Reach-scale stream restoration in agricultural streams of southern Minnesota alters structural and functional responses of macroinvertebrates

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  - Joe Magner
  - Len Ferrington
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Stream Restoration

- $1 billion spent in U.S. annually
- Biodiversity effects rarely evaluated
- "If you build it, they will come"?
- Palmer *et al.* 2010→ no improvements in biodiversity

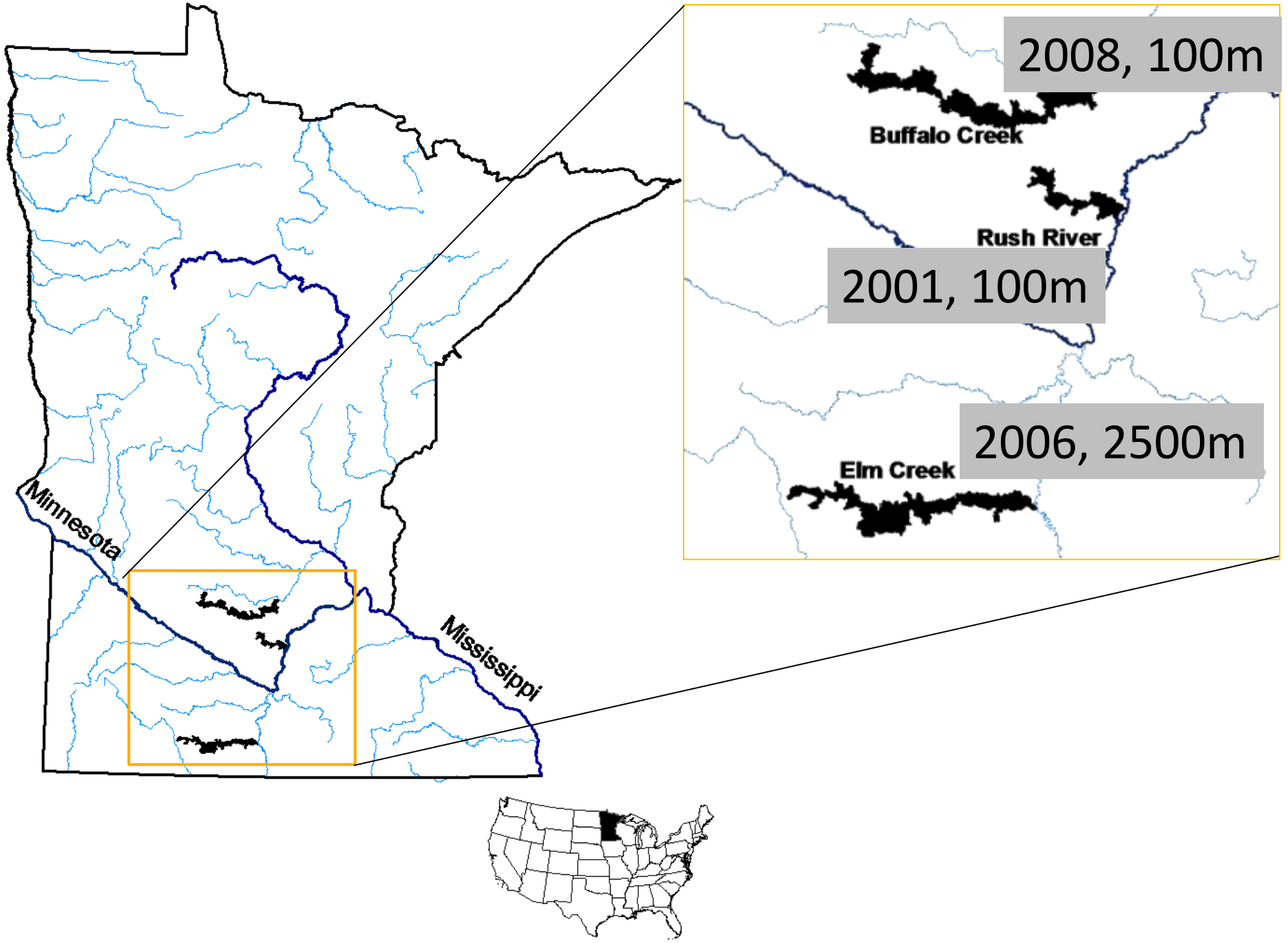
Restoration: Effects beyond diversity?

- Macroinvertebrate Secondary Production
  - Invert biomass produced over time
  - Reproduction, growth rate, survivorship, density
  - Ecosystem function: energy flow thru food webs
  - May reflect increases in habitat or food for inverts
  - May represent food resources for higher trophic levels

Objectives

1. Compare invert community structure in restored and unrestored reaches of three streams: Total richness, #EPT, IBI

2. Compare secondary production in restored and unrestored reaches of all three streams


2008, 100m
Buffalo Creek
Rush River
2001, 100m
2006, 2500m
Elm Creek
Minnesota
Mississippi

Study System Characteristics

- 3rd order
- Land use: corn, soy, cattle, hogs
- Flashy
- High sediment loads

Stream Restoration

Goals: Reduce channel erosion, improve habitat

Actions:

1. Adding boulders/wood → Redirect flow; Strengthen banks; Structural heterogeneity
2. Bank re-vegetation → Stabilize banks; Improve bank habitat
3. Engineer benches → Prevent sloughing

For each stream:

- Restored Reach (100m)
- Unrestored Reach (100m)
- Two reach types separated by 100m

Macroinvertebrates: biodiversity & secondary production

6 samples: Apr-Nov, 2010

Sampling approach:

5 macroinvertebrate habitat types

- riffle/run
- overhanging banks
- emergent veg
- woody debris
- debris dam

- D-frame dip net
- Sample 1 sq. ft habitat

Taxa Richness

121 taxa (mostly genus IDs) total, 52 families

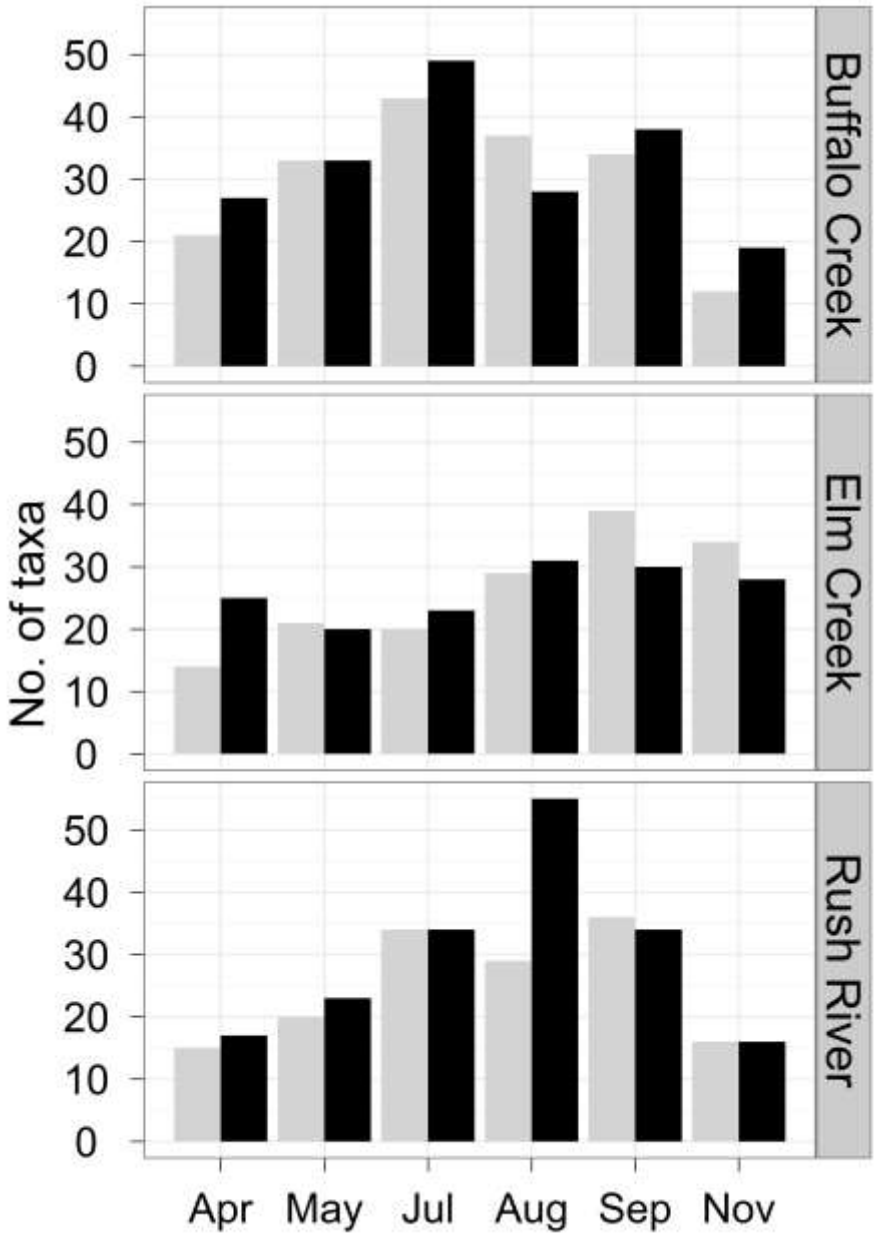
- 62 Diptera
- 19 Ephemeroptera
- 13 Coleoptera
- 11 Trichoptera
- 6 Plecoptera
- 4 Hemiptera
- 3 Odonata
- 1 Amphipoda
- 1 Collembola







Total taxa richness



Unrestored

Restored

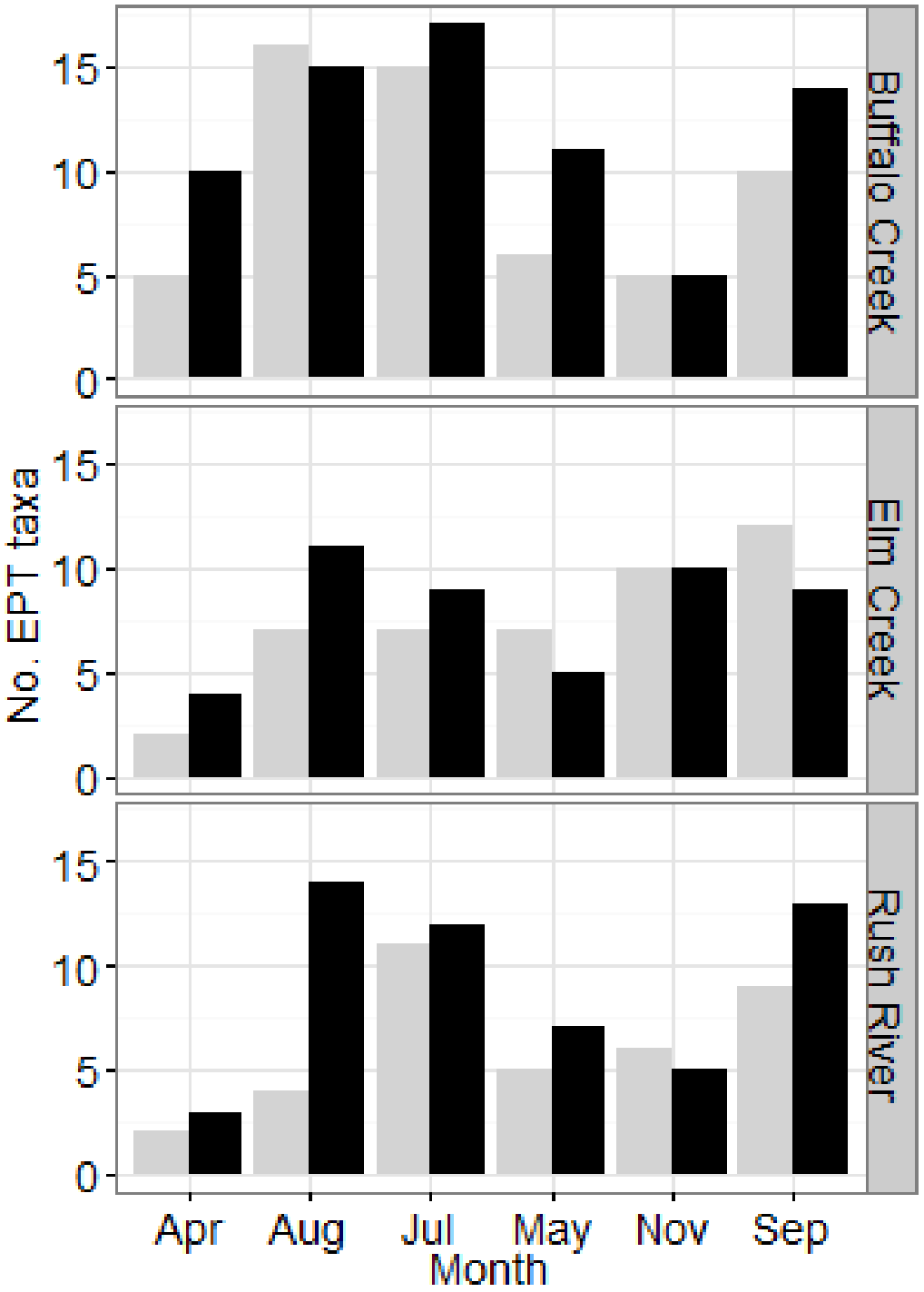
No significant difference in richness between restored and unrestored reaches

of EPT taxa

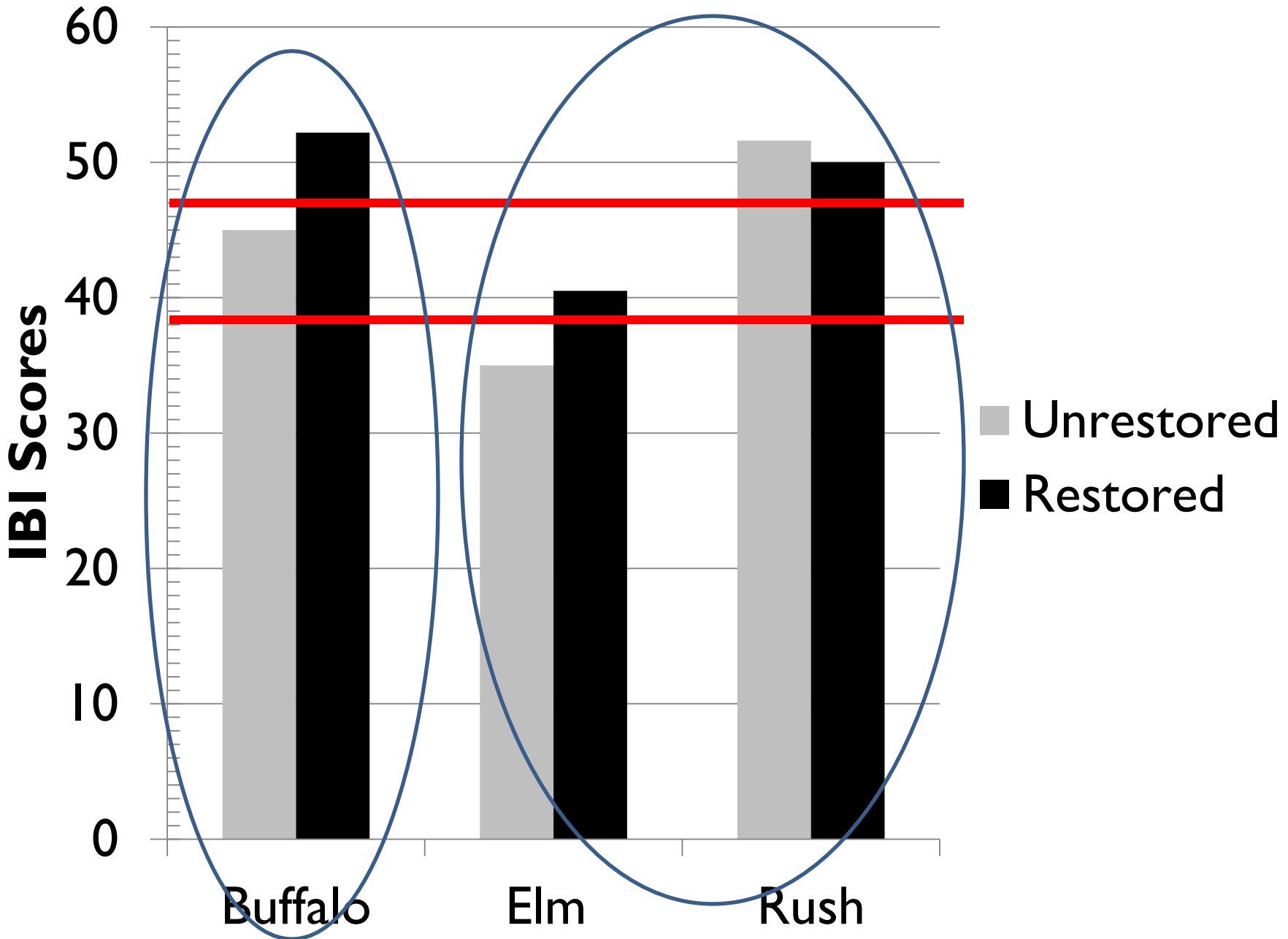
Unrestored

Restored

Controlling for site and month effects, **restored reaches yielded 2 additional EPT taxa** compared to unrestored reaches, on average



IBI Scores: Prairie & Forest, Low-Gradient

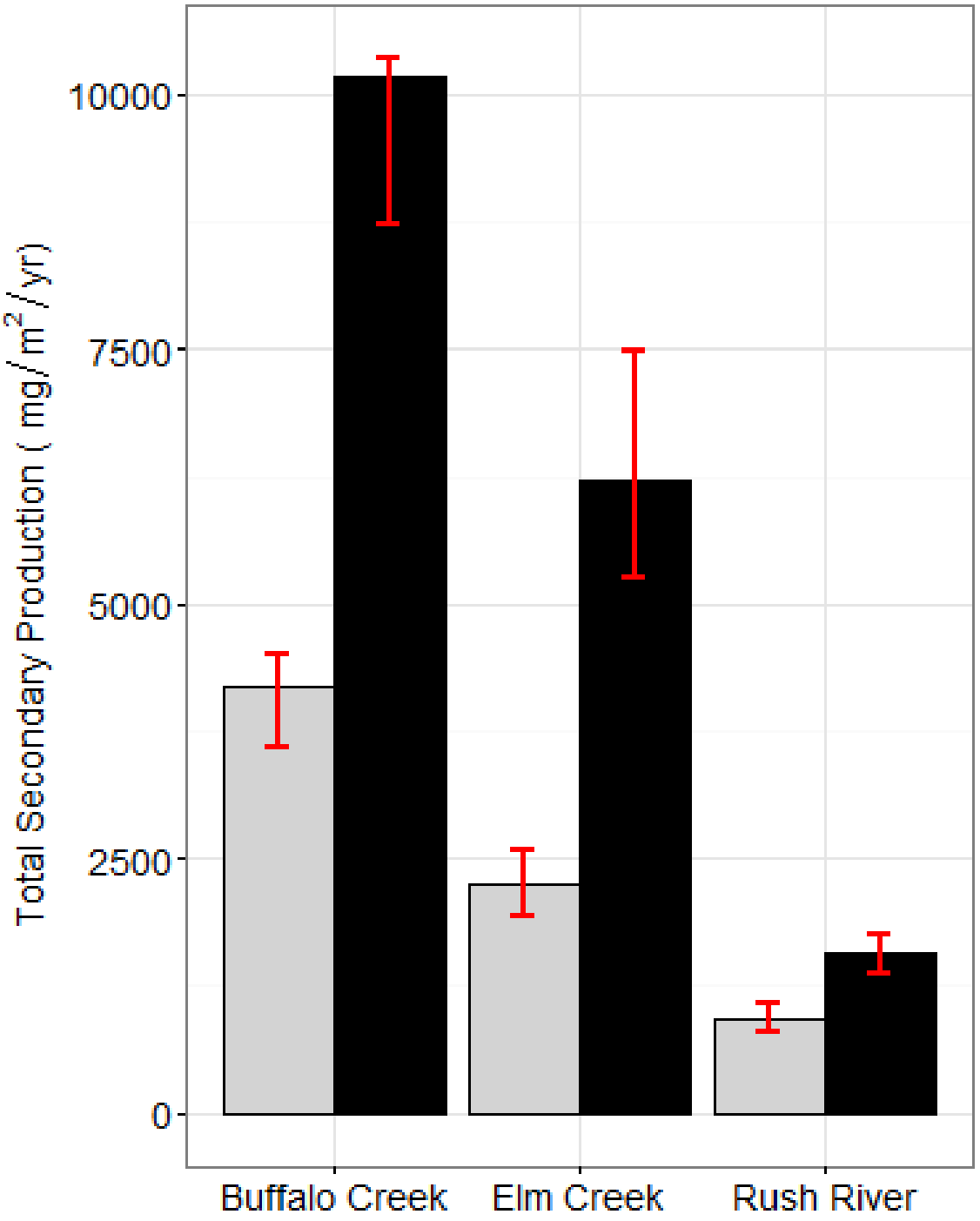


Secondary Production

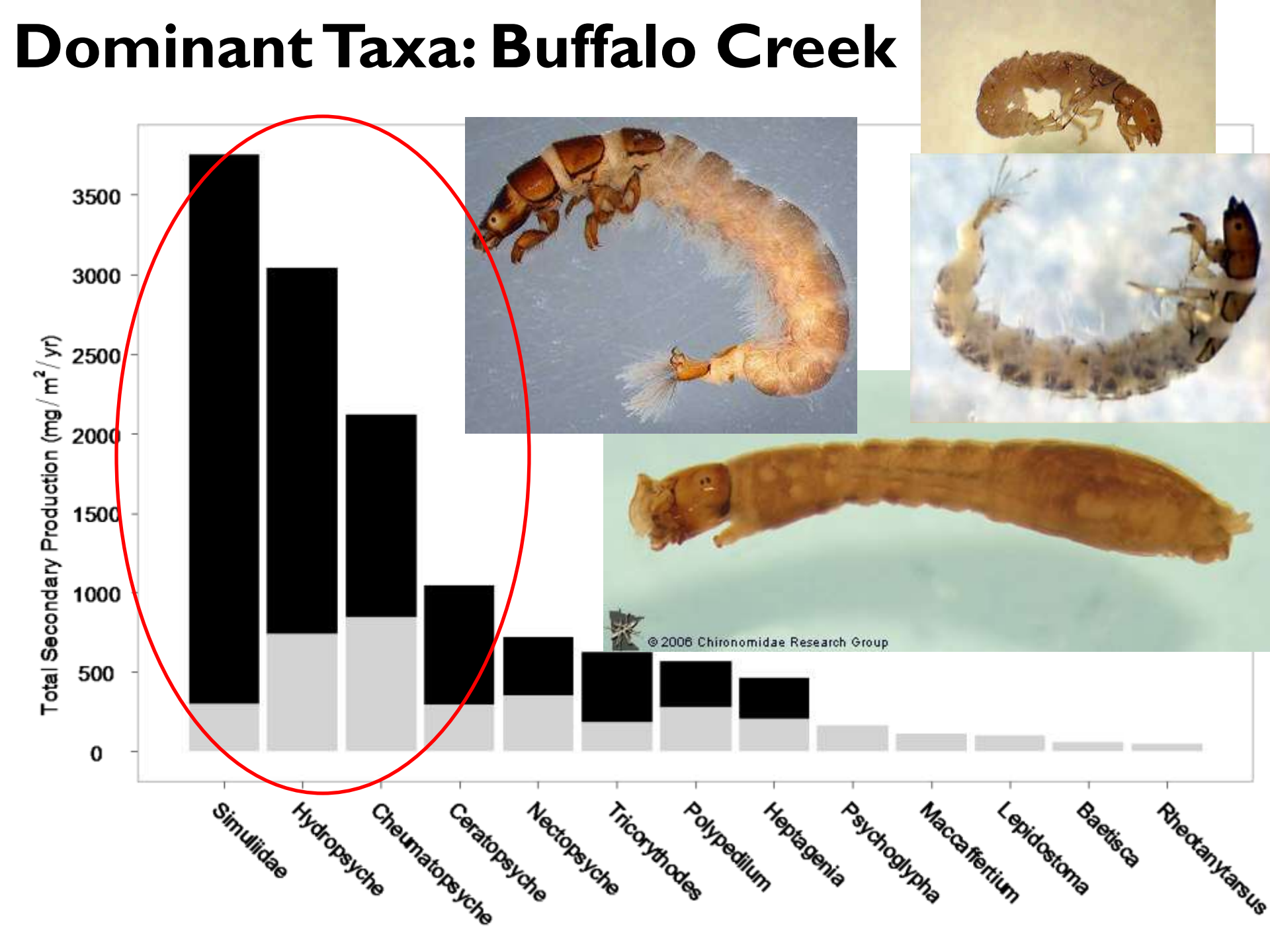
Production 2-3 x higher in restored reaches

Unrestored

Restored



Dominant Taxa: Buffalo Creek



Conclusions

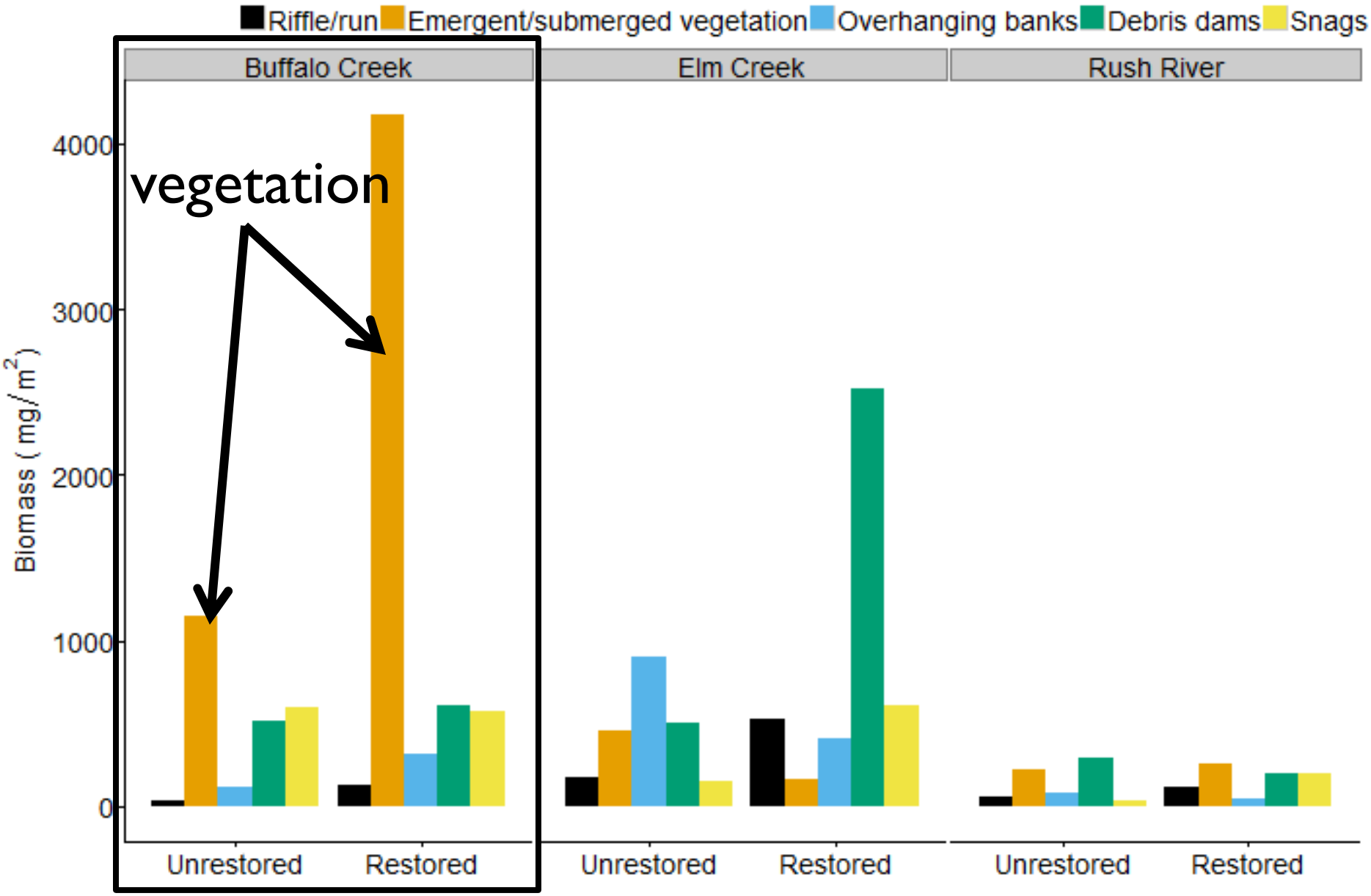
- No difference in taxa richness → larger-scale drivers may limit sensitive species

- Reach scale restoration may have effects beyond total taxa richness (#EPT, IBI, production)

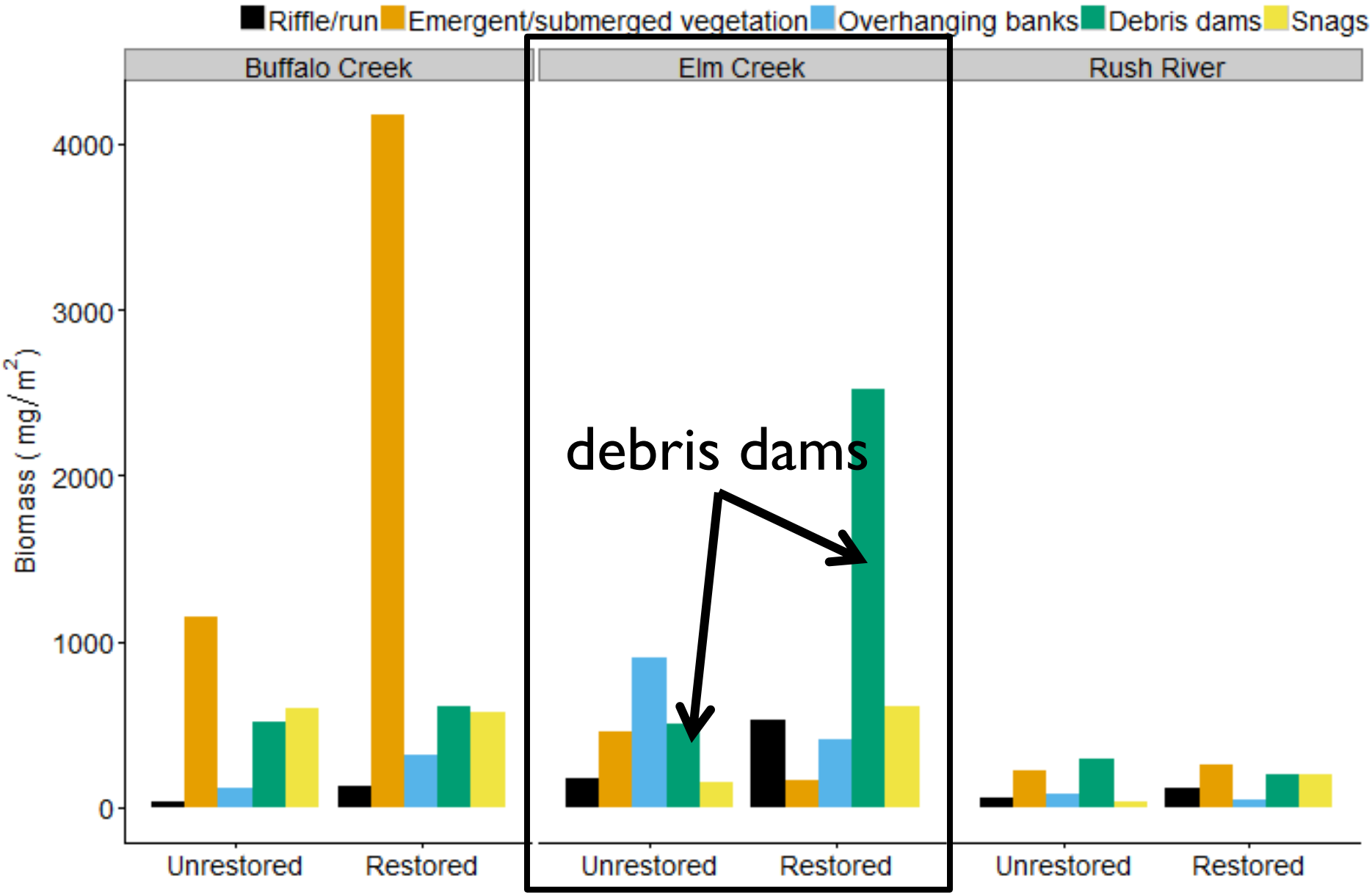
- Higher production of some taxa may indicate more stable habitat or higher quality food resources

- Conservation implications: production effects limited to dominant, tolerant taxa?

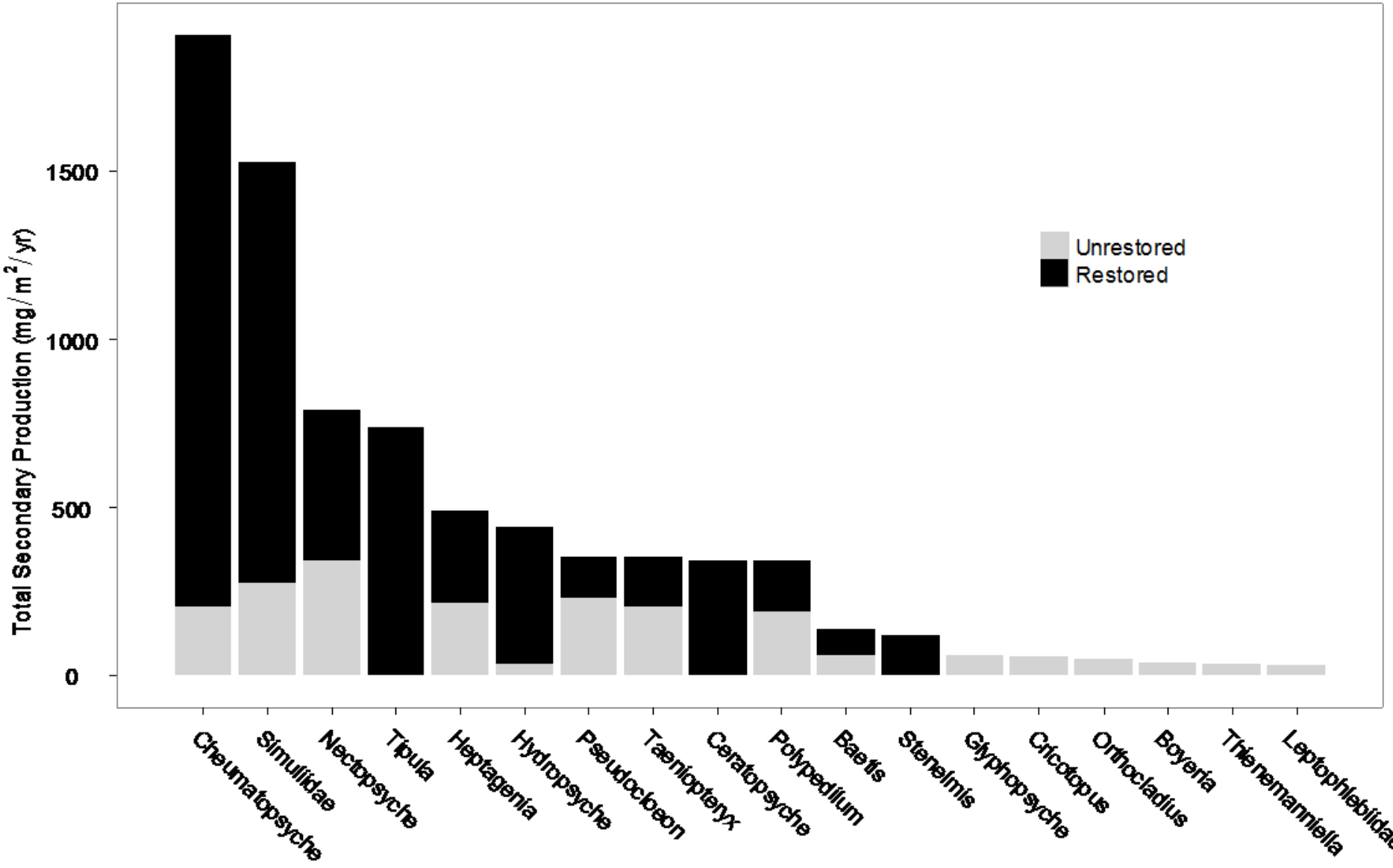
Biomass by Habitat Type



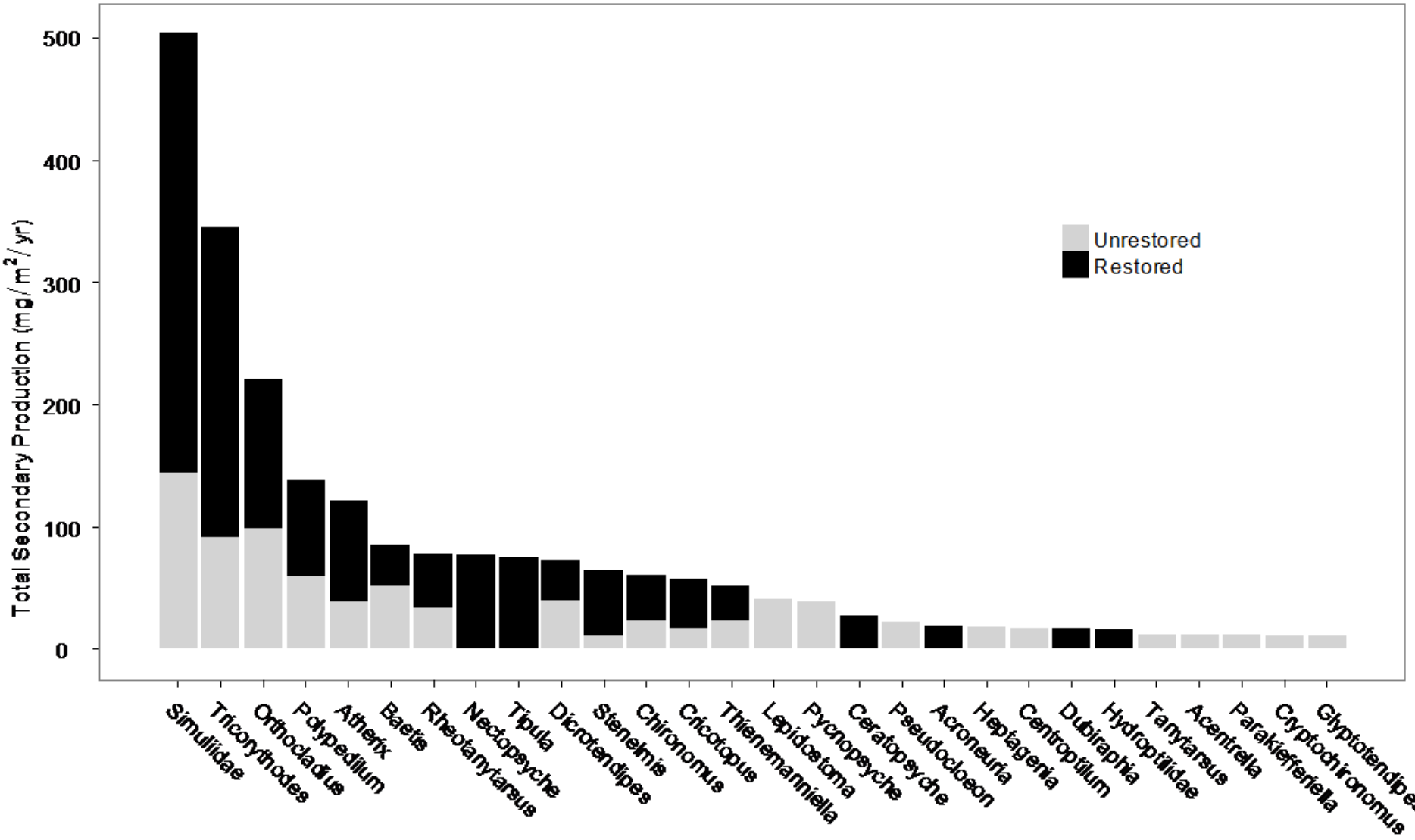
Biomass by Habitat Type



Dominant Taxa: Elm Creek



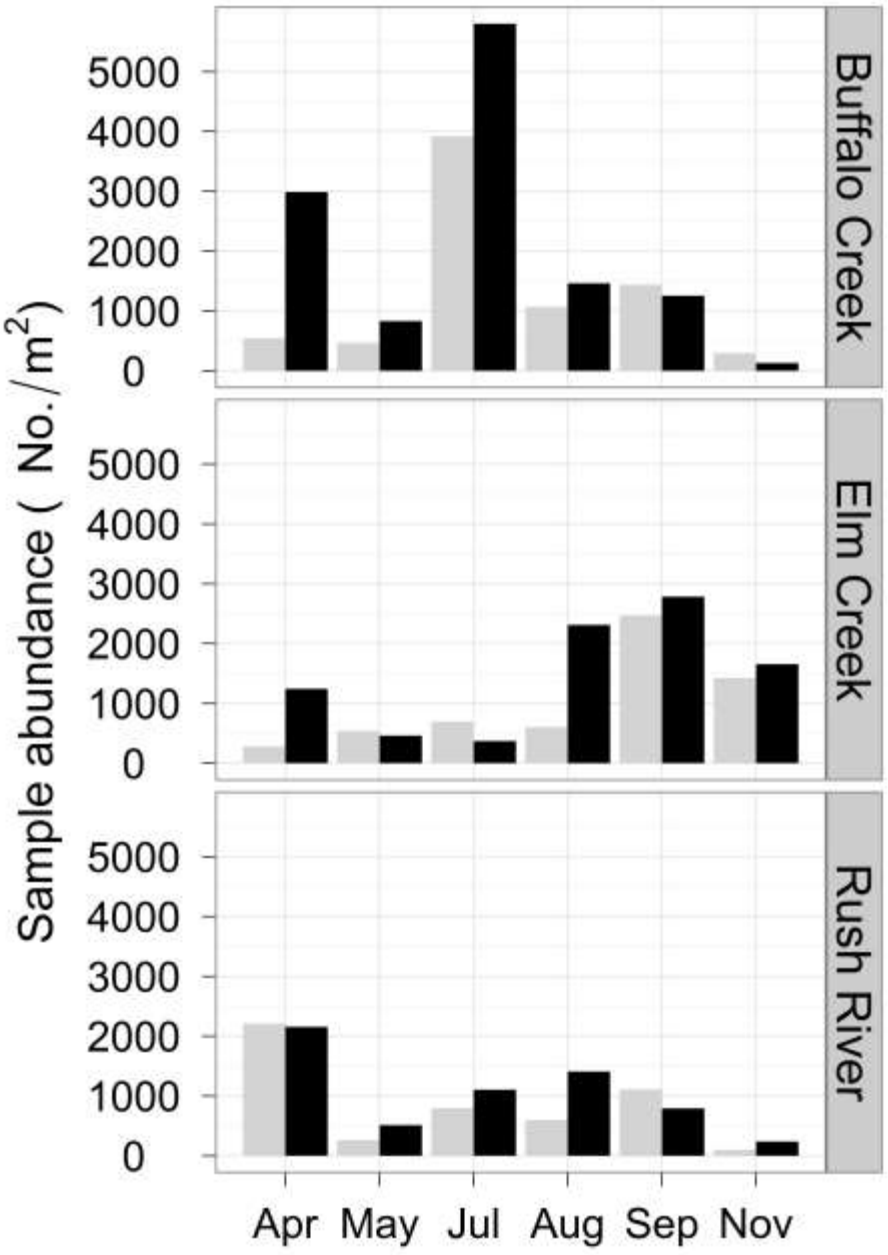
Dominant Taxa: Rush River



In-stream Habitat

Habitat	Buffalo Creek		Elm Creek		Rush River	
	U	R	U	R	U	R
% embedded	**86%**	**64%**	**63%**	**40%**	24%	28%
% sand	**70%**	**48%**	30%	24%	54%	44%
% gravel	8%	24%	52%	56%	10%	16%
% cobble	8%	20%	12%	14%	20%	30%

Invertebrate abundance



Unrestored

Restored

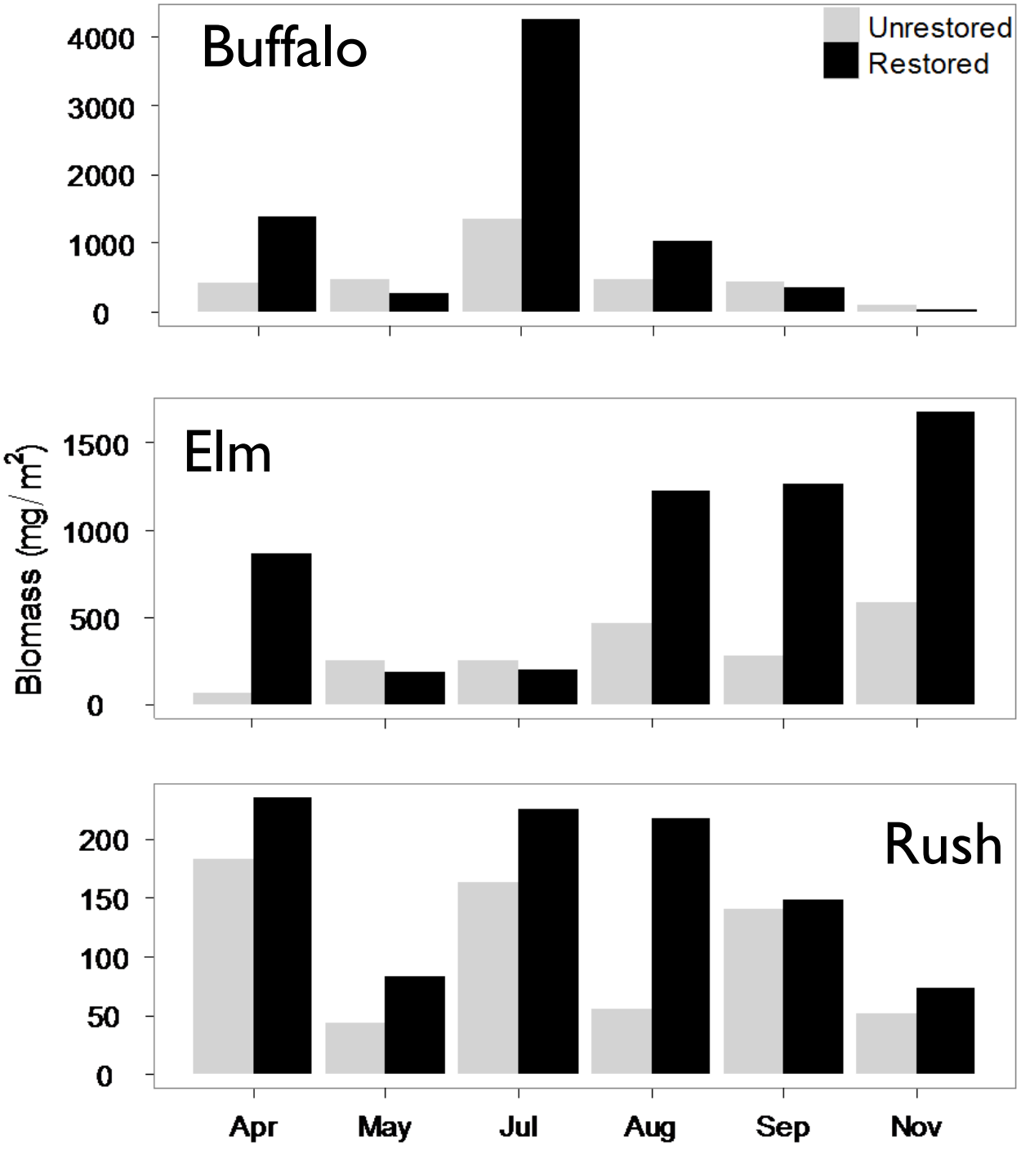
No significant difference in <u>mean abundance</u> between restored and unrestored reaches

Biomass

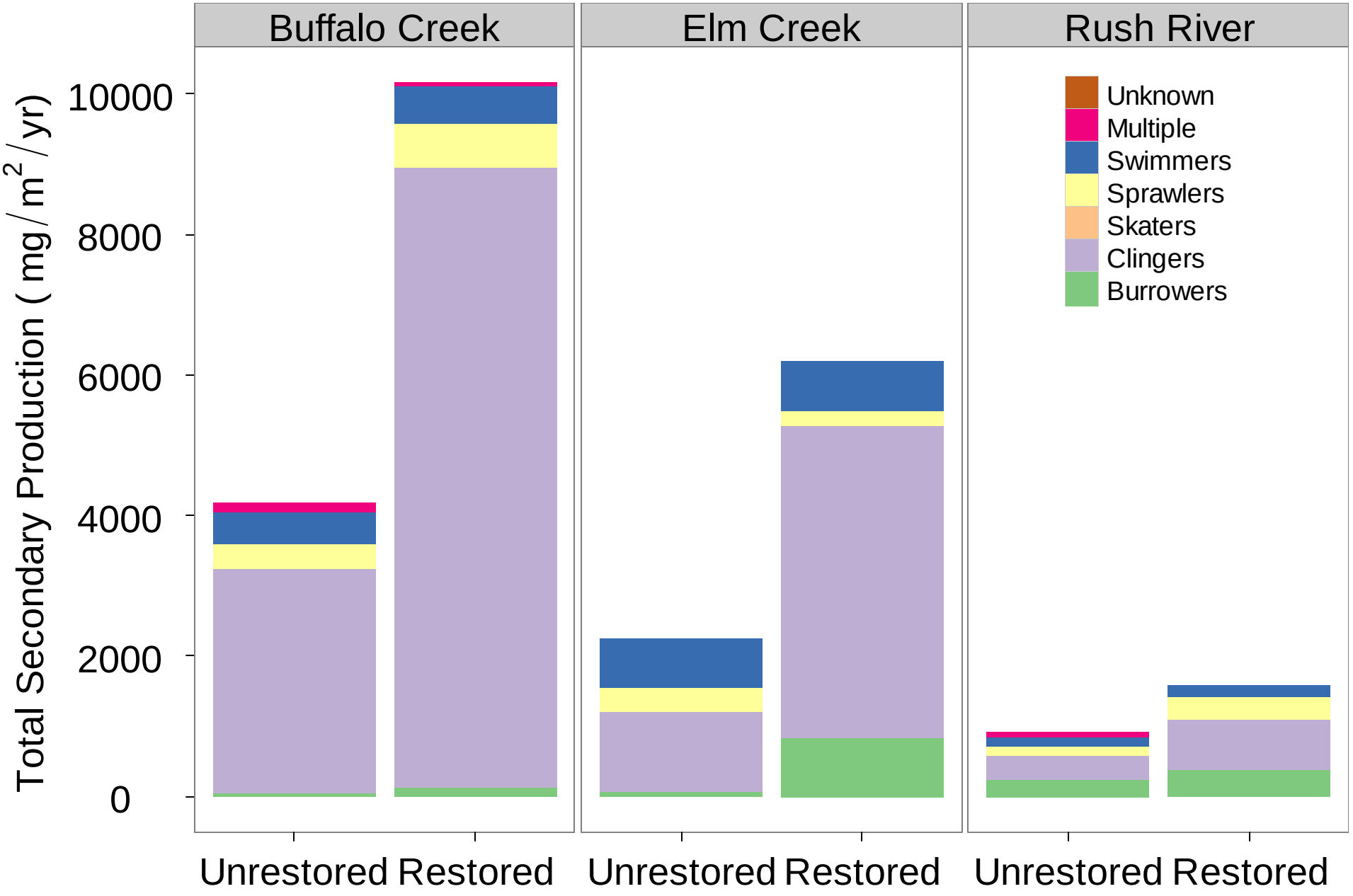
Mean biomass per visit:

Restored = 760 mg/m²

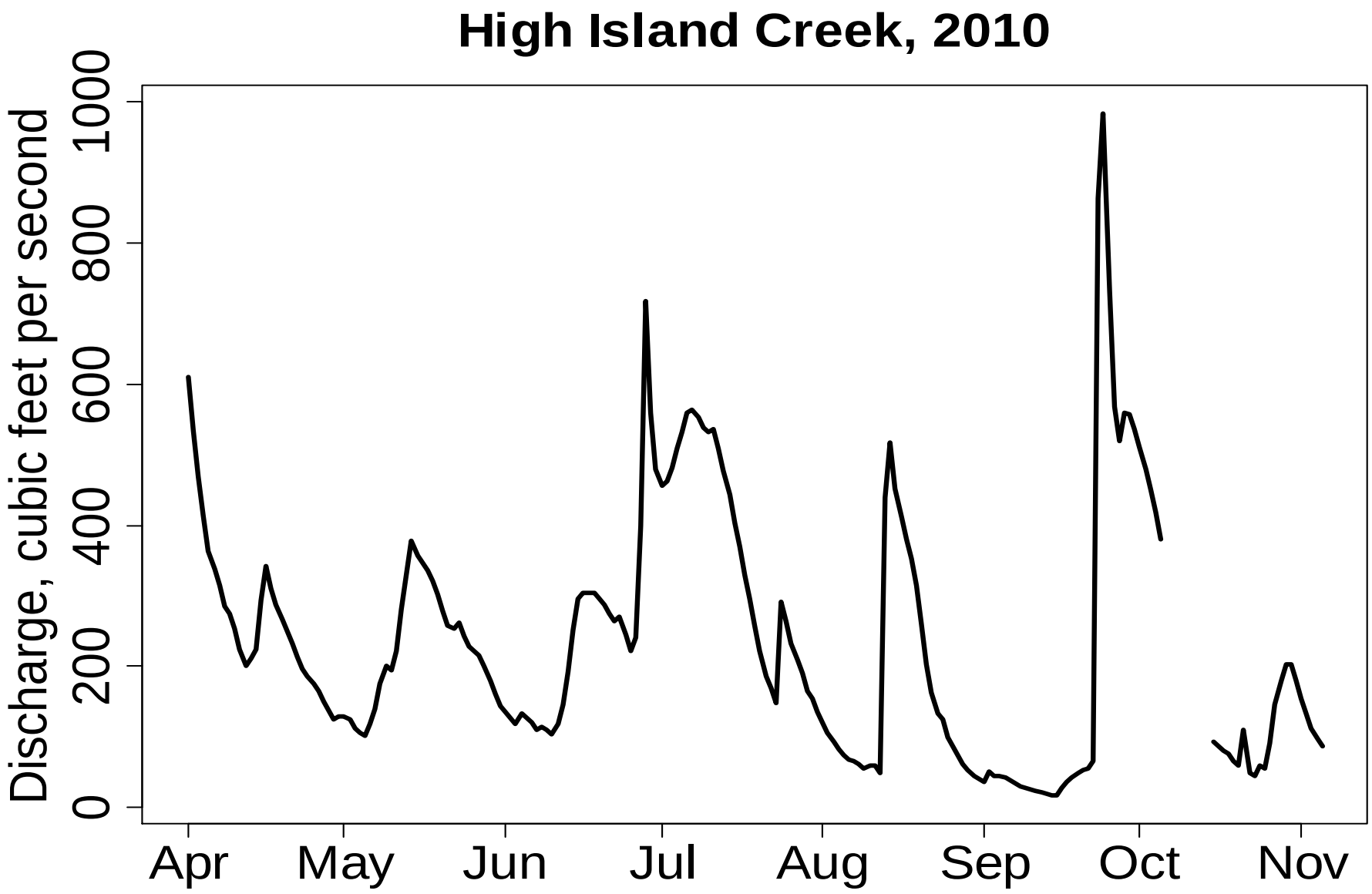
Unrestored = 320 mg/m²



Production by Habit Groups



Drainage & Discharge

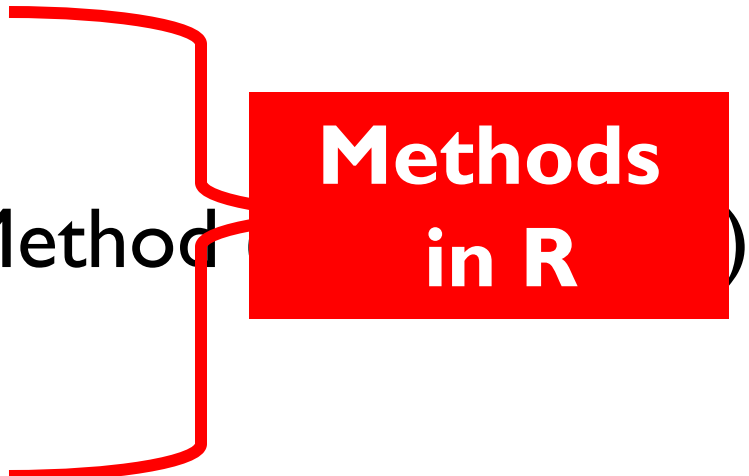


Methods

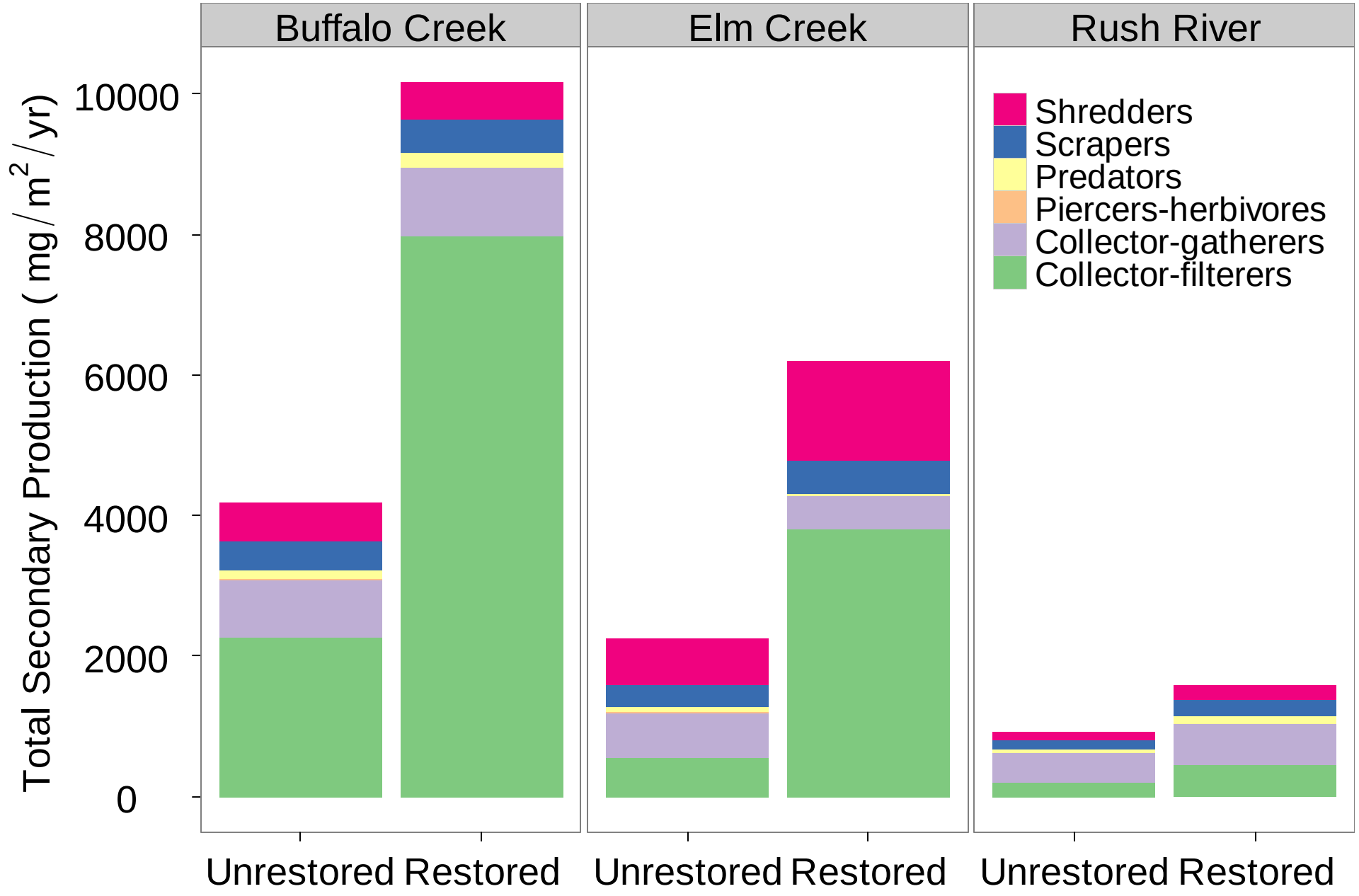
Biodiversity = Taxa richness (most common taxonomic unit = genus)

Secondary production = Biomass over time

1. Measure length of each specimen (extra work!)
2. Use existing length-mass regression equations to determine mass
3. Calculate production (P) from mass using one of three methods:
    - Size-frequency method
    - Instantaneous Growth Method
    - Published P/B ratios



Production by Functional Feeding Groups



Density

Unrestored

Restored

Controlling for site and month effects, **density was 258 individuals/m2 higher in restored reaches** compared to unrestored reaches, on average