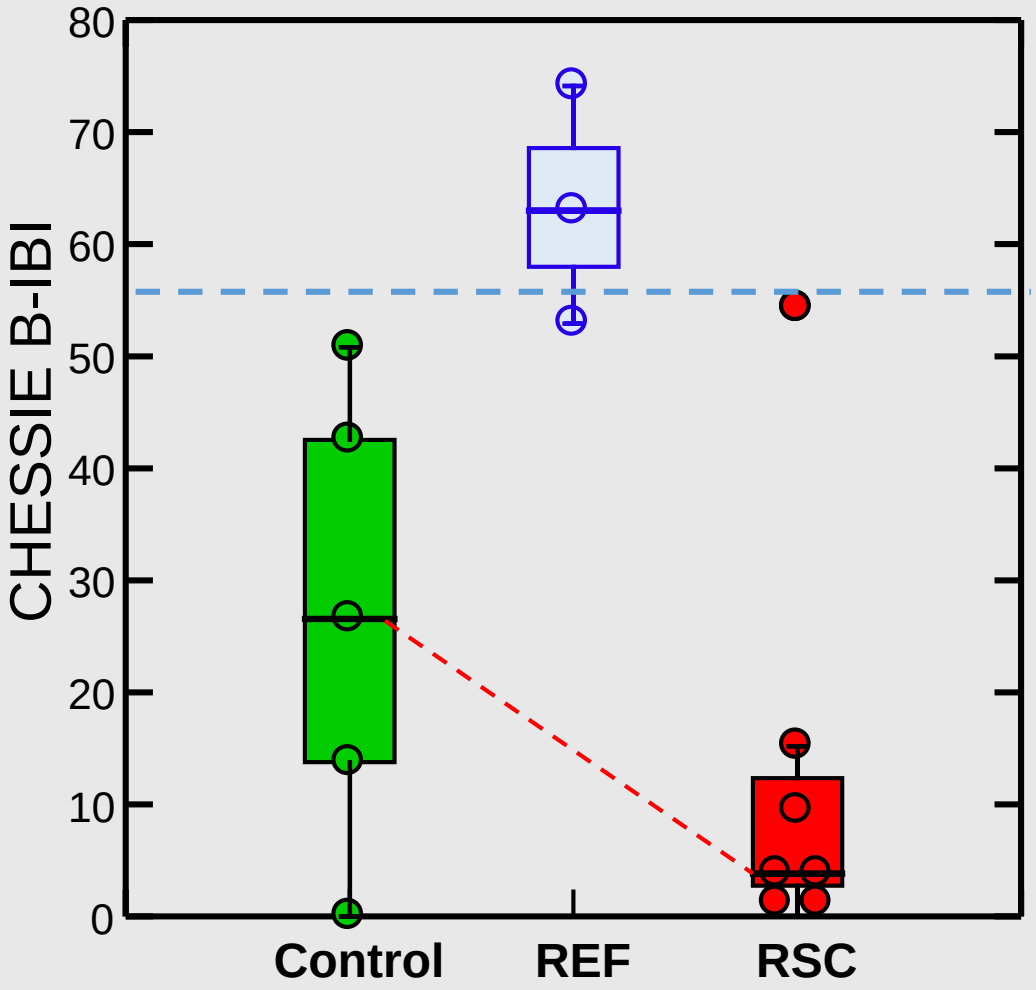
MD B-IBI= 1.86

CHESSIE B-IBI= 1.9

Worms and maggots dominated here

B-IBI Results

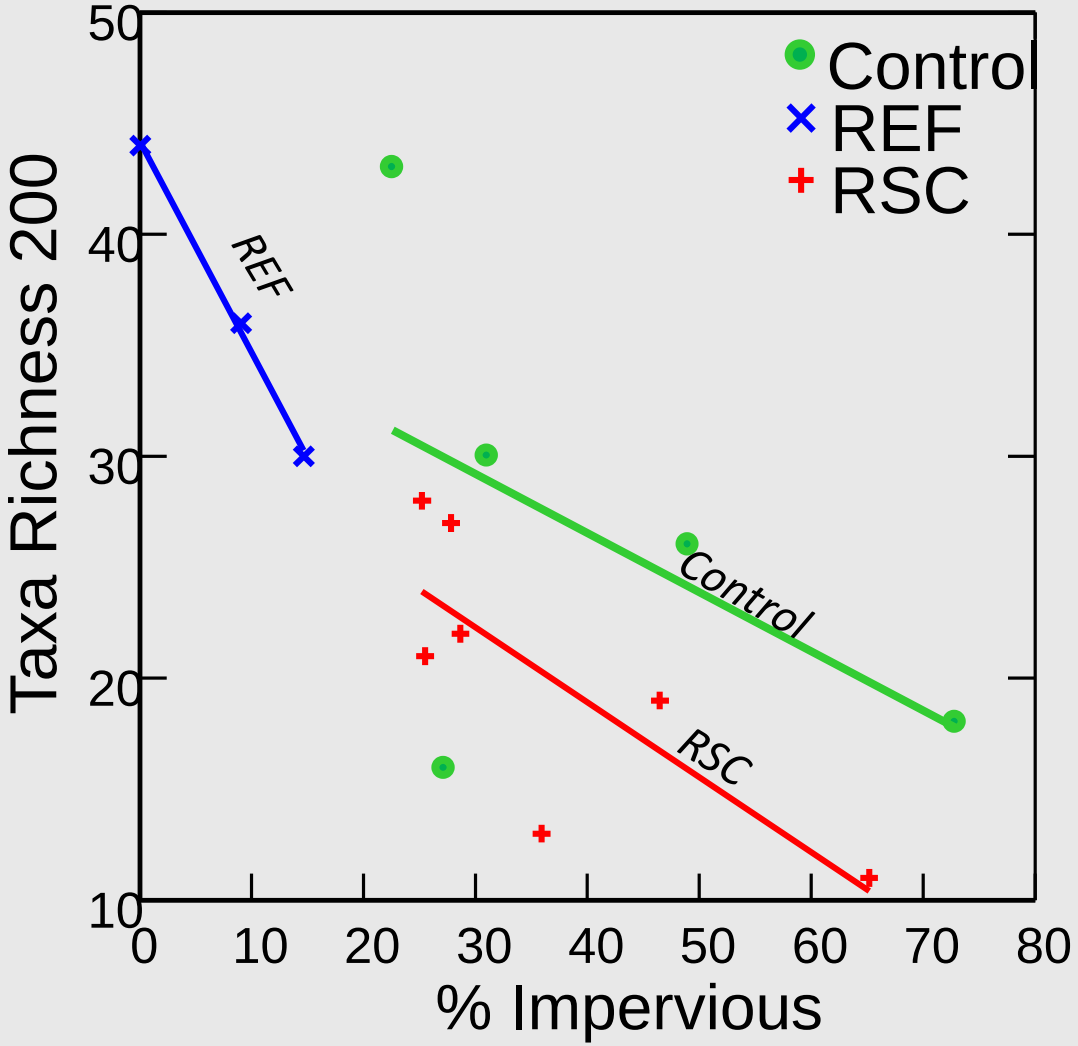


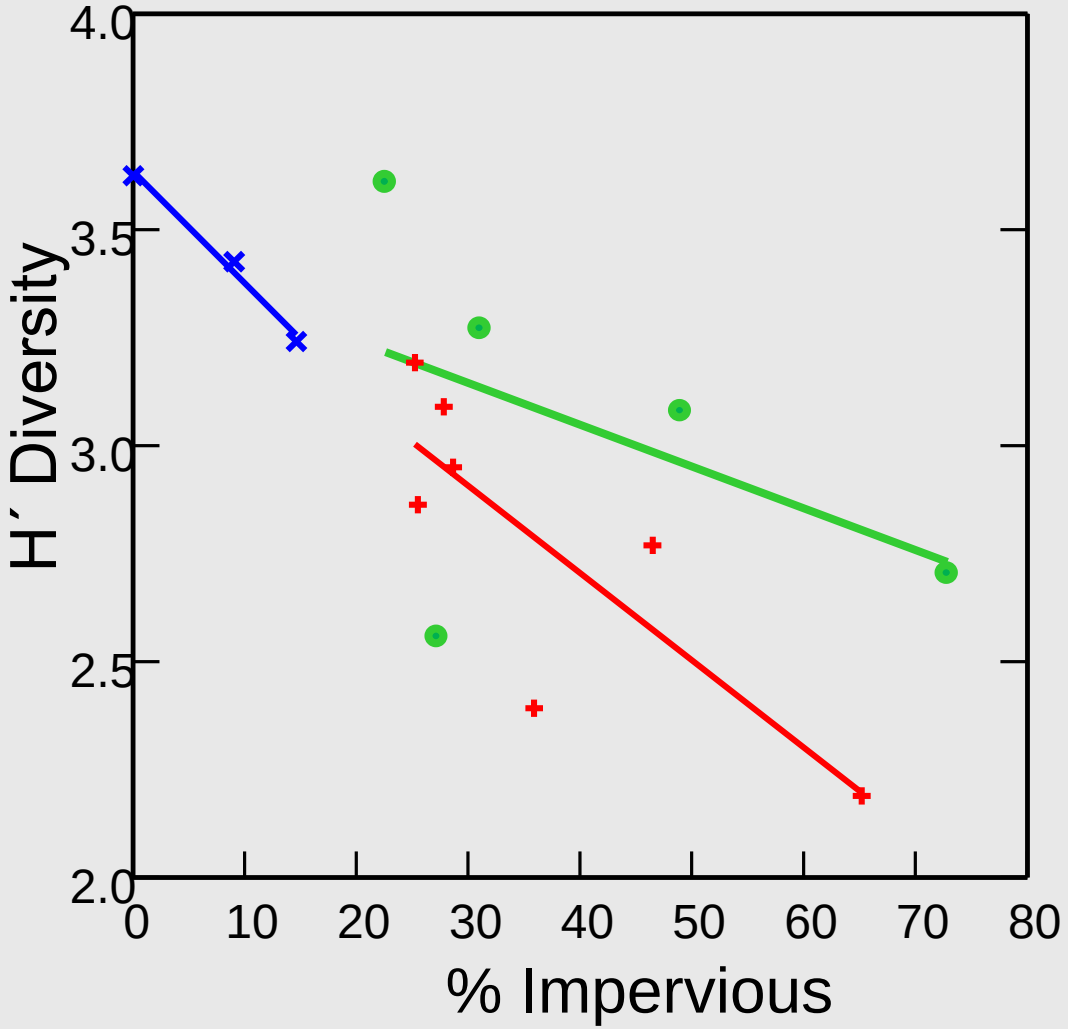


On average…

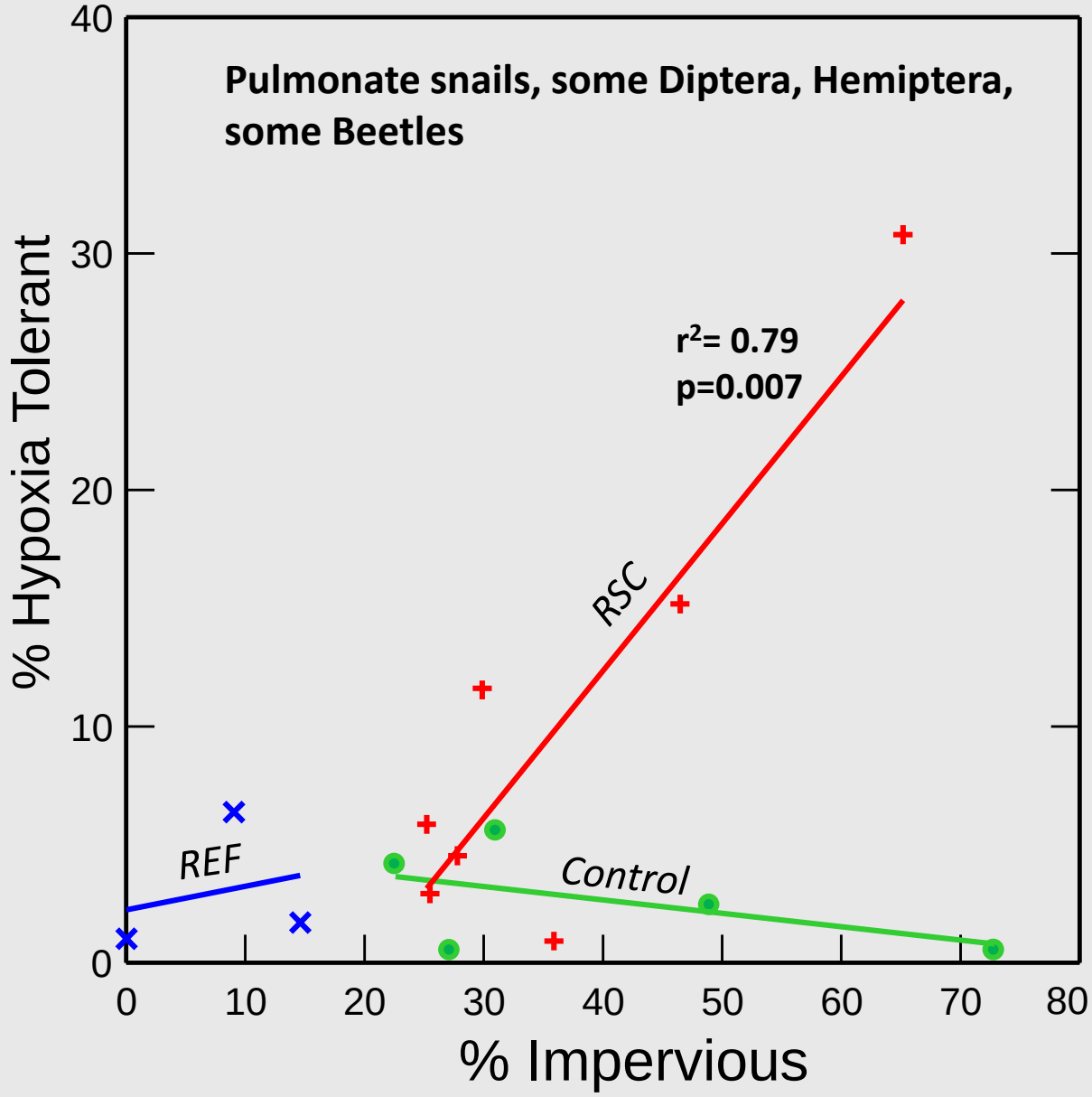
Means	REF (n=3)	CONTROL (n=5)	RSC (n=7)
TR (200)	36.7	26.4	20.1
EPT (200)	8.6	1.4	1.4
%Intol (Urban)	32.1	3.5	1.7
Ephem Richness	1	0	0.1
% Ephem	2.8	0	0.1
Scraper Rich	0.7	1.6	1.3
% Climbers	0.6	3.4	7.8
MD BIBI (120)	3.4	2.1	2.1
Chessie BIBI (120)	63.3	26.8	12.6
% Impervious	7.9	40.6	36.4

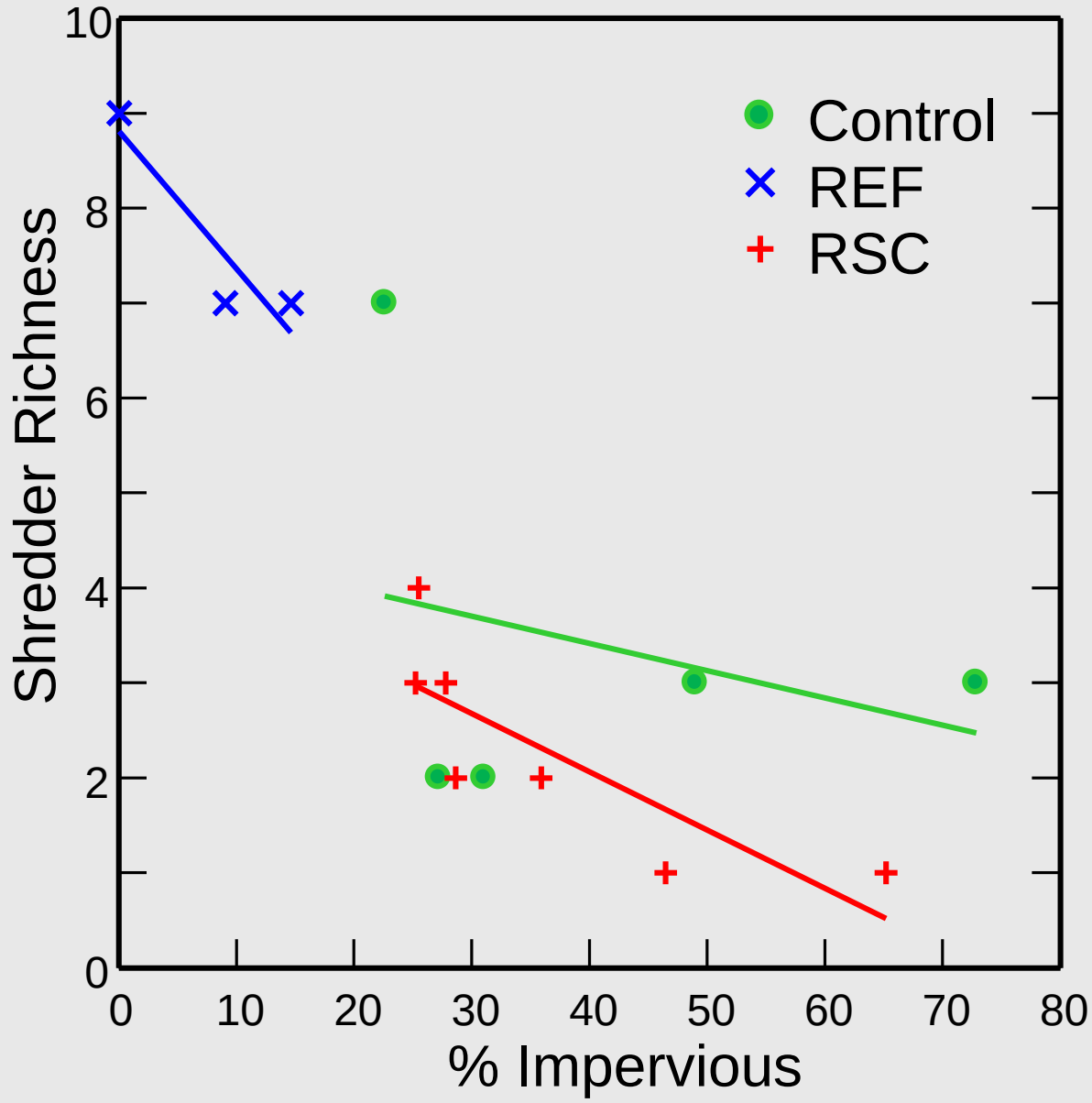
Imperviousness drives biology



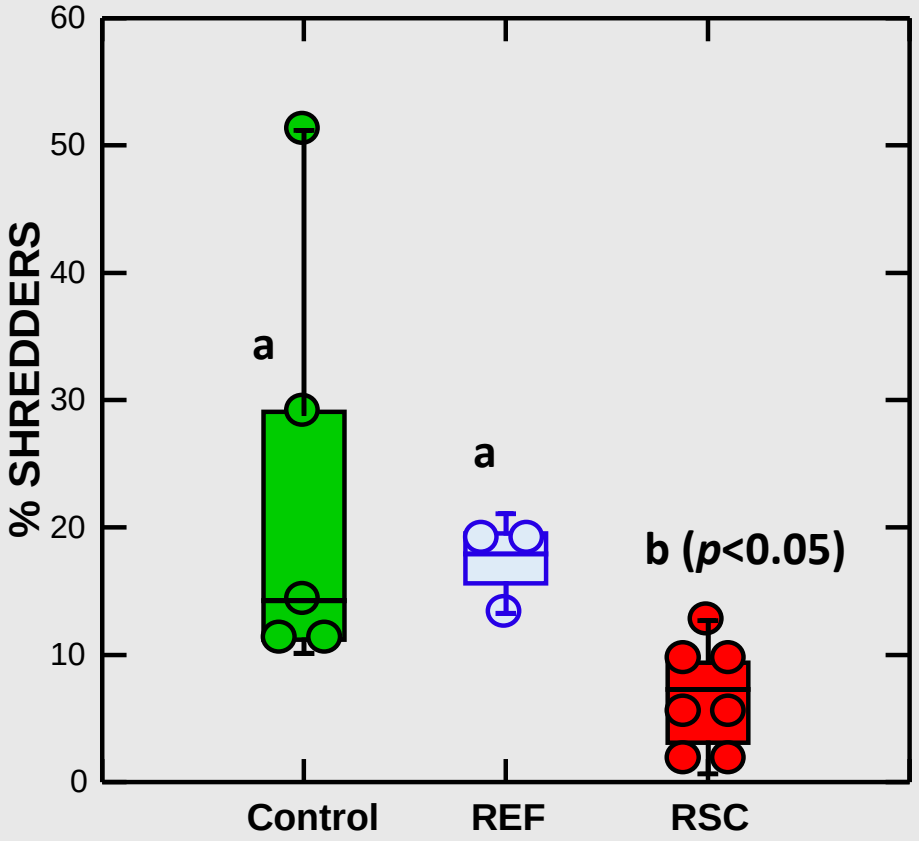


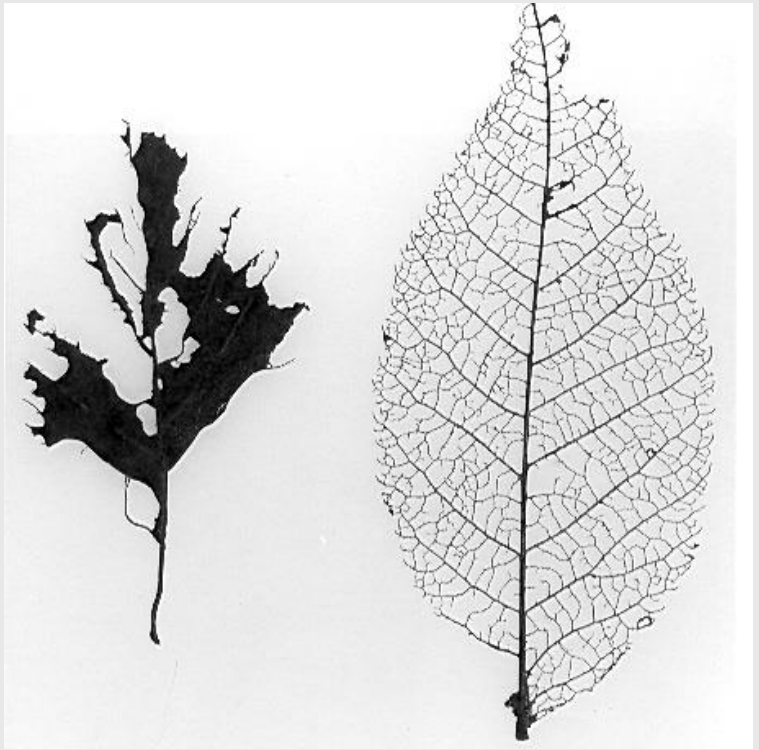
But RSCs tend to show reduced richness and diversity along gradient


Pulmonate snails, some Diptera, Hemiptera, some Beetles
r²= 0.79
p=0.007
RSC
REF
Control
% Hypoxia Tolerant
% Impervious
0
10
20
30
40
50
60
70
80


Control
REF
RSC
Shredder Richness
% Impervious
0
2
4
6
8
10
0
10
20
30
40
50
60
70
80

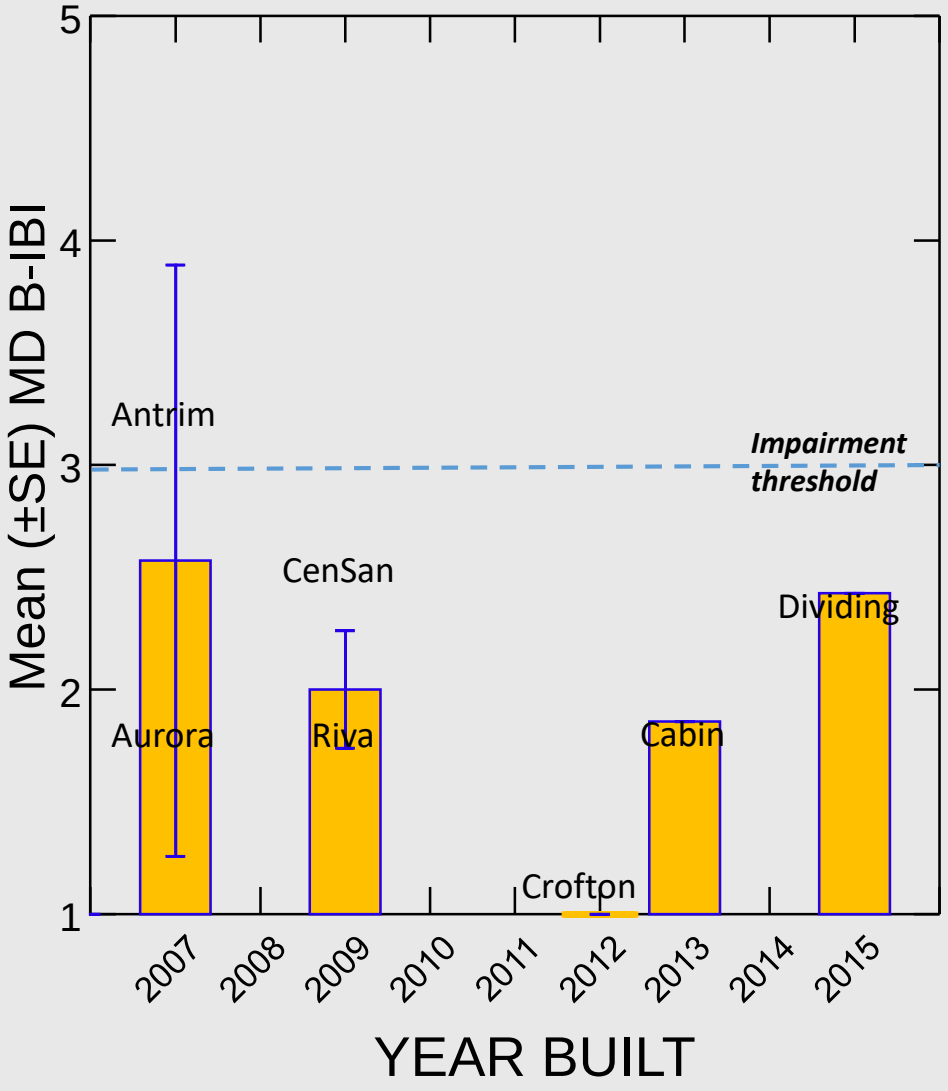
Shredders are important to functioning headwater streams

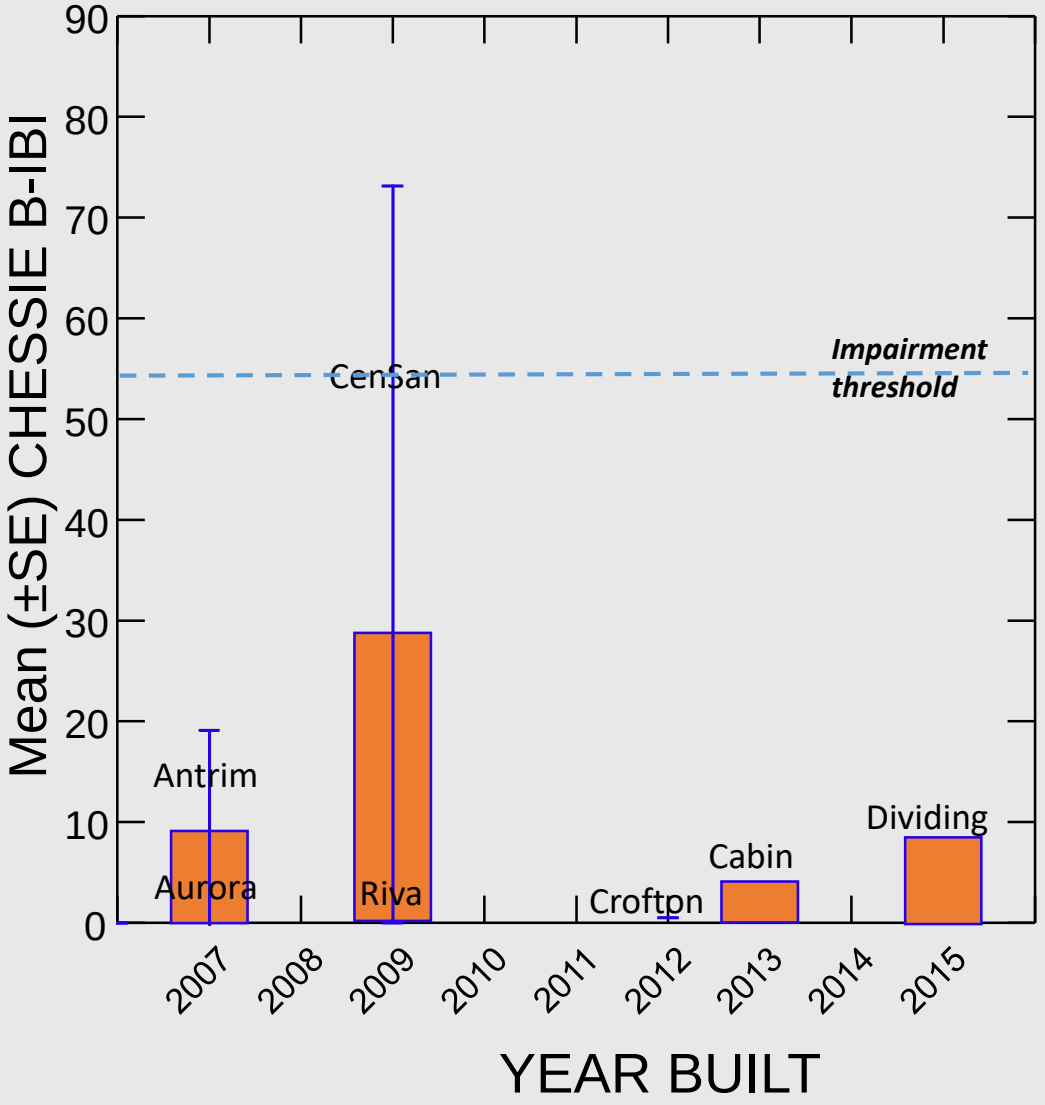




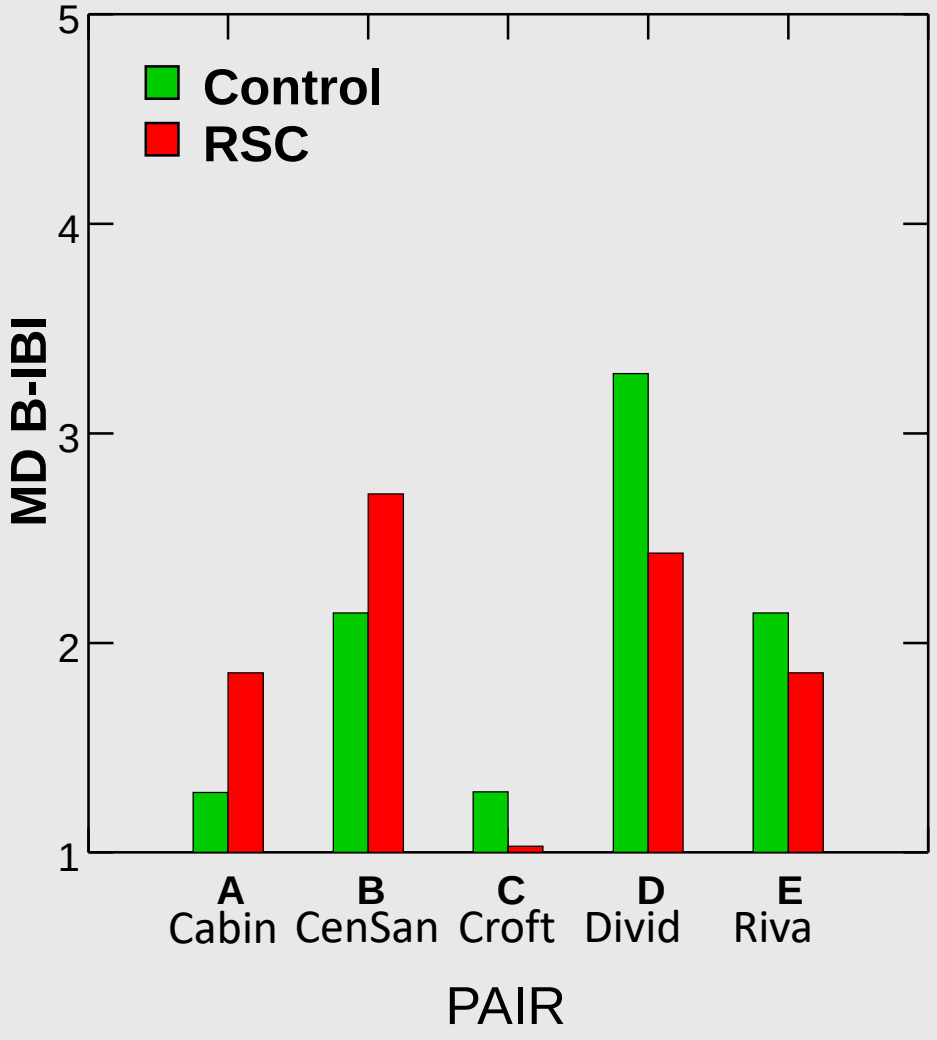
Shredder abundance significantly lower at RSC sites

No distinctive age—B-IBI patterns at RSCs

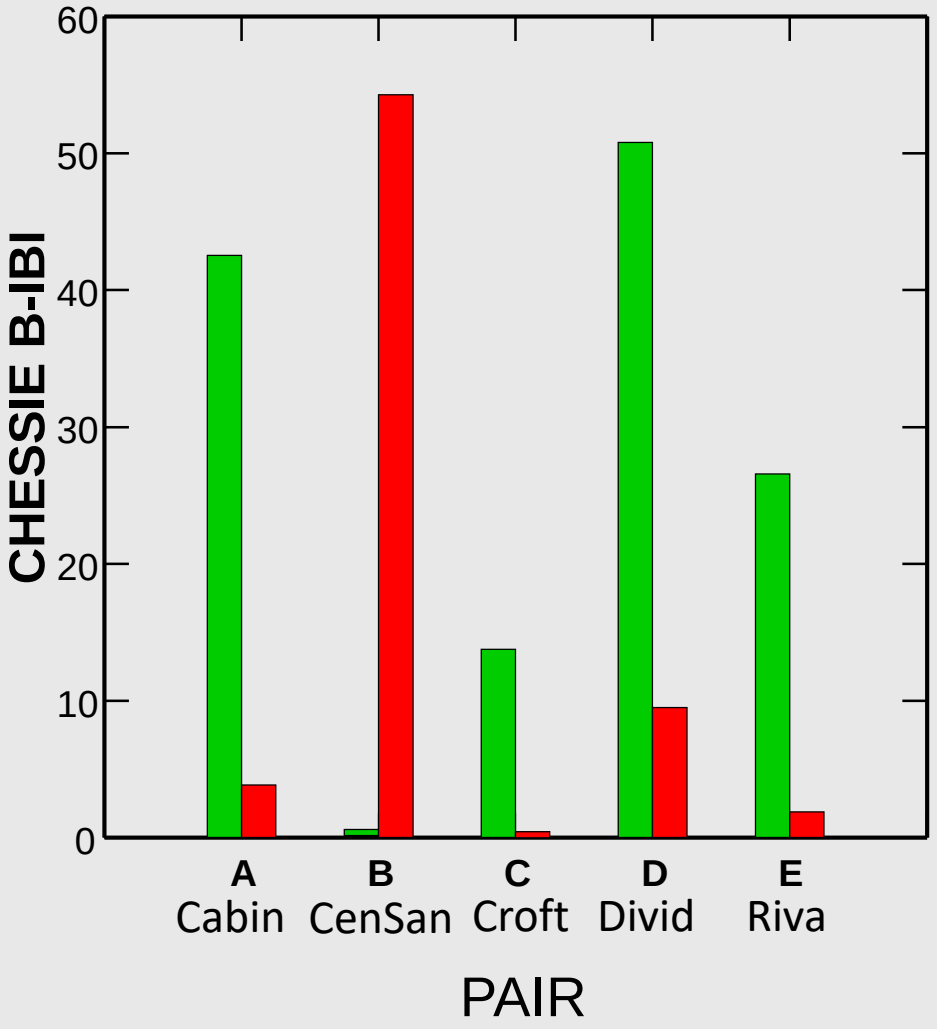




RSC vs. Control Pairs

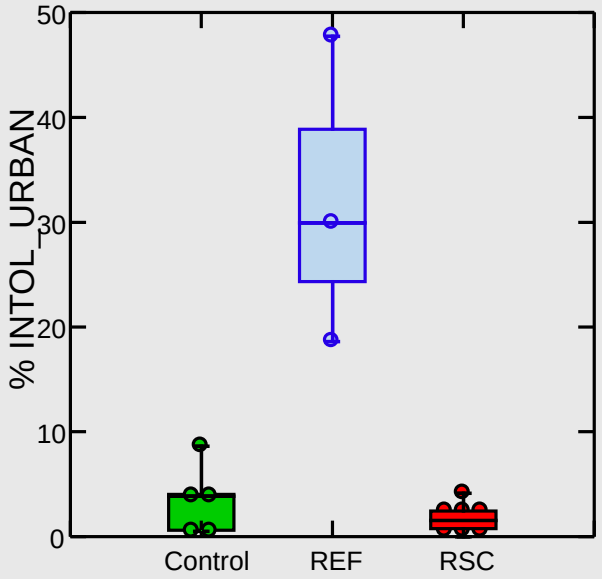


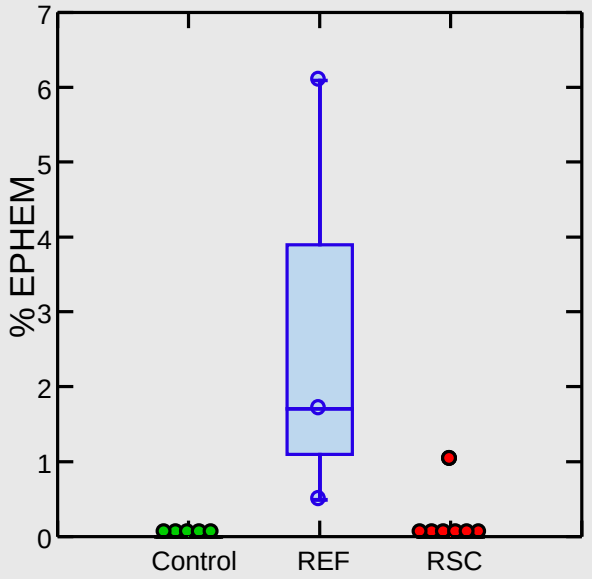
2 of 5 RSCs "improved"



1 of 5 RSCs "improved"

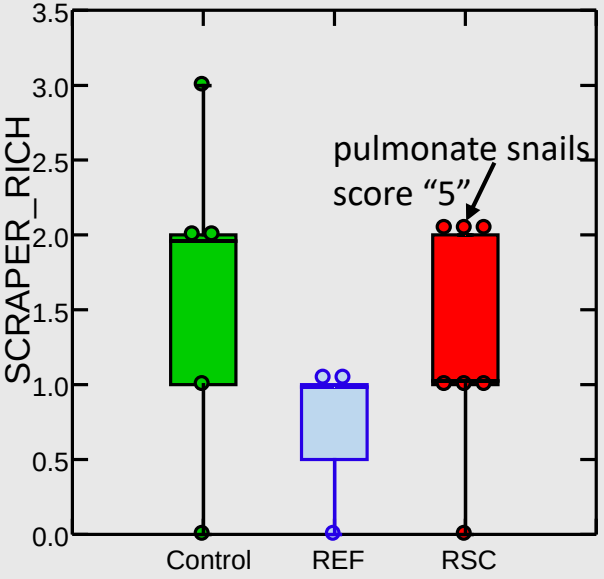
Component MD B-IBI metrics

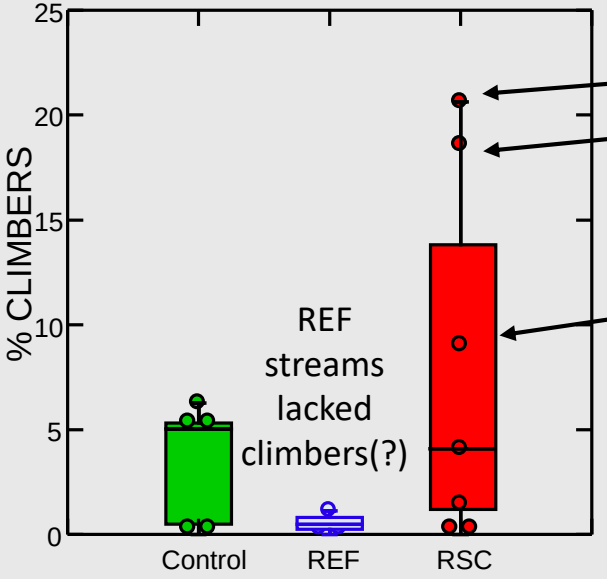




2 B-IBI metrics giving false impressions ?

Highly tolerant snails and zygopterans increase <u>scrapers</u> and <u>climbers</u>—tended to *inflate* B-IBI scores.





Cabin scores a "5" having 20% tolerant *Physa* snails

Central Sanitation scores a "5" having 18% pollution tolerant damselflies (*Ischnura*)

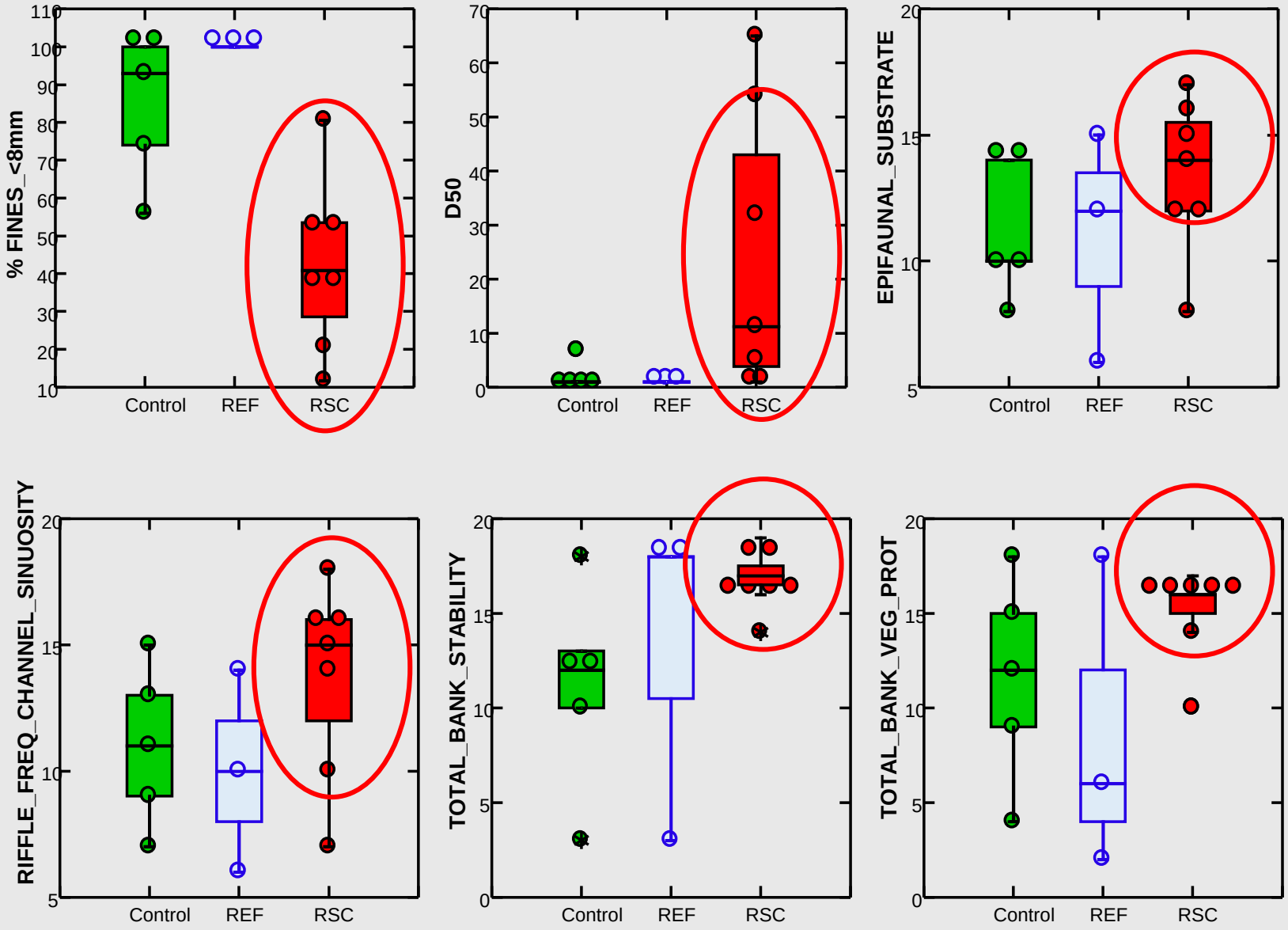
Dividing Cr scores a "5" having 9% tolerant *Physa* snails

Habitat

Substrate and RBP Habitat metrics

% Fines reduced, and median substrate diameter (D_{50}) increased at RSC sites

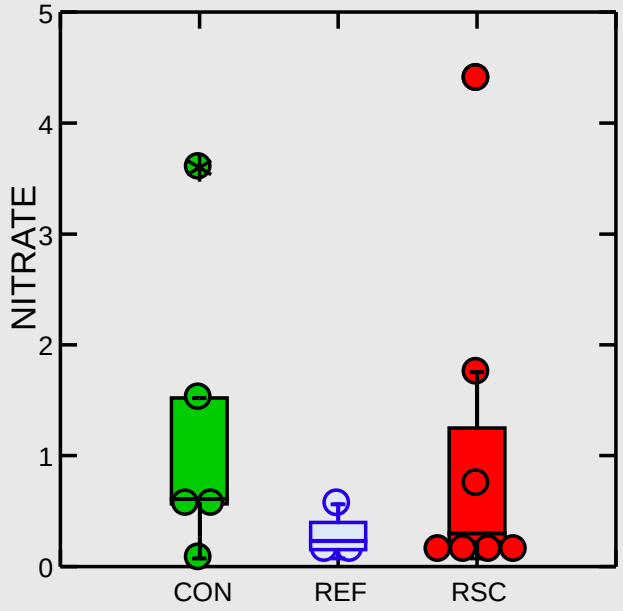
Bank stability and bank vegetation increased at RSCs

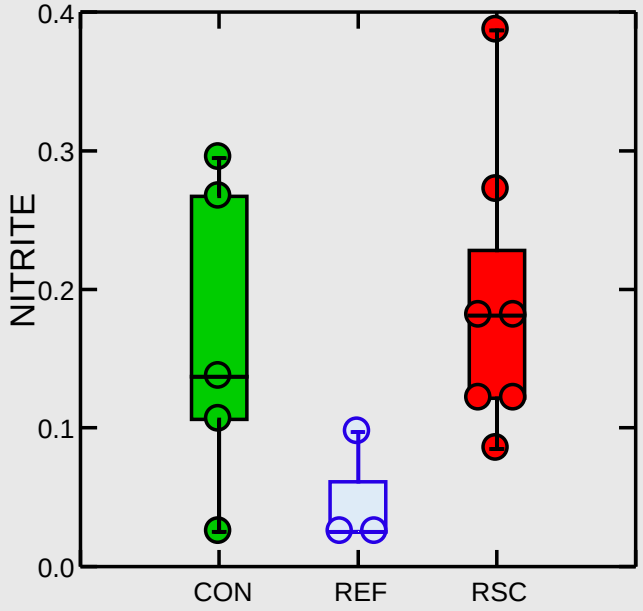


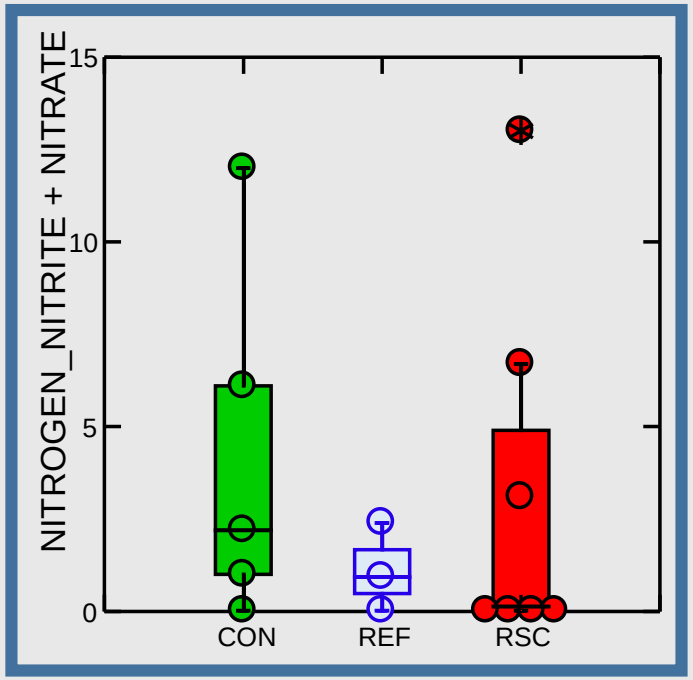
Nutrients

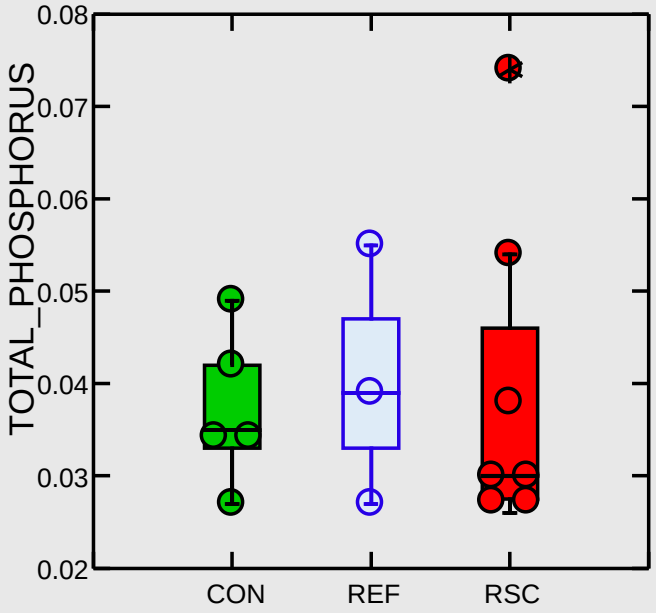
No significant difference in nutrients ($p>0.05$) between RSCs and Controls

**nutrient holding time exceeded at lab—but better confidence in



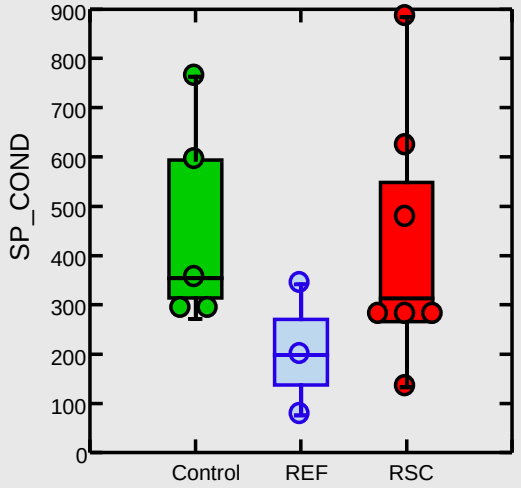


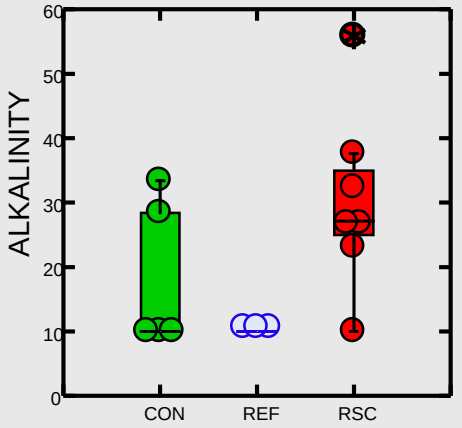


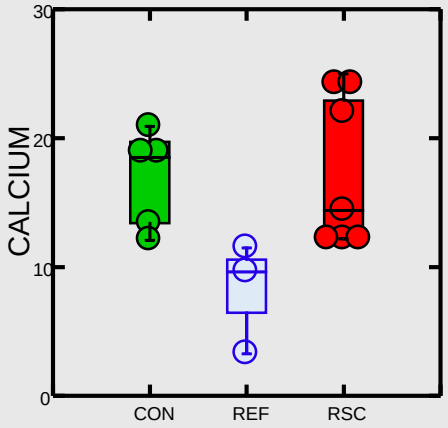


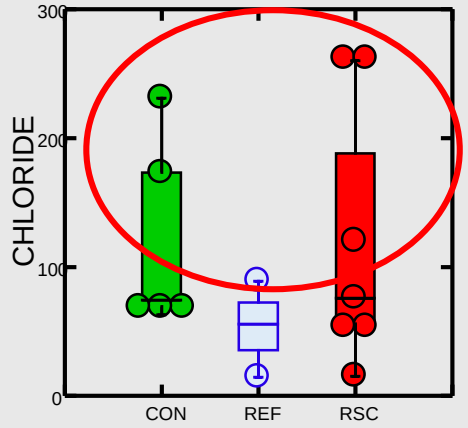
Ions

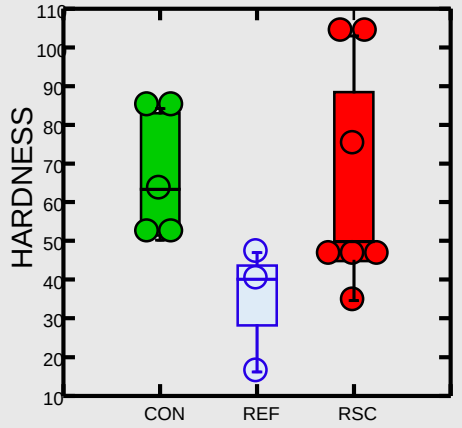
No significant difference in ions (p>0.05) between RSCs and Controls

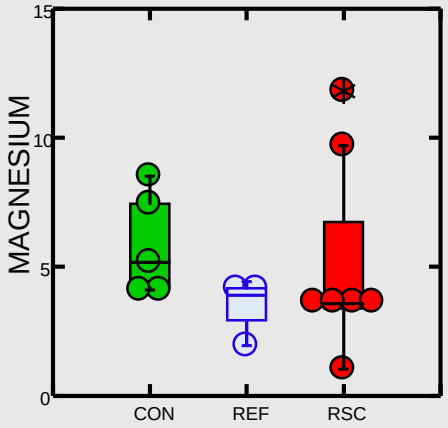


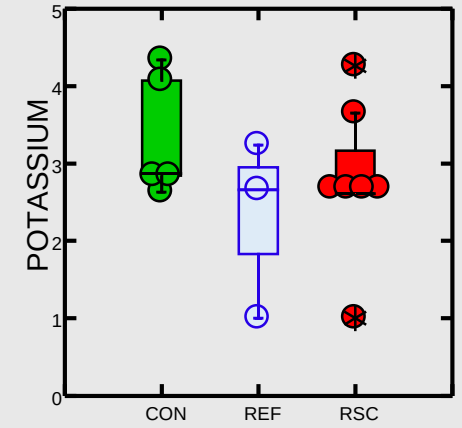


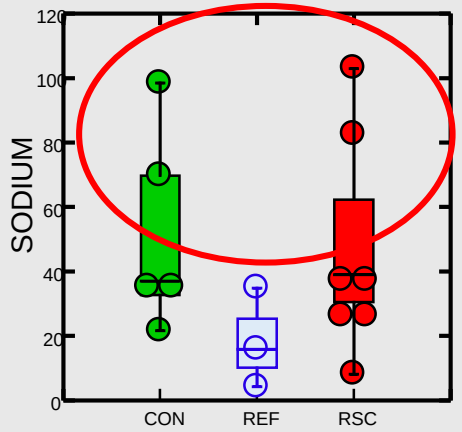


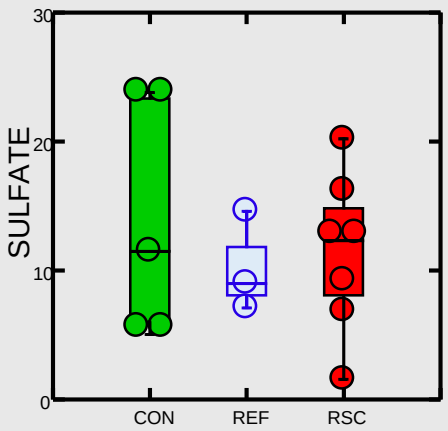


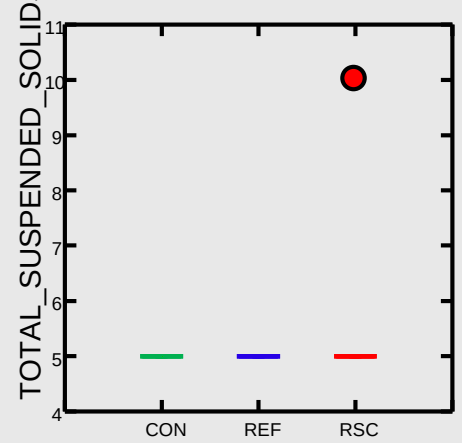








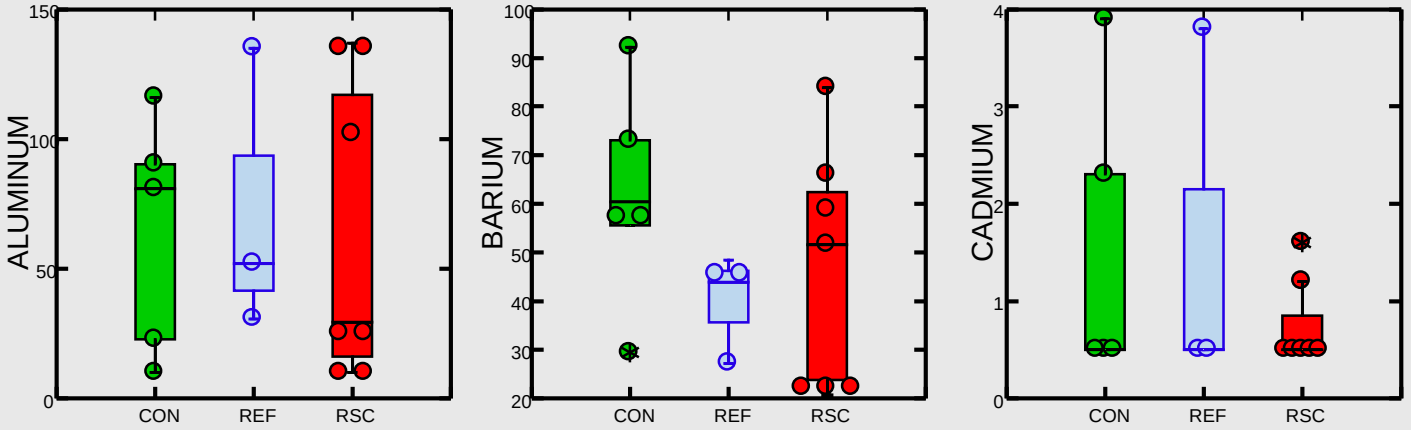


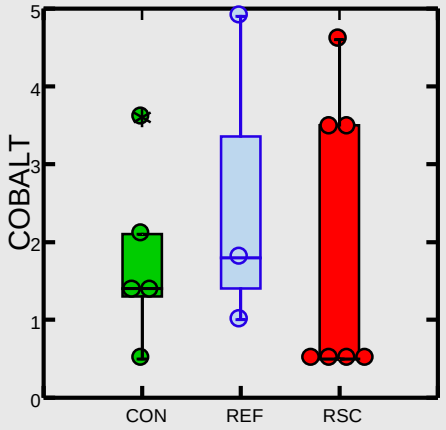


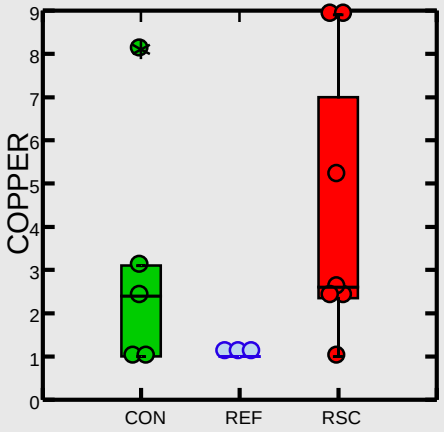
Clear water sampling conditions

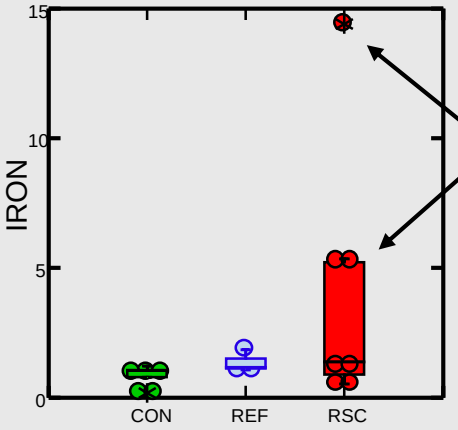
Metals

No significant difference in metals (p>0.05) between RSCs and Controls

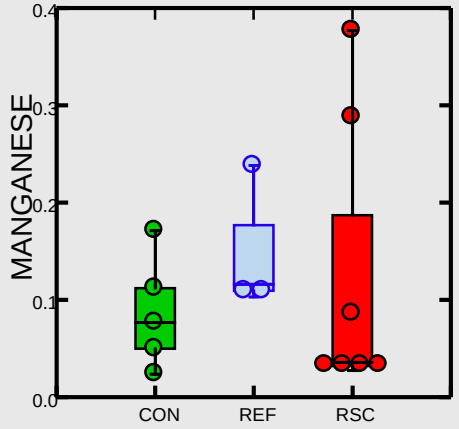


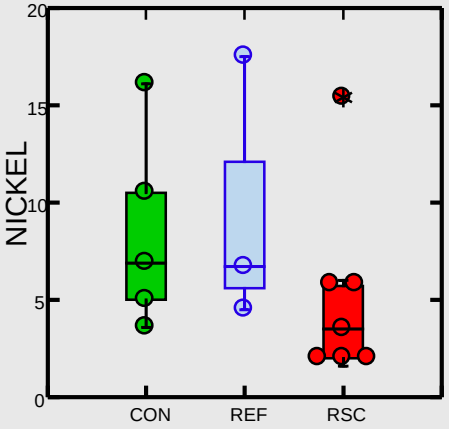


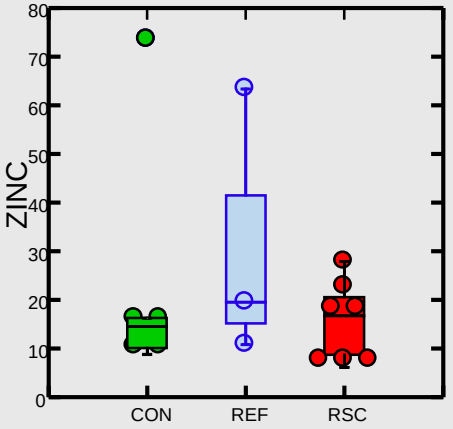




Water column Fe was elevated at 3 RSC sites

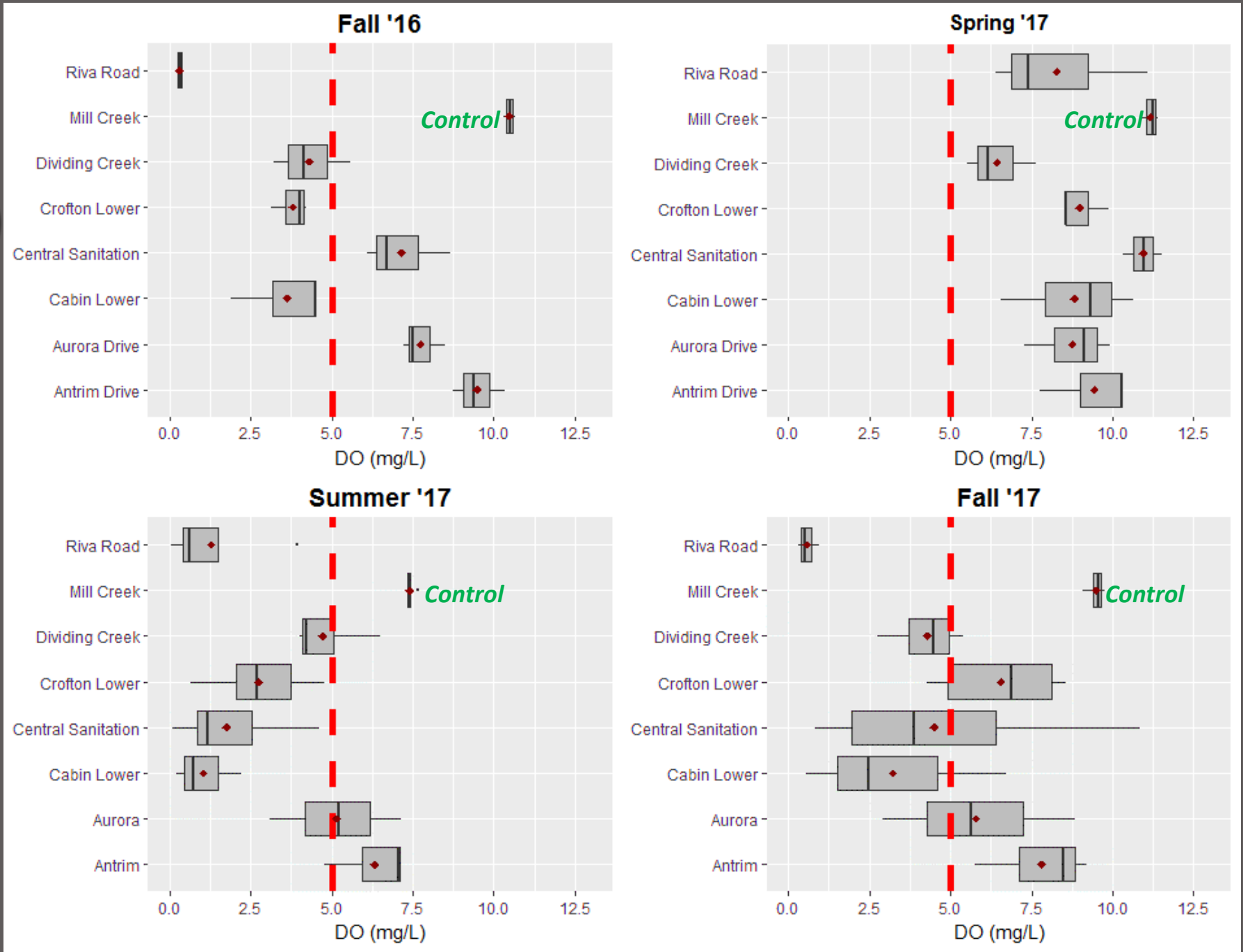






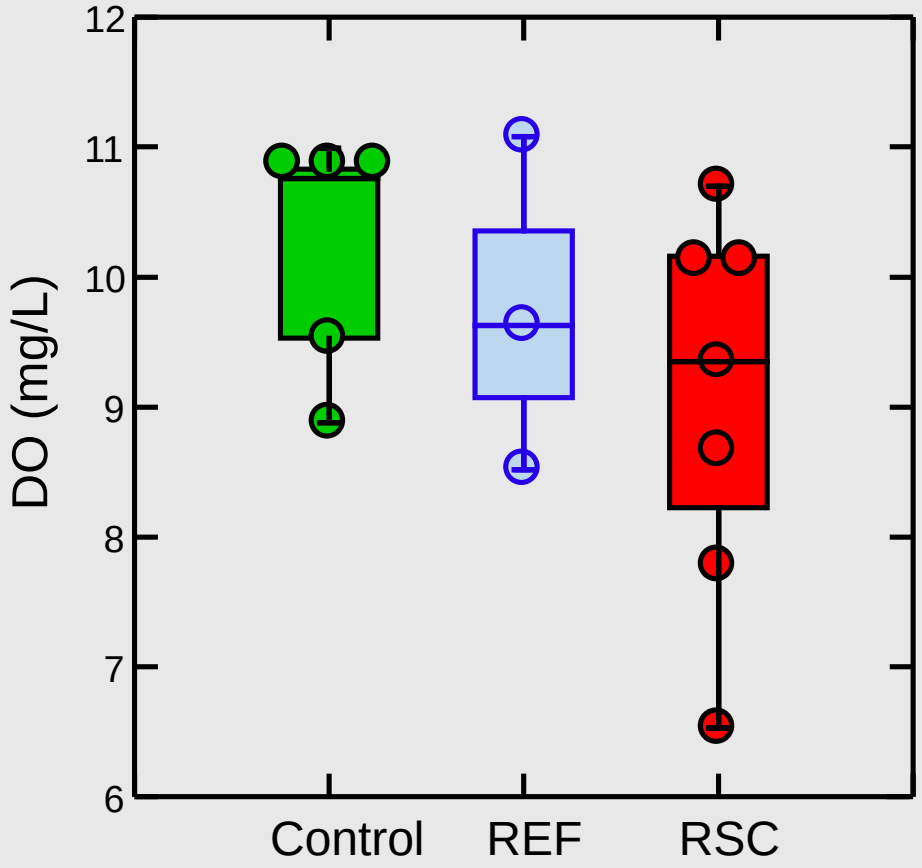
RSCs (transect data)

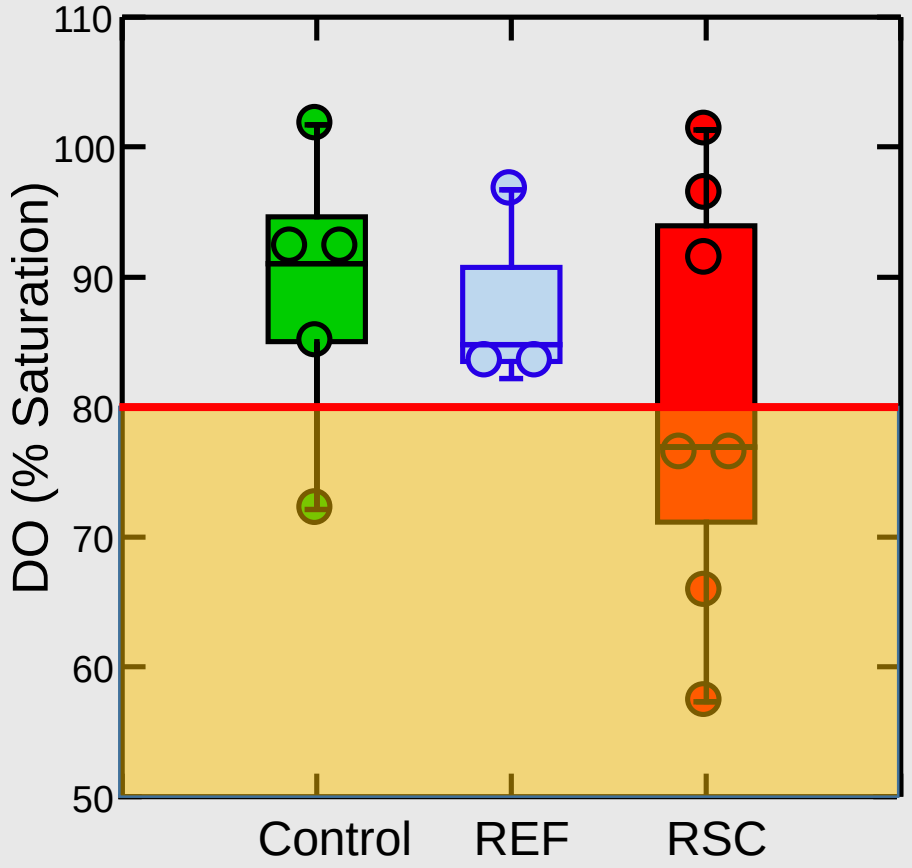
Dissolved Oxygen (2016-2017)



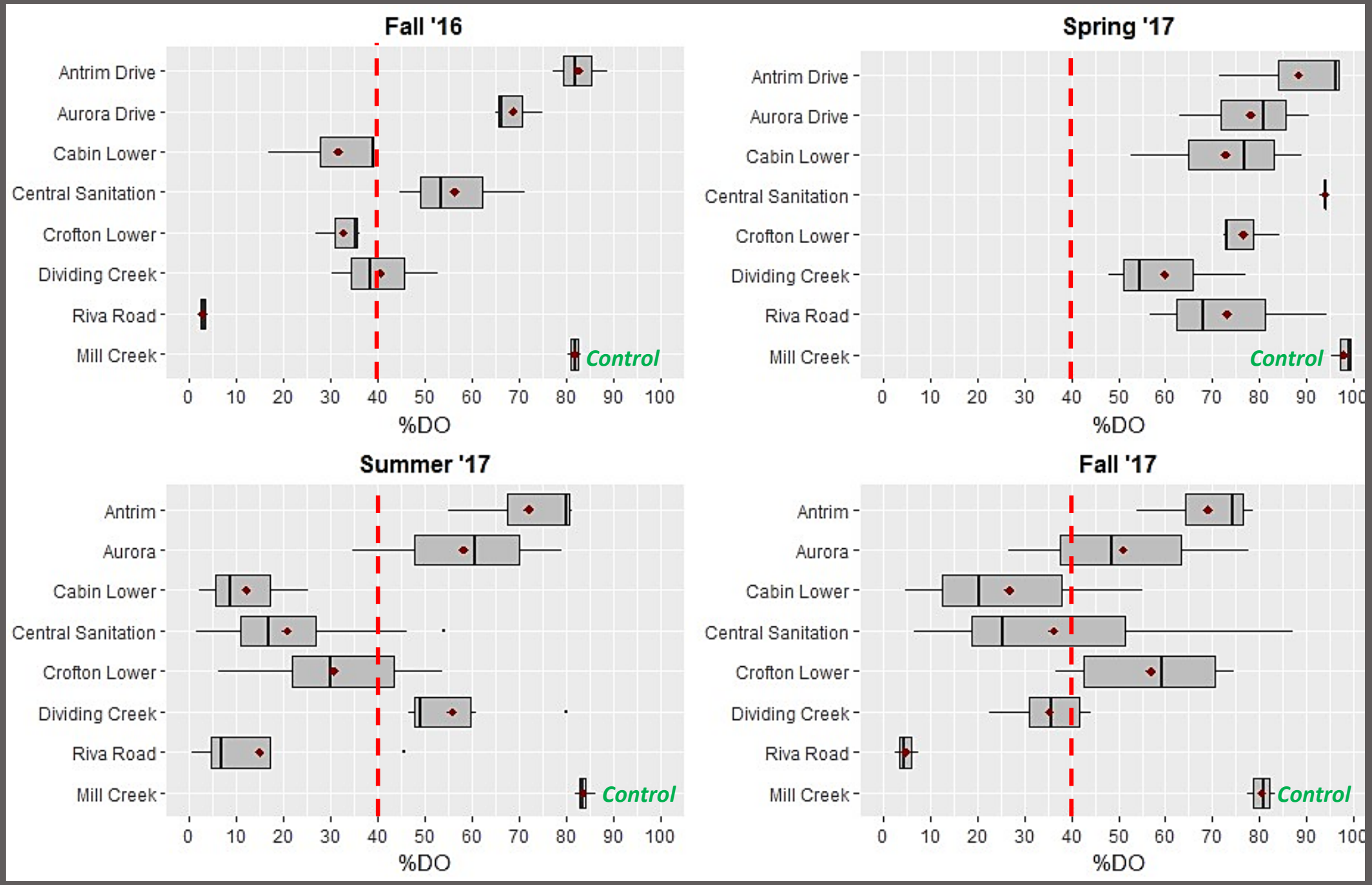
March 2017 Dissolved Oxygen at Benthic Sites

(Temperature 6—13° C)





MDE Stressor Guidance: 40% saturation for Coastal Plain



Spearman Correlation:
significant correlates (p<0.05) with 1 or more biological indicators

n=15	MD BIBI	CHESSIE BIBI	TAXA_RICH 200	EPT_RICH 200
% IMPERVIOUS	-0.75	-0.57	-0.76	-0.85
% FOREST	0.60	0.63	0.63	0.62
%FINES<8 ★	0.54	0.61	0.65	0.44
D50 ★	-0.37	-0.49	-0.53	-0.31
DO % SAT	0.35	0.21	0.54	0.28
SP COND	-0.48	-0.47	-0.48	-0.67
RIFFLE FREQ/ SINUOSITY ★	-0.45	-0.51	-0.63	-0.40
RIPZONE	0.54	0.37	0.43	0.35
% mRBP HAB	0.55	0.26	0.56	0.22
% RIFFLE ★	-0.57	-0.67	-0.63	-0.51
% RUN	0.61	0.50	0.63	0.44
ALKALINITY	-0.11	-0.46	-0.38	-0.54
CALCIUM	-0.46	-0.61	-0.61	-0.80
CHLORIDE	-0.33	-0.40	-0.42	-0.64
HARDNESS	-0.34	-0.48	-0.37	-0.70
NITRITE	-0.31	-0.34	-0.45	-0.61
SODIUM	-0.38	-0.45	-0.47	-0.68

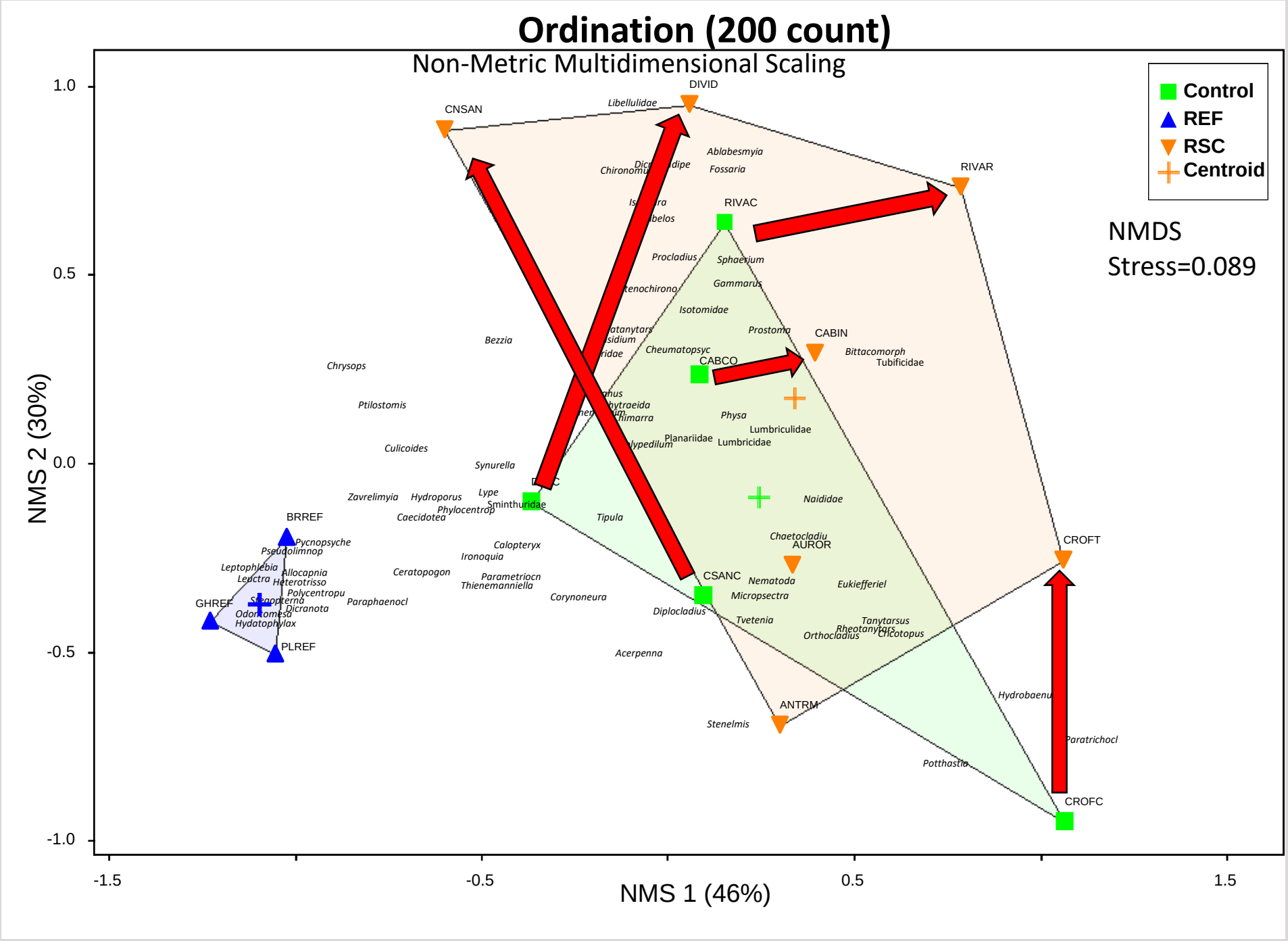
★ Counterintuitive response (±)

Community Composition and Similarity:

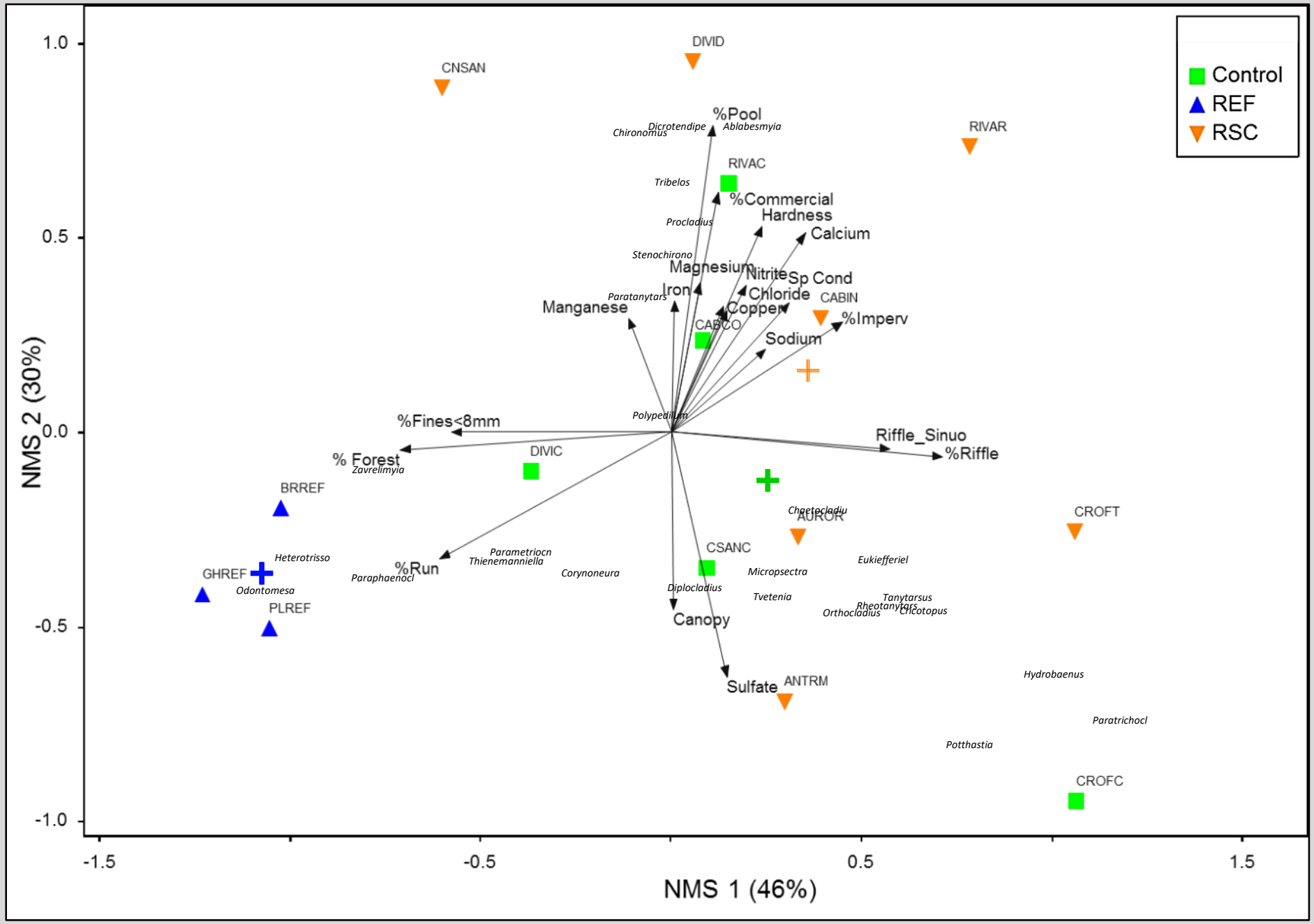
REF sites distinctive from others.

Overlap between RSCs and Controls

RSCs show further shift from REF and Controls in ordination space



Abiotic vector fitting on NMS: Major factors contributing to spread of assemblages with |r|>0.3 for clarity



Summary

- Impervious surface drives biology and is the main impediment to aquatic life recovery following restoration; dissolved ions are key chemical stressors
- Accounting for % impervious surface, little to no biological lift observed in RSCs compared to Controls; more biological degradation found at some RSCs.
  - Both MD and Chessie BIBI scores did not support our prediction that RSCs improve benthics.
  - The MD B-IBI over-estimated biological health in some instances where 2 of the B-IBI metric scores (% climbers and no. of scrapers) were inflated by highly pollution tolerant or hypoxia tolerant taxa.
  - Taxonomic composition at RSCs shifted further away from Reference in multivariate space

Summary

- Improved habitat metrics at RSCs, but seasonal low D.O. and iron bacteria proliferation are probably key limiting factors for RSC benthos
- Prior low D.O. values at RSC sites probably served as a “reset button”, eliminating many taxa that might have colonized during winter/spring seasons when D.O. is normally higher given lower water temperatures.
- Improving D.O. throughout the year and eliminating pervasive iron bacterial mats could improve benthic health at RSC sites.
- Siting conditions that promote within-network connectivity (proximity to colonization sources) might also enhance biotic uplift.