Towards an understanding of Bonneville cutthroat trout responses to riparian grazing exclosures

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ICRRR
Intermountain Center for River Rehabilitation and Restoration

UtahStateUniversity

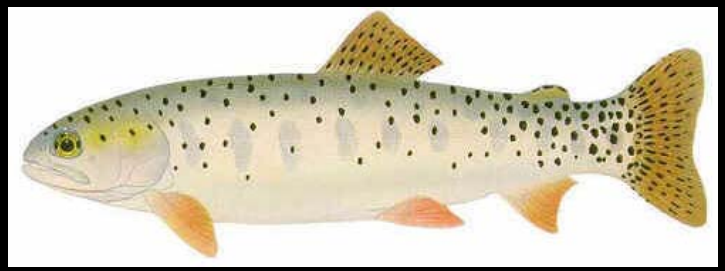
BUGLAB

Introduction

Habitat Degradation

Disease

Invasive Species



Bonneville cutthroat trout (BCT)

Introduction

- Livestock grazing is leading cause of riparian and instream habitat degradation in western U.S.
- > 80% of western riparian areas affected

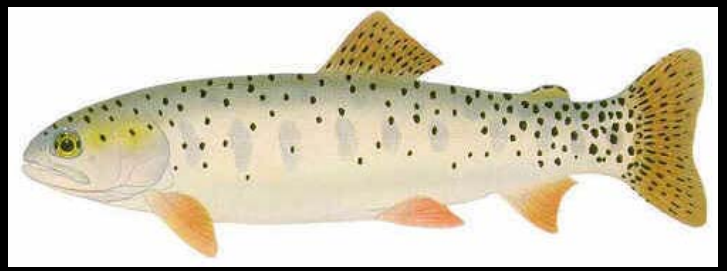
Introduction

Grazing

Habitat Degradation

Disease

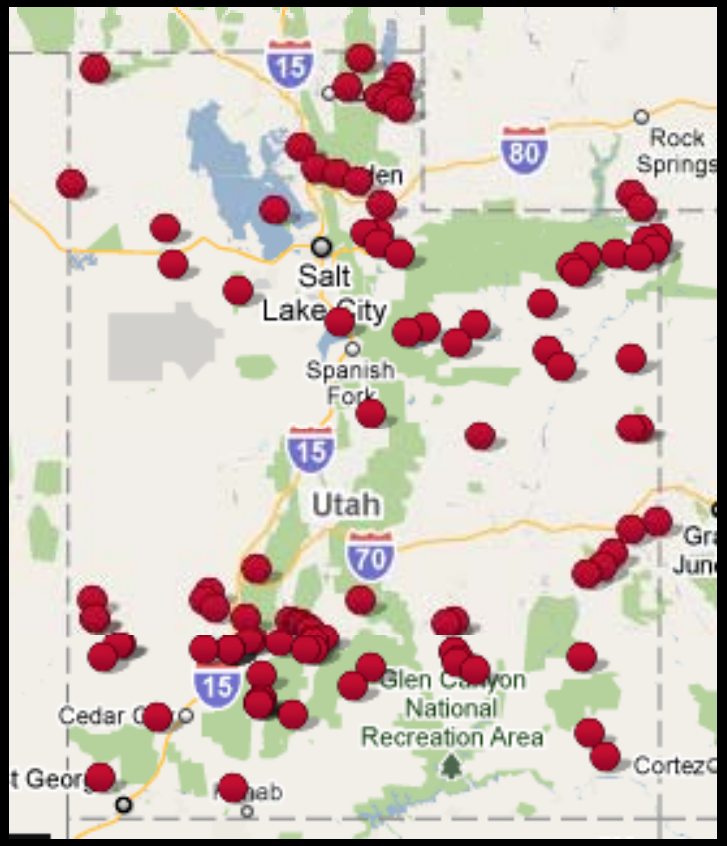
Invasive Species



Bonneville cutthroat trout (BCT)

Introduction

- Riparian grazing exclosures widely implemented on public lands
- UT public lands: > 150 riparian exclosures
- Goals: Restore degraded habitat and facilitate the coexistence of grazing and native fish populations



Source: ICRRR Restoration Database

Introduction

- Despite widespread implementation, few studies assess restoration efficacy
- Cutthroat: Equivocal or conflicting results
- What factors contribute to differential responses among system?

Introduction

Grazing

↓ (-)

Riparian vegetative cover/biomass

↓ (-)

Terrestrial arthropod inputs

↓ (-)

Salmonid biomass

Saunders and Fausch 2007

Introduction

Questions:

1. Do BCT populations differ between grazed and ungrazed reaches?

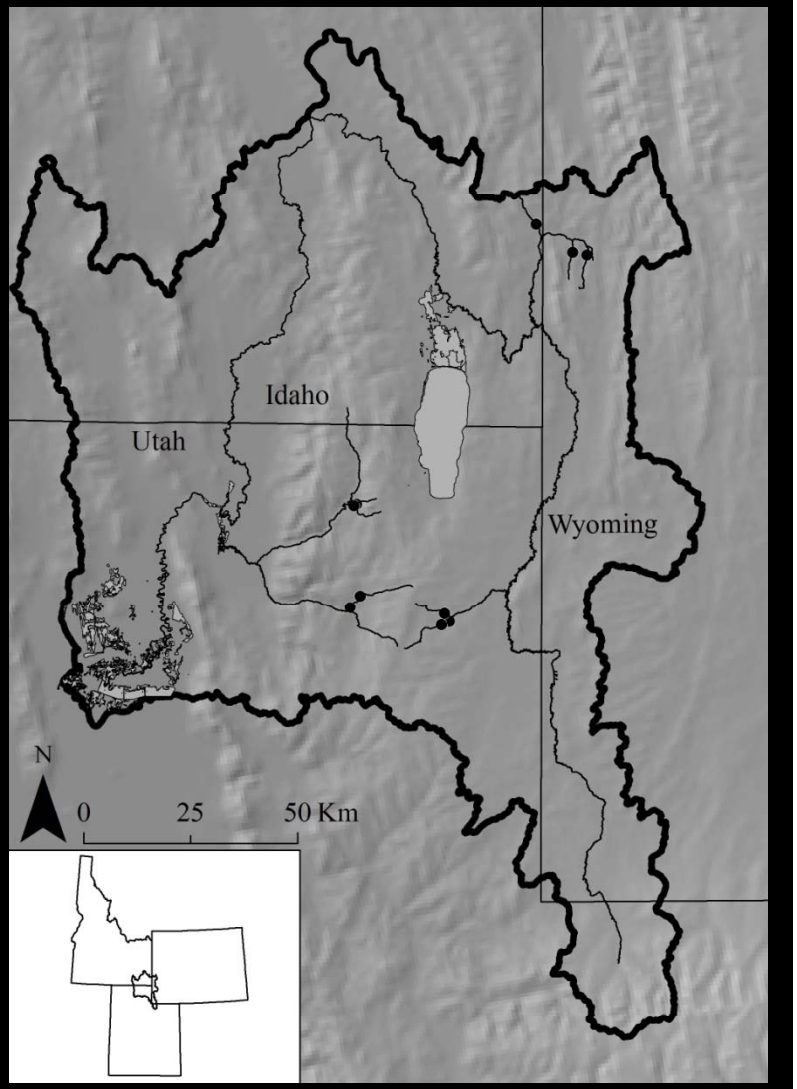
2. What reach-scale factors are related to differences in BCT populations between grazed and ungrazed reaches?

3. Do recovery patterns vary as a function of grazing regime, exclosure age, or exclosure size?

Site selection

- 10 paired grazed and ungrazed reaches
  - BCT
  - 2nd & 3rd order reaches
  - Maintained exclosure
  - Active grazing
  - Minimize geomorphic differences between pairs

- System characteristics
  - Grazing regime: season long vs. rotational
  - Age: 4 – 39 years
  - Size: 0.06 – 96%



Sampling

Paired study design

Upstream: Grazed

Downstream: Ungrazed

Min. 1 km buffer

- Reach lengths: 20x bankfull
- Sampled once: summer 2008 or 2009

Response variables

- Fish assemblages
  - 3-pass depletion
  - Reaches: 20x bankfull
  - Response variables: Density, biomass, condition, composition

- Diet
  - Stomach contents - gastric lavage
  - Stable isotopes (δ13C and δ15N)

Response variables

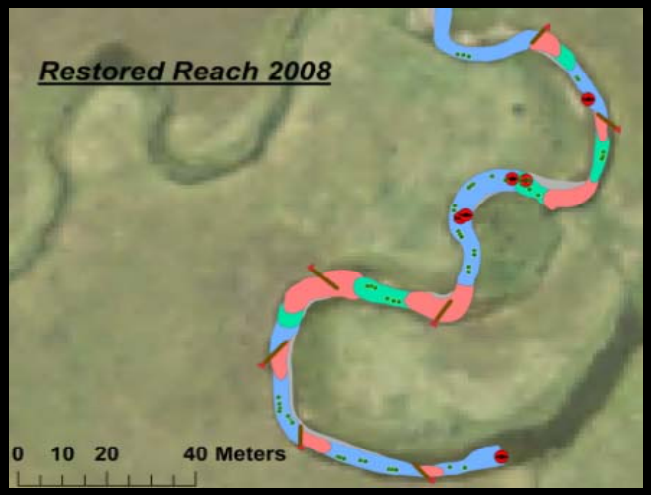
- Physical habitat measurements:

<u>Continuous</u>

Undercut banks

Overhanging vegetation

Habitat units (e.g., riffle, run, pool)



Response variables

- Physical habitat measurements:

Continuous	Point
Undercut banks	Depth
Overhanging veg.	Velocity
Habitat units (e.g., riffle, run, pool)	Substrate
	Temperature*
	Width

Response variables

- Prey availability
  - Terrestrial arthropod prey
    - 5 pan traps/reach
    - 48 hours
  - Aerial aquatic insects
    - 5 pan traps/reach
    - 48 hours
  - Benthic aquatic arthropod prey
    - 8 composite Surbers/reach

Results

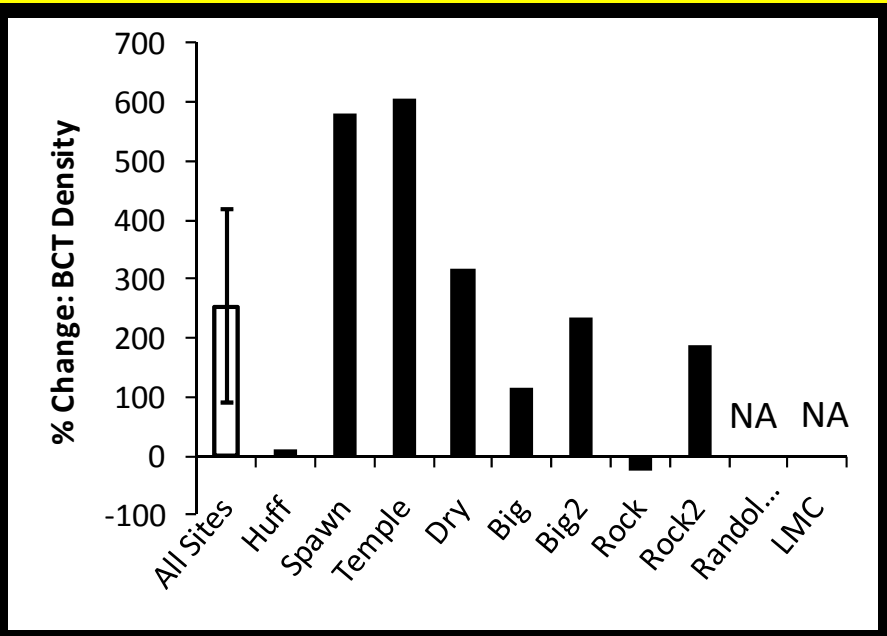
Do BCT populations differ between grazed and ungrazed reaches?

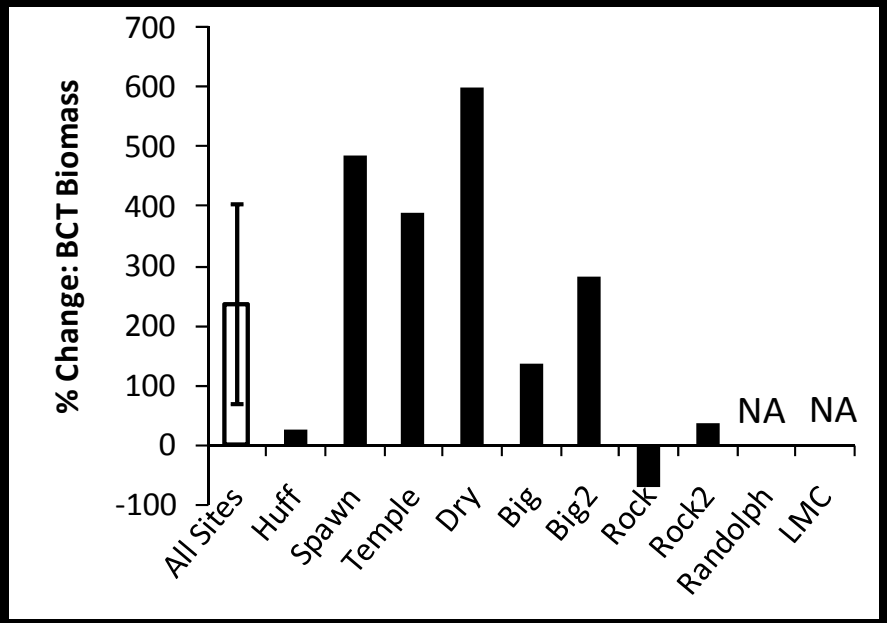
Response Variable

% change =
100* ((Ungrazed-Grazed)/Grazed)

Statistical Test

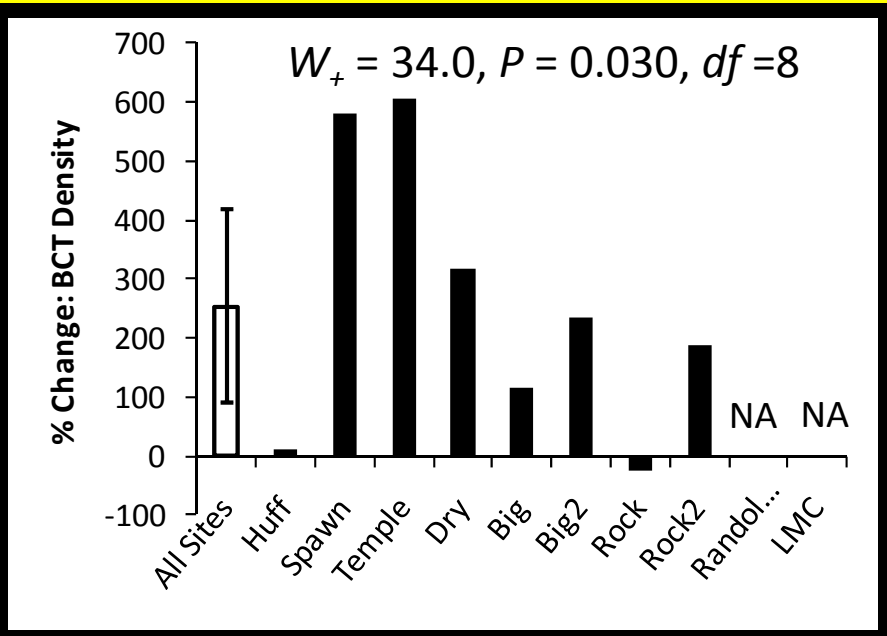
Wilcoxon signed rank test

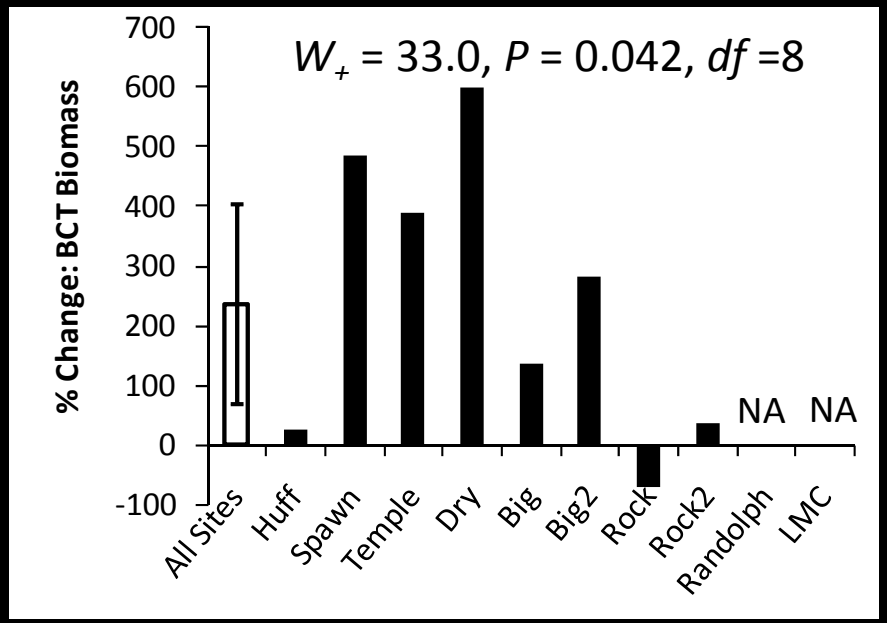




Results

- On average, density and biomass significantly greater within exclosures
- Consistent directional changes, while magnitude of change highly variable
- No differences in condition, age structure, or assemblage composition





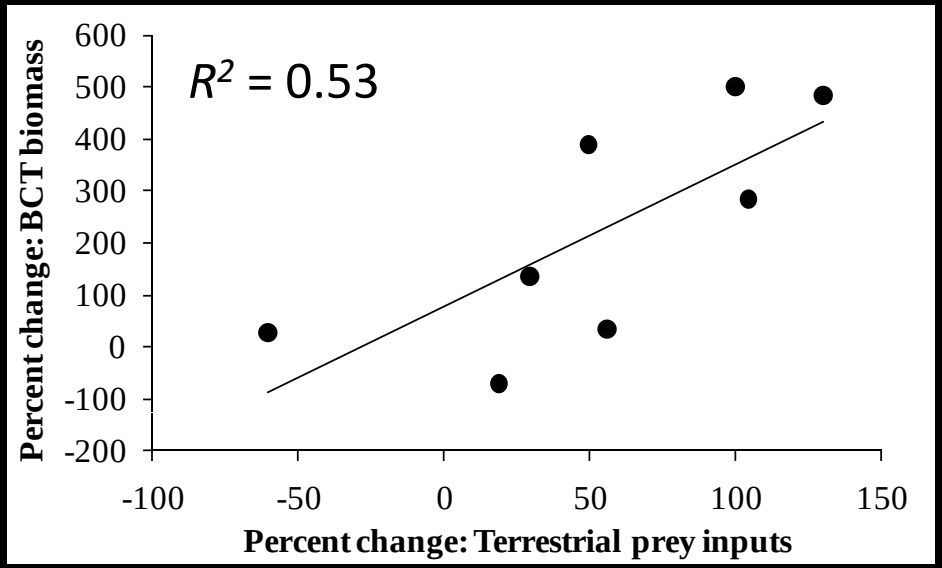
Results

What reach-scale factors are related to differences in BCT populations between grazed and ungrazed reaches?

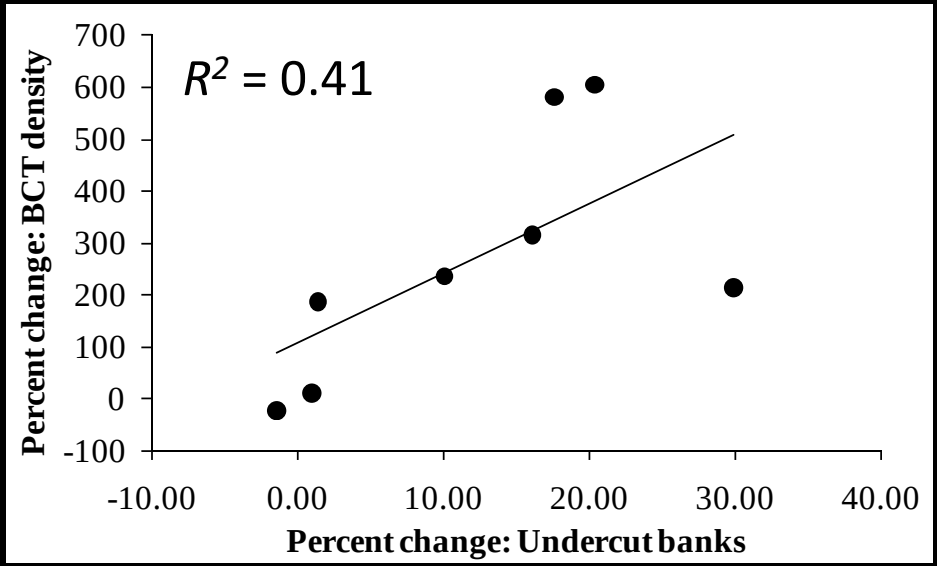
	Kendall's tau: % Change	
	BCT Density	BCT Biomass
Proportion overhanging vegetation	**0.57**	**0.46**
Aquatic benthic prey biomass	0.21	**0.43**
Terrestrial prey biomass	**0.50**	**0.57**
Aerial aquatic prey biomass	0.28	0.36
Width-to-Depth ratio	0.21	0.14
Proportion undercut banks	**0.71**	**0.5**
Residual Pool Depth	-0.07	0.14
Habitat Diversity	0.21	-0.14
Temperatue	-0.21	0.29
Substrate (D16)	**-0.43**	-0.36

Results

BCT biomass responses proportional to increases in terrestrial prey availability

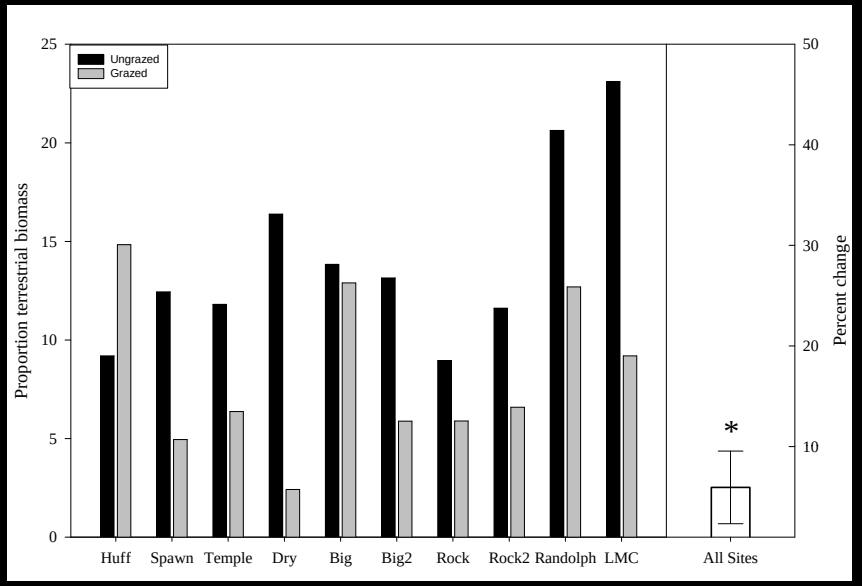


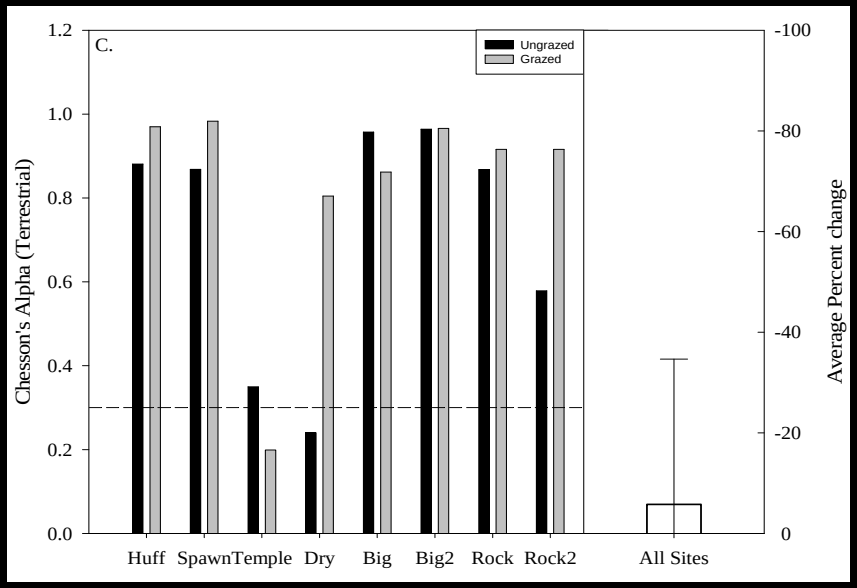
BCT density responses scaled with increases in cover availability



Results

- Terrestrial prey comprised only 11% of prey availability by biomass
- BCT foraging behavior: strong preference of terrestrial prey
- 50% of ingested prey





Results

Do recovery patterns vary as a function of grazing regime, exclosure age, or exclosure size?

	Kendall's tau: % Change		
	Grazing regime	Exclosure Age	Exclosure Size
Aquatic benthic prey biomass	0.06	0.05	0.28
Terrestrial prey biomass	**0.46**	0.18	0.11
Aerial aquatic prey biomass	0.09	-0.3	-0.03
Width-to-Depth ratio	**-0.43**	-0.1	**0.63**
Proportion undercut banks	0.12	-0.32	-0.14
Proportion overhead vegetation	**0.43**	0	0.13
Residual Pool Depth	0.06	0.14	-0.04
Habitat Diversity	**0.43**	**0.41**	0.17
Substrate	0.37	0.18	-0.2
Temperature	-0.3	-0.1	-0.21
BCT Density	**-0.47**	-0.07	-0.14
BCT Biomass	**-0.47**	0	-0.07
Averages	**0.33**	0.17	0.19

Results

Weak relationships with age…

1978 (SL)

1978 (SDR)

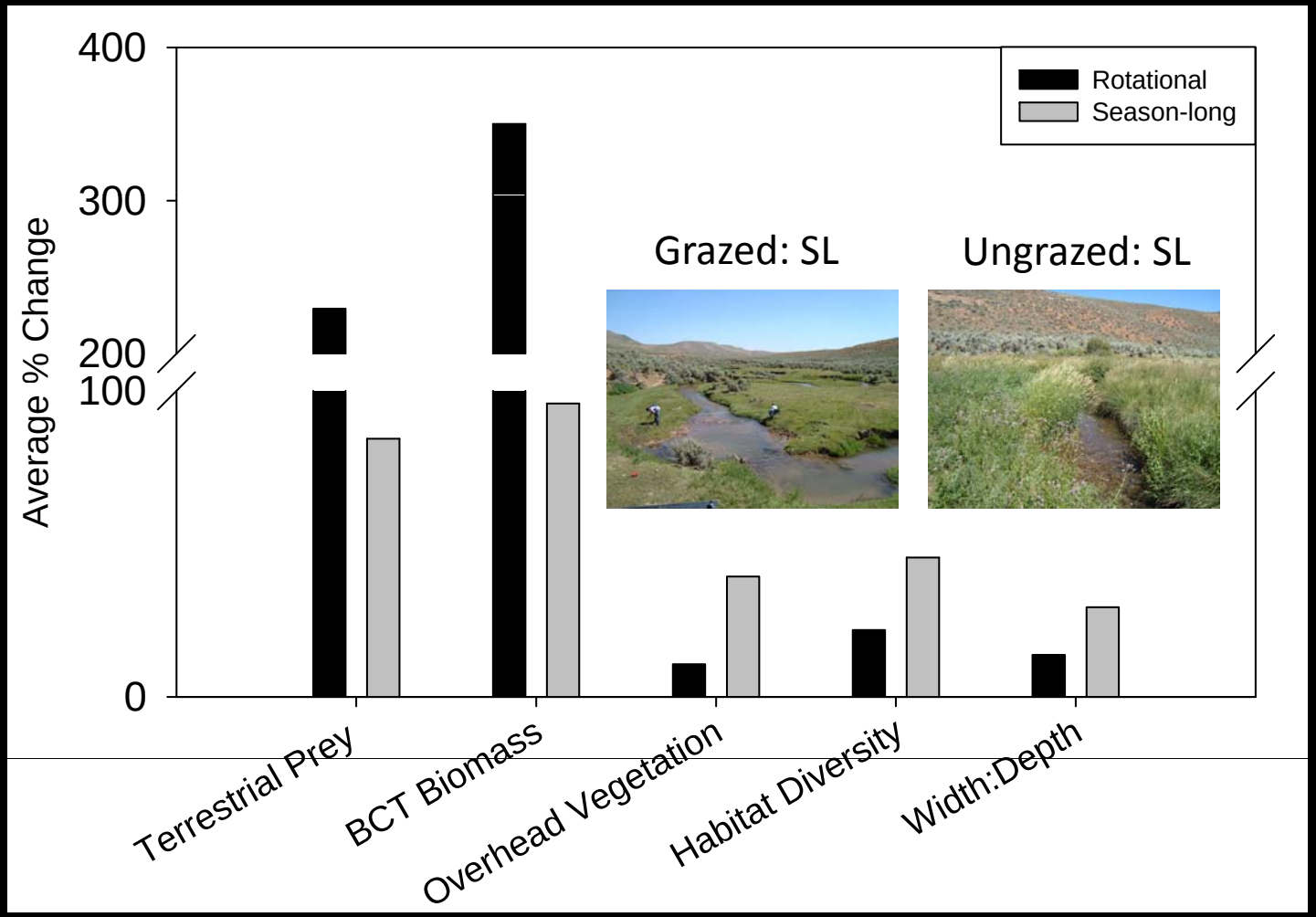
Grazed

Overriding influence of grazing practices

Ungrazed

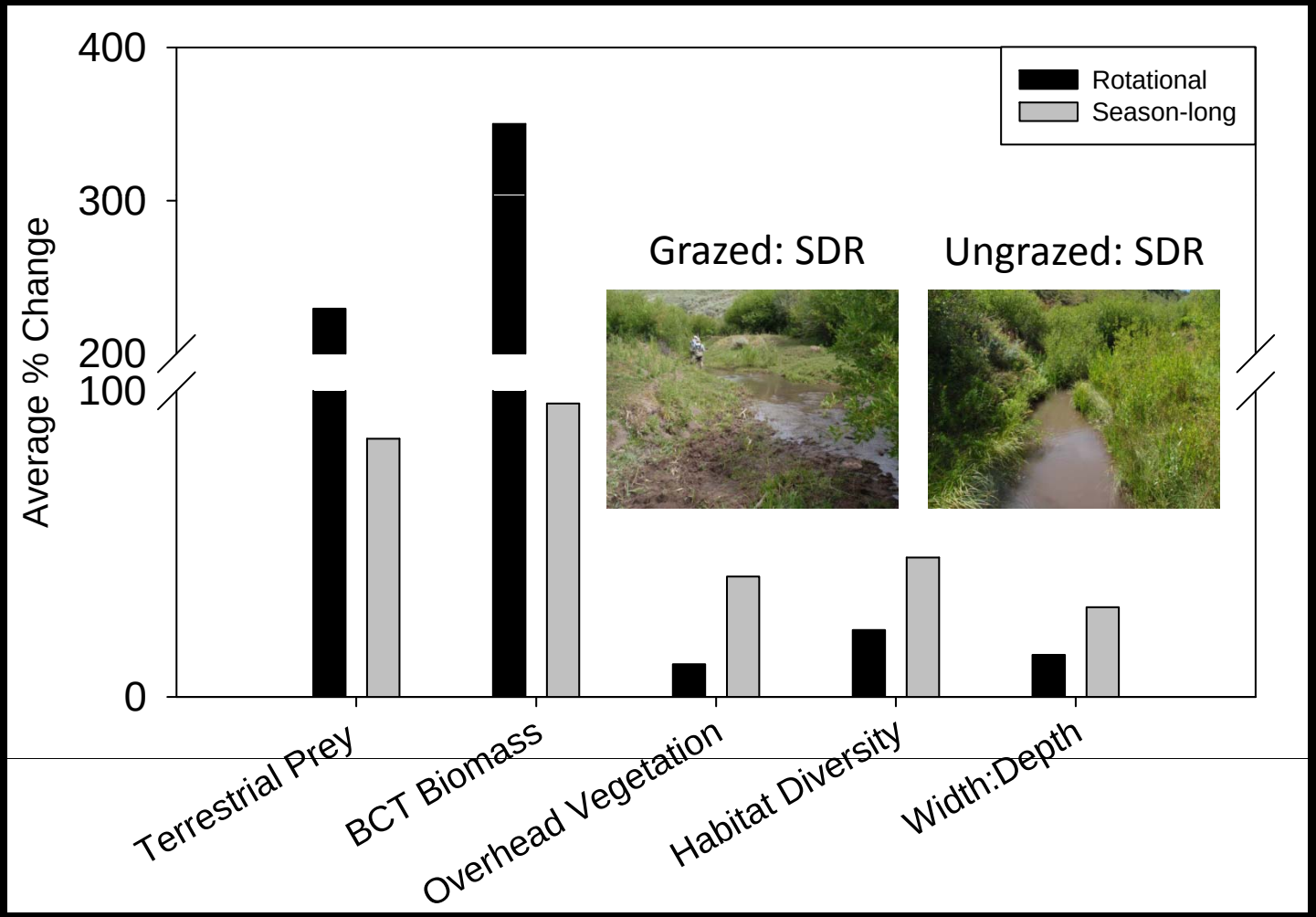
Results

Differential responses between grazing regimes and among abiotic and biotic variables



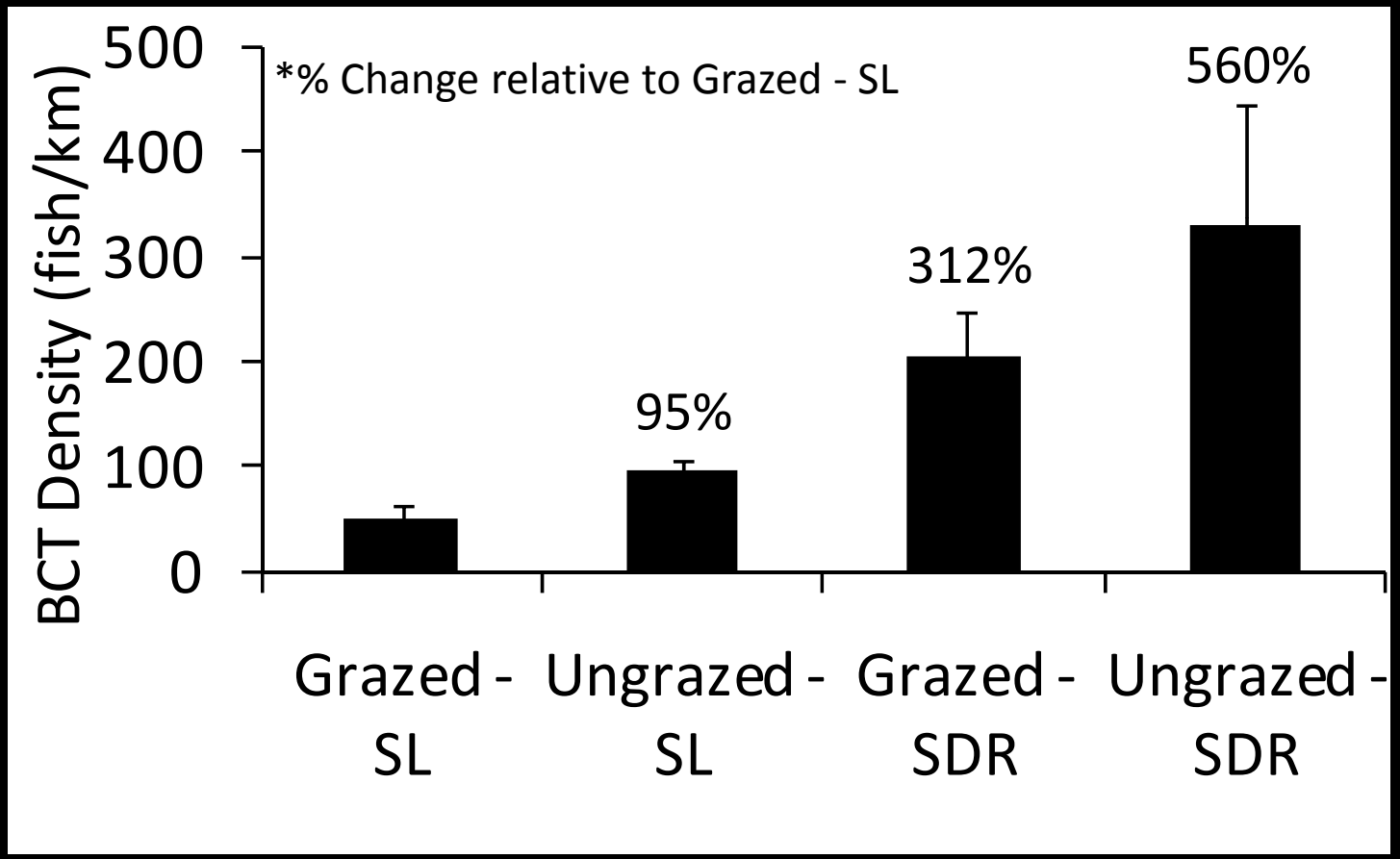
Results

Differential responses between grazing regimes and among abiotic and biotic variables



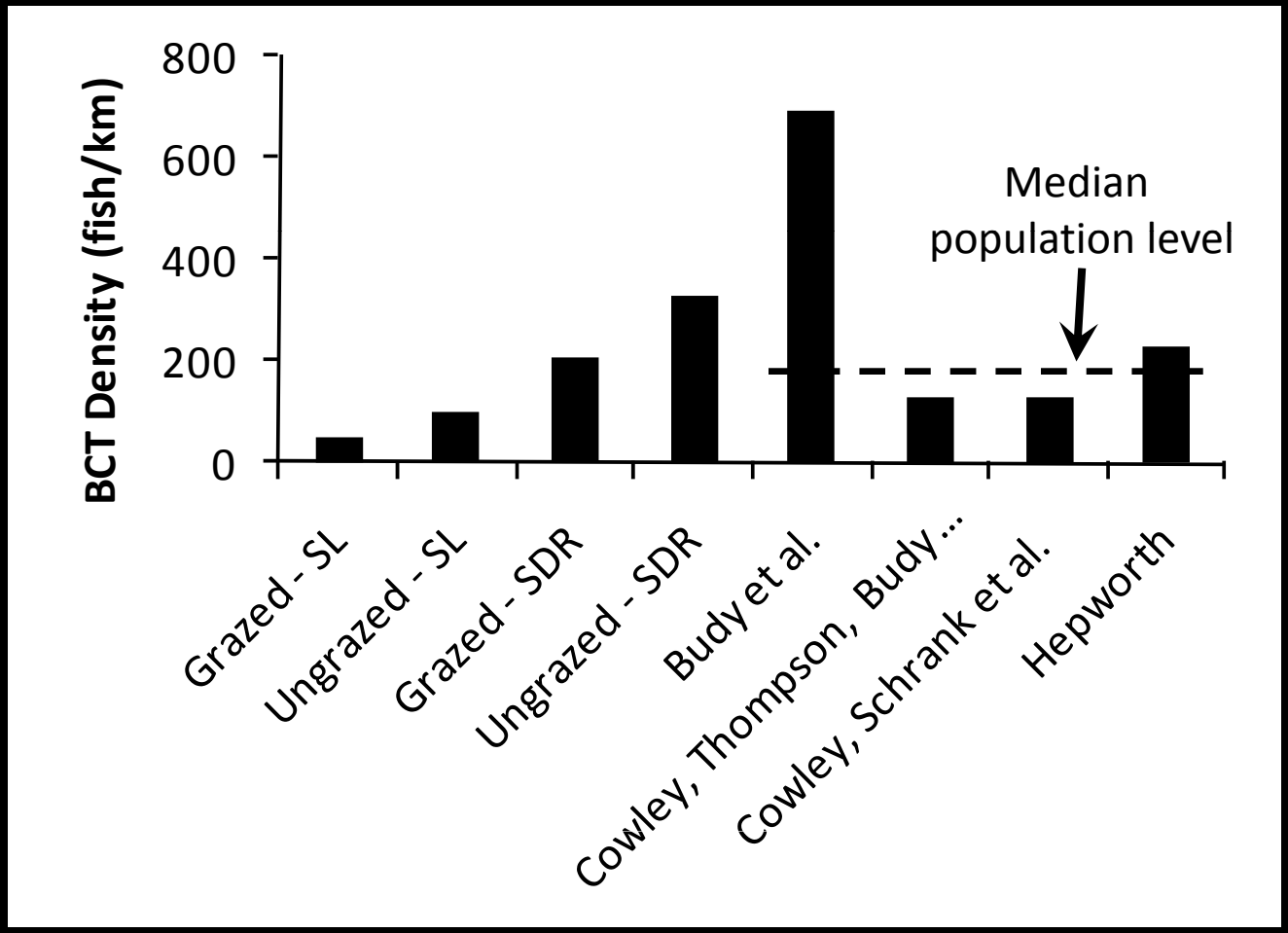
Results

Passive restoration bang for your buck: BCT responses



Results

Putting responses in a regional context



Take home points

- Variable fish responses to grazing management are likely predictable
- Both habitat and prey resource availability (terrestrials) likely facilitate BCT recovery
- Grazing management at larger spatial scales will greatly increase efficacy of passive restoration efforts
- Landscape versus local-scale processes in facilitating abiotic and biotic recovery trajectories

Future questions

- What factors control the recovery of terrestrial arthropod assemblages
- Do exclosures facilitate increased growth and survival = source populations
- Identify interactions among grazing regime, exclosure age, and size
- How robust are these patterns

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