

Native Herbivores as Mediators of an Exotic Grass Invasion



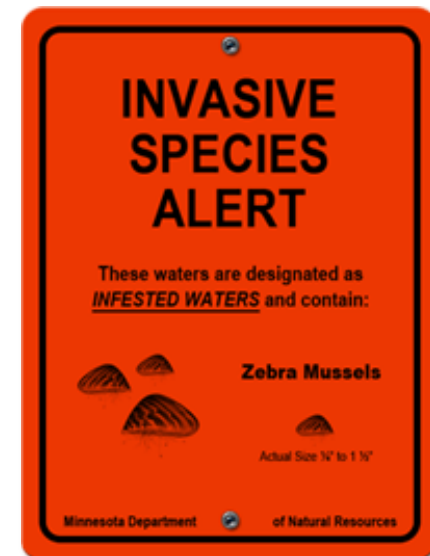
Cody Ender, Caroline Christian, and Hall Cushman

Department of Biology
Sonoma State University



Biological invasions

- A time of unprecedented global change
 - Atmospheric CO₂
 - Patterns of land use
 - Biological invasions
- Large ecological impacts
 - Reduce native abundance and/or diversity
 - Alter ecosystem functioning



Herbivores and plant invasions

- Herbivores can promote or suppress exotic taxa
- Direct and Indirect effects
 - Eat invaders
 - Eat neighbors of invaders
 - Disturb invaders and their neighbors
 - Deposit metabolic wastes



Megaherbivores and restoration

- Decline of native megaherbivores
- Reintroduction efforts
 - Invaded landscapes
- Outstanding questions
 - Do they affect plant invaders
 - Habitat specific effects
 - Long-term effects



Research questions

1. Do native herbivores affect the growth, abundance and recruitment of an exotic perennial grass?
2. What are the long-term dynamics of this perennial grass invasion?
3. How do native herbivores influence the trajectory of this perennial grass invasion?



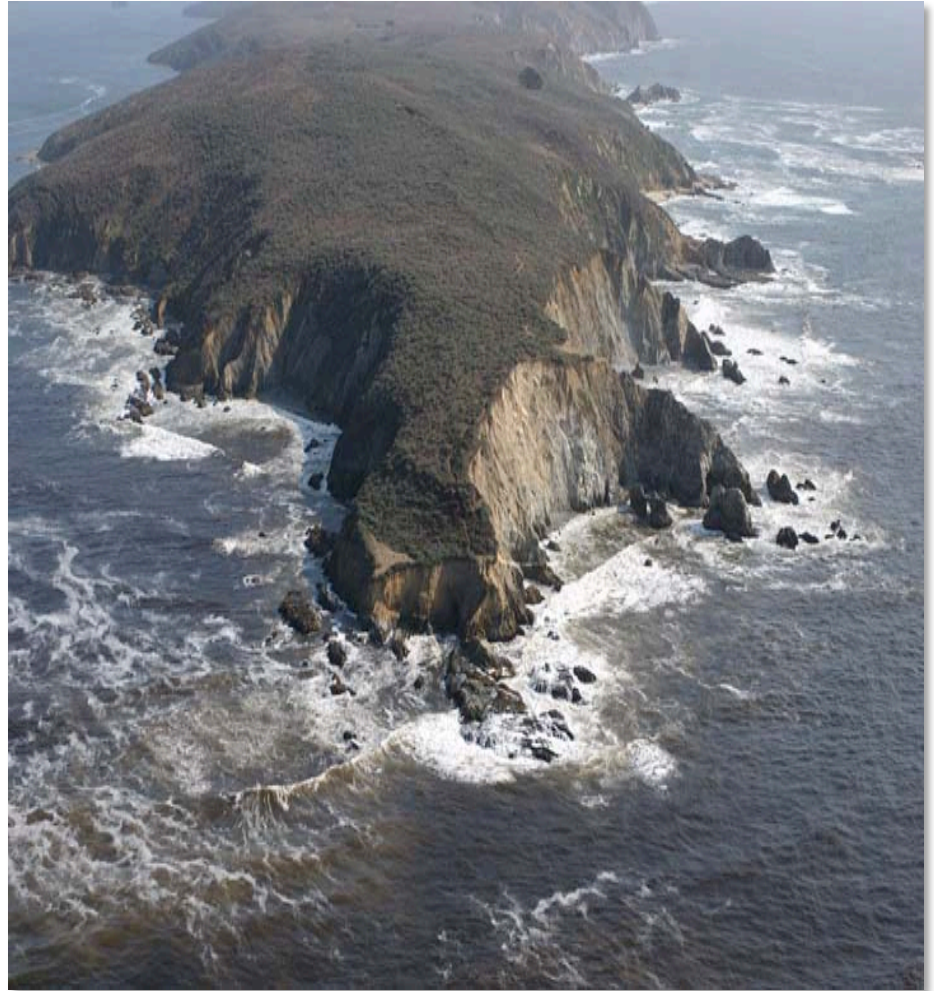
Tule elk

- *Cervus canadensis nannodes*
- Native herbivore
 - endemic to CA
- Underwent catastrophic population declines in 1800s
- Reintroduced to 20+ areas

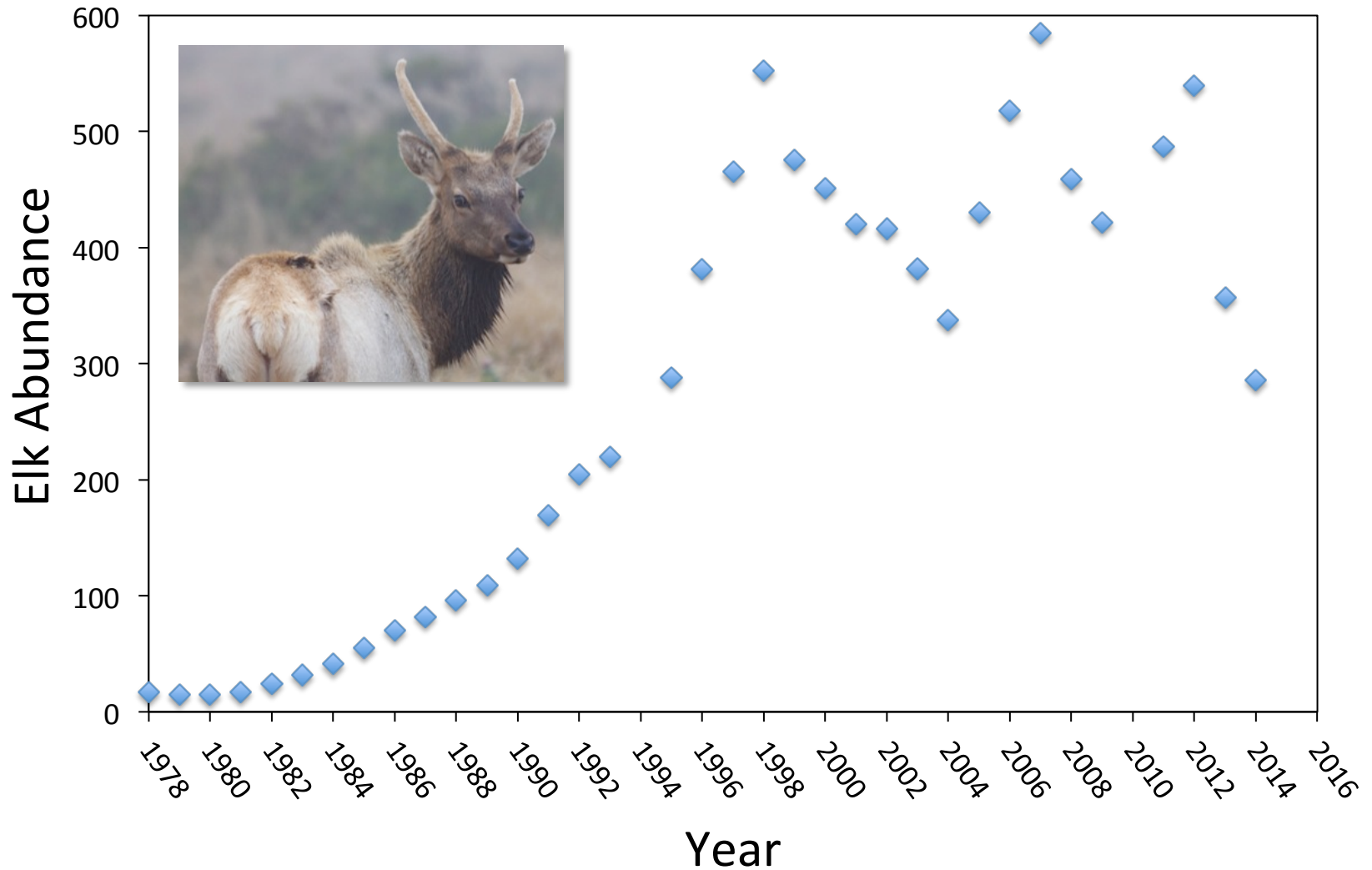


Tomales Point

- 2,500 acre wilderness area
- Point Reyes National Seashore

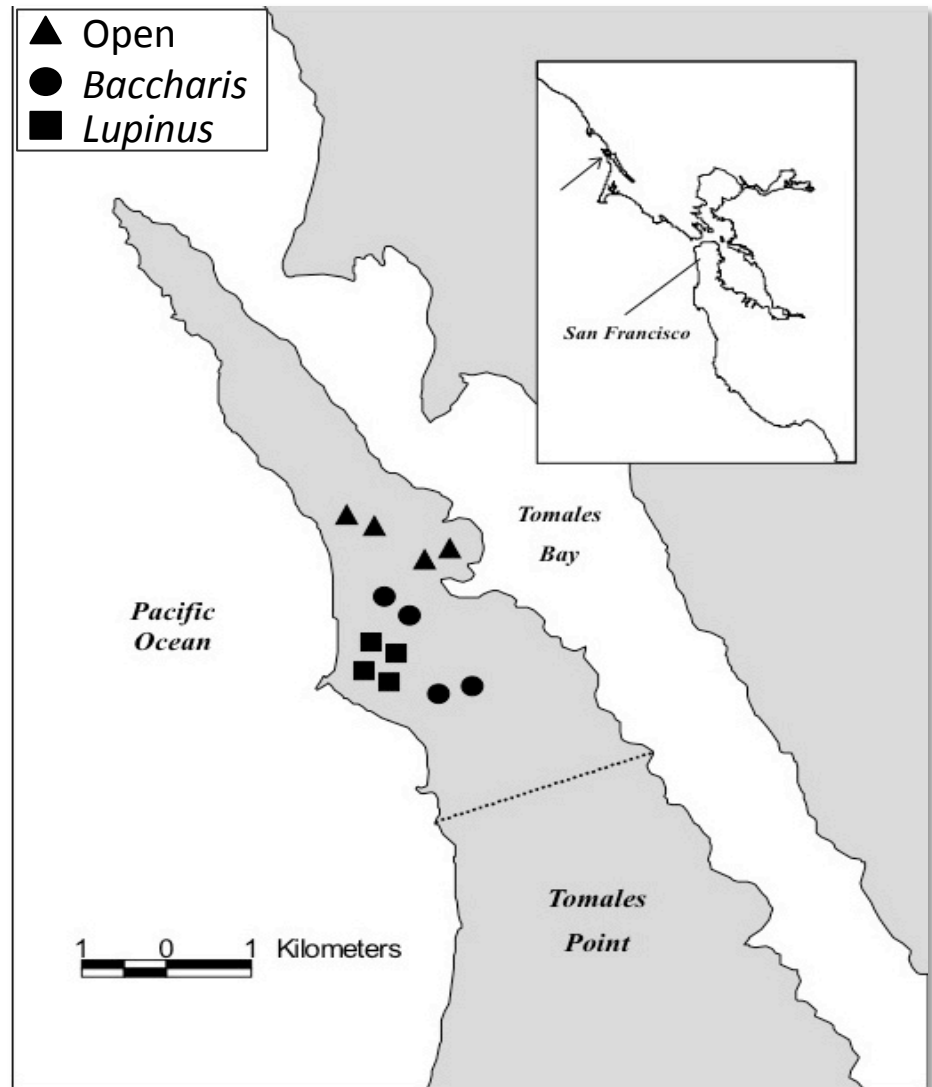


Elk at Tomales Point



Long-term exclosure experiment

- Established 1998
 - currently 17 years old
- 24 36 x 36 m plots
- Paired design
 - Fenced to exclude elk or unfenced (control)
- Stratified over 3 habitat types



Tomales Point Habitat Types

- Underlying parent material
- Soil characteristics
 - Moisture, texture, bulk density, nutrient levels
- Vegetation characteristics
 - Grasses and forbs
 - *Baccharis*-dominated
 - *Lupinus*-dominated



Holcus lanatus (Velvet grass)

- Perennial grass
- Native to Eurasia
- Introduced in coastal California
- Wet environments
- Effects above- and below-ground
 - Outcompete natives
 - Litter and decomposition
 - Bacteria to fungi ratio



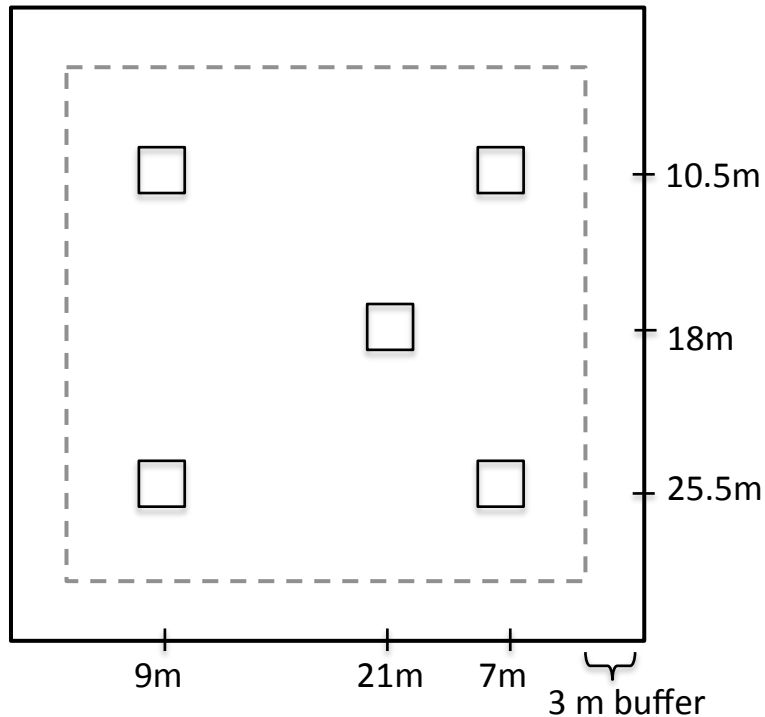
1. How do tule elk affect *Holcus*?

Response variables:

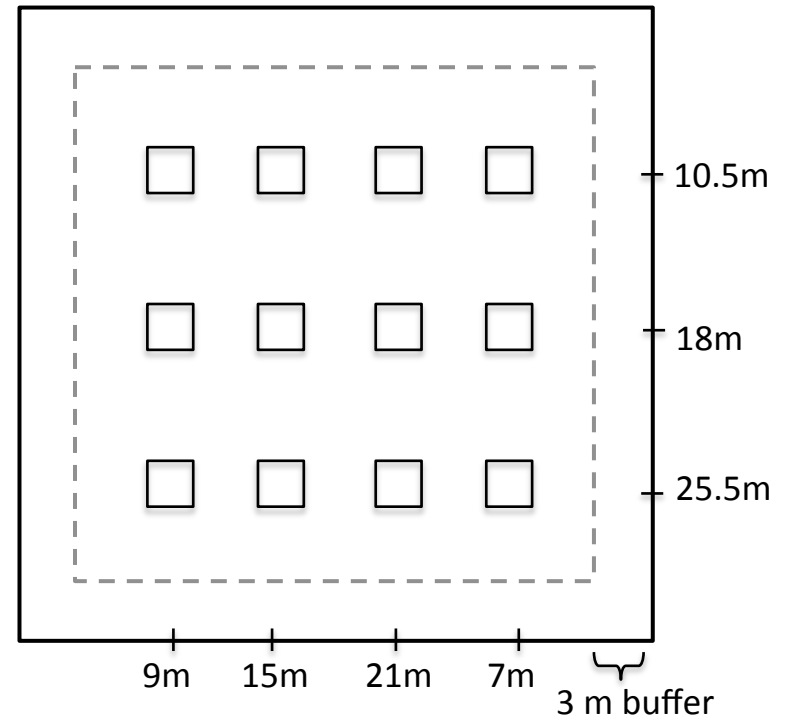
- Aboveground biomass
- Seedling abundance
- Seedling frequency } recruitment
- Abundance
- Cover



Quadrat placement

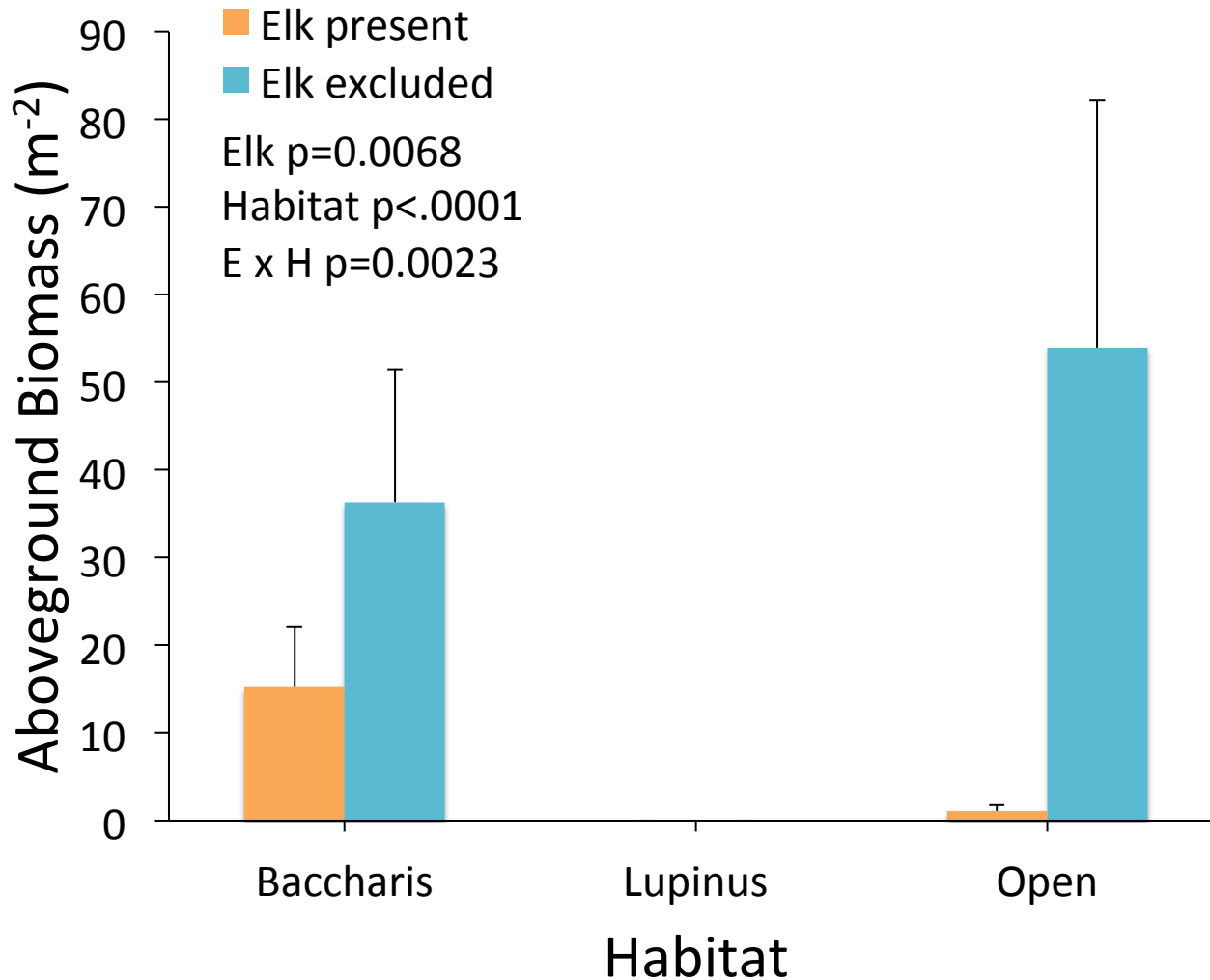


- Aboveground biomass

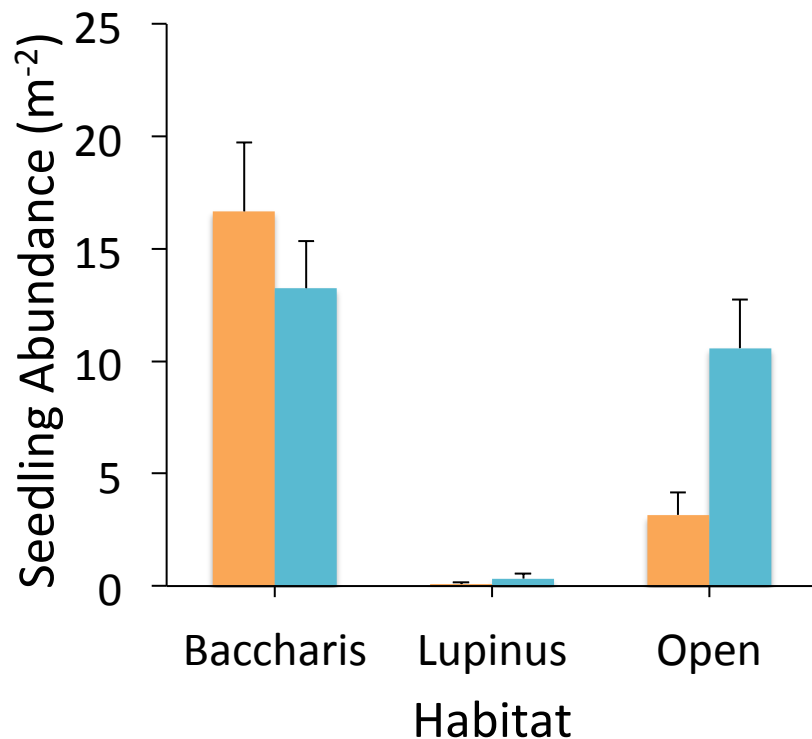


- Abundance
- Cover
- Seedling abundance
- Seedling frequency

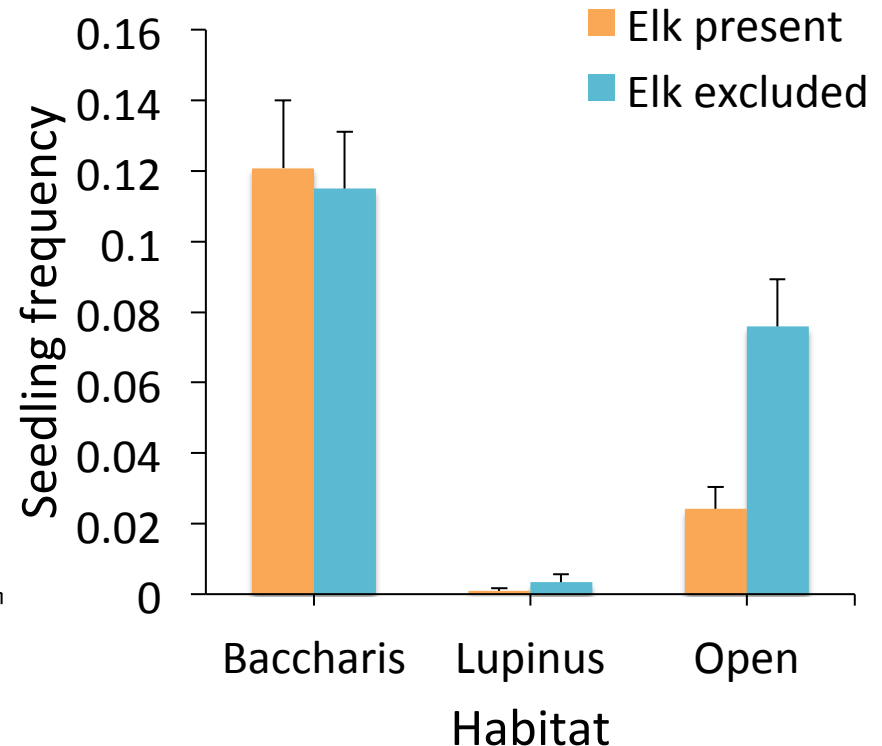
Holcus aboveground biomass



Holcus seedling recruitment

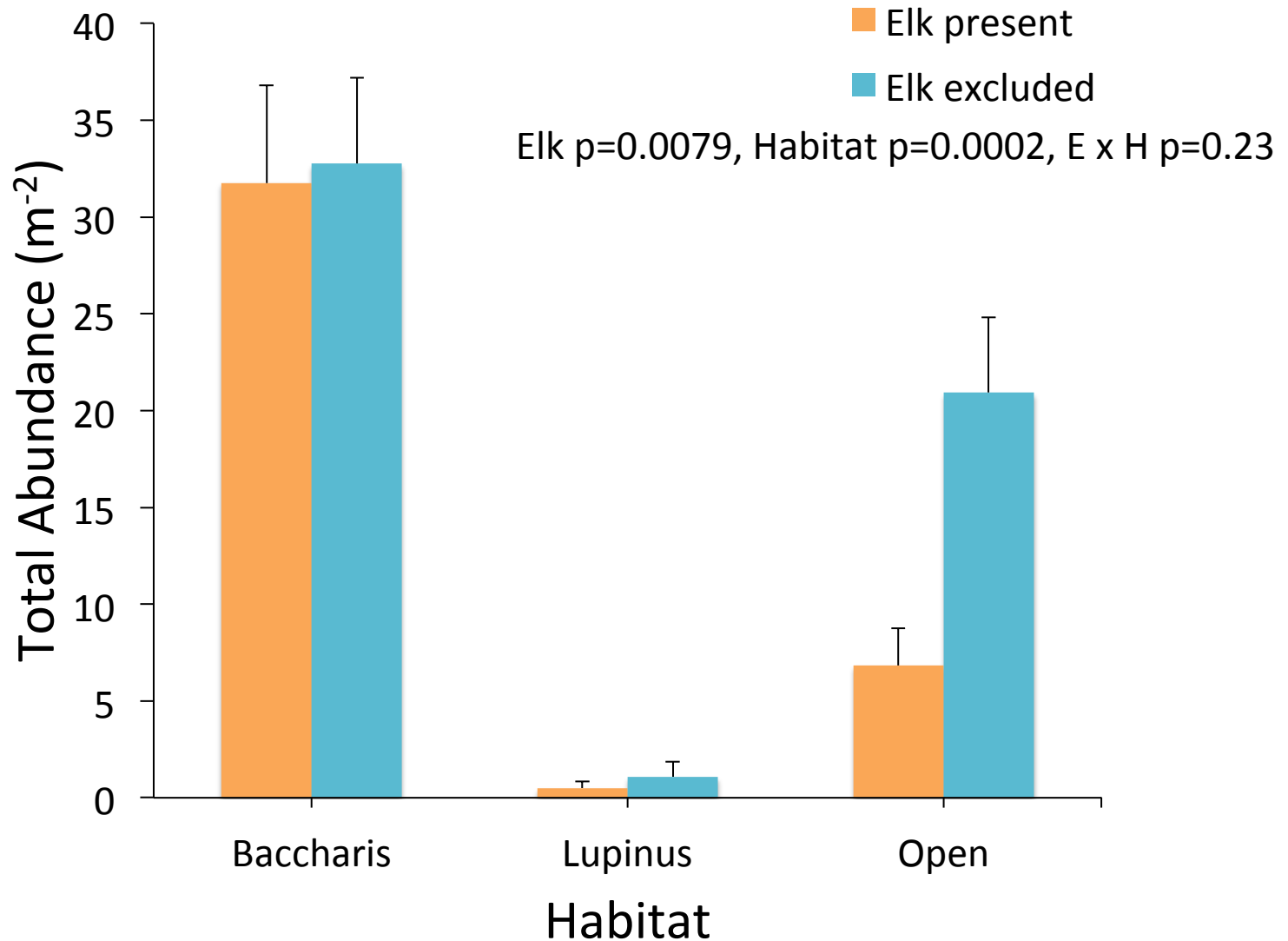


Elk $p=0.072$
Habitat $p=0.0003$
E x H $p=0.135$

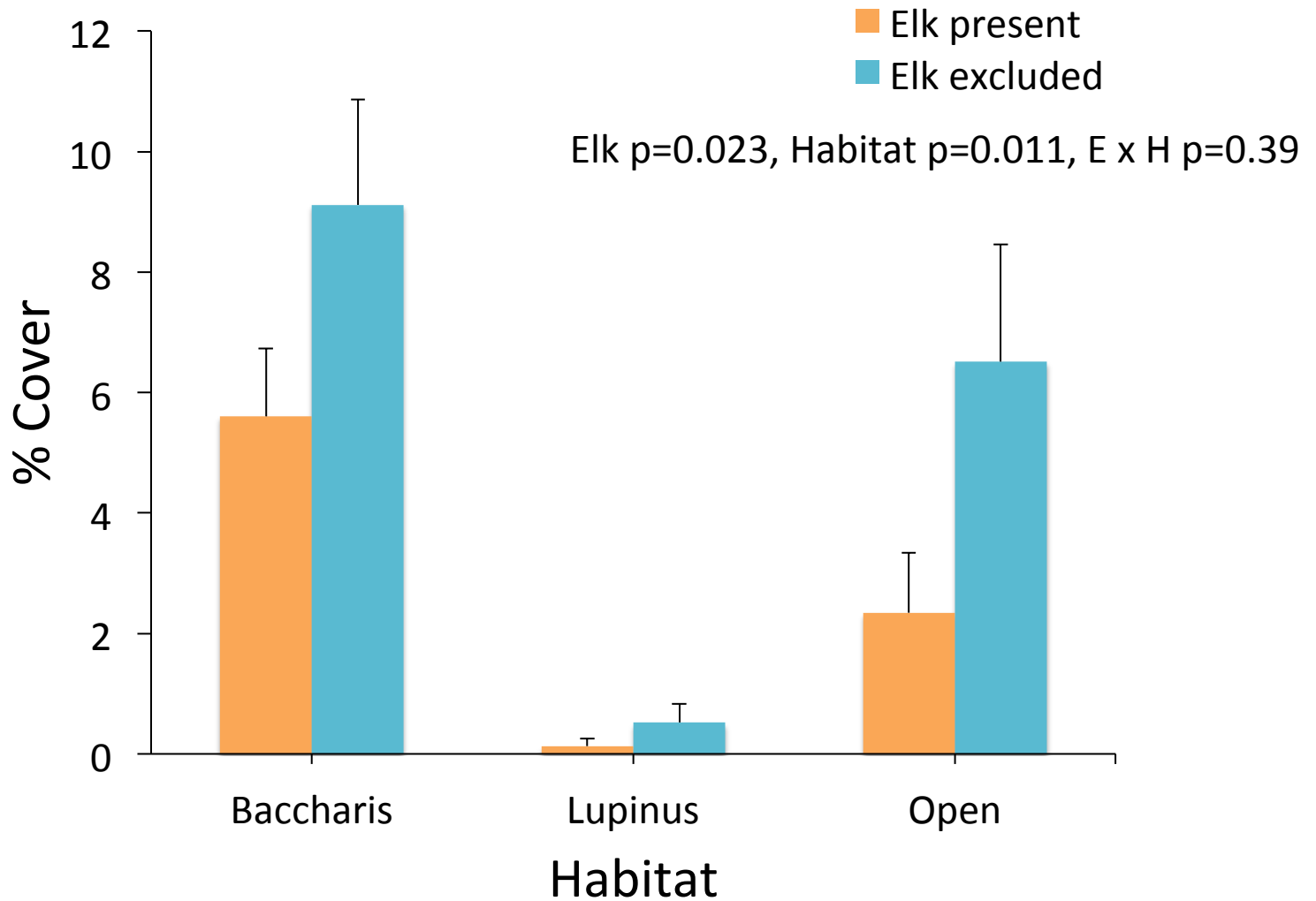


Elk $p=0.069$
Habitat $p=0.0008$
E x H $p=0.28$

Holcus abundance



Holcus cover



2. What are the long-term dynamics of *Holcus* invasion?

- Make use of data collected by Johnson and Cushman in 2002 and 2003
 - Re-analyze biomass and abundance
- Compare data from 2002 with those from 2015
 - 13-year time span

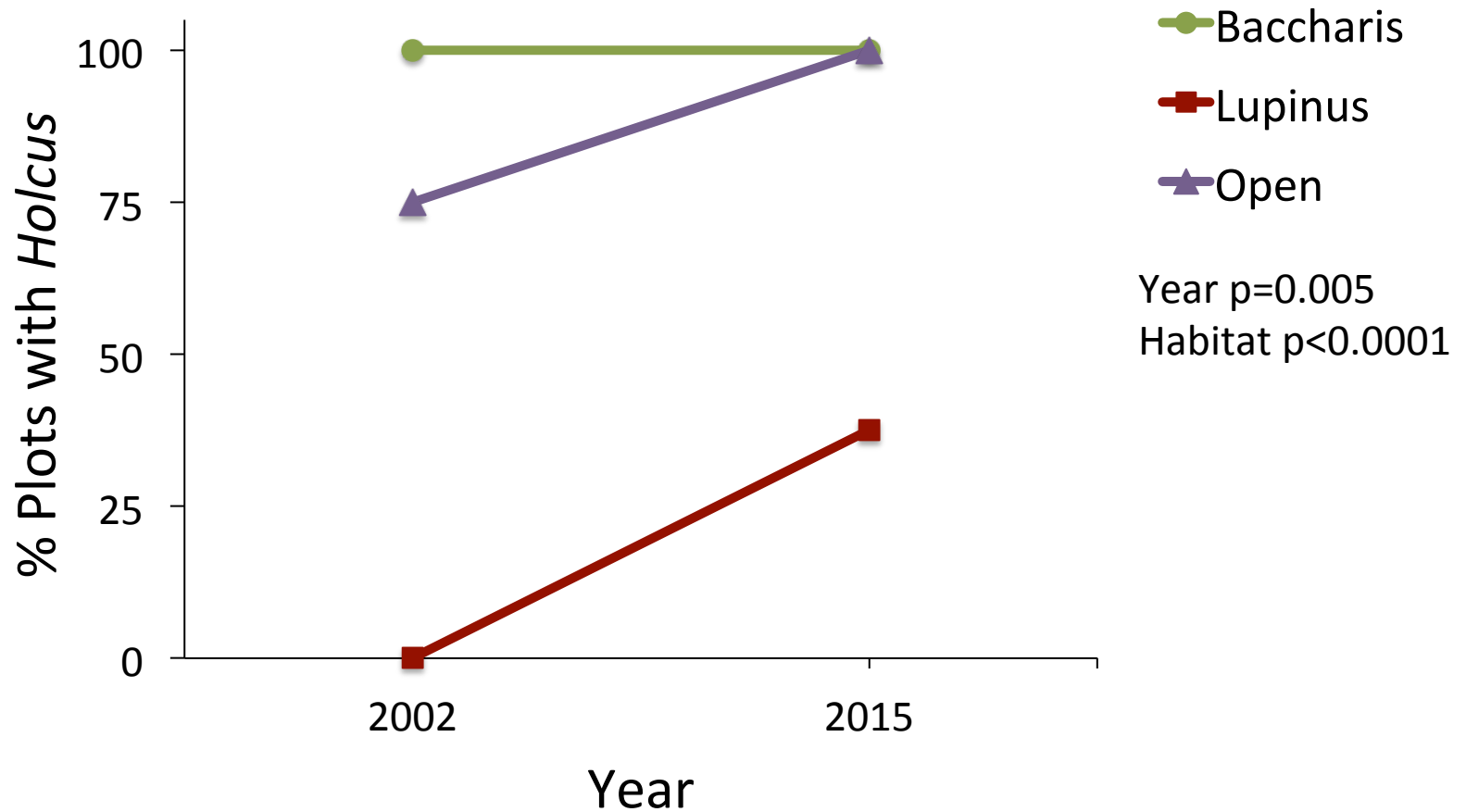


Brent Johnson

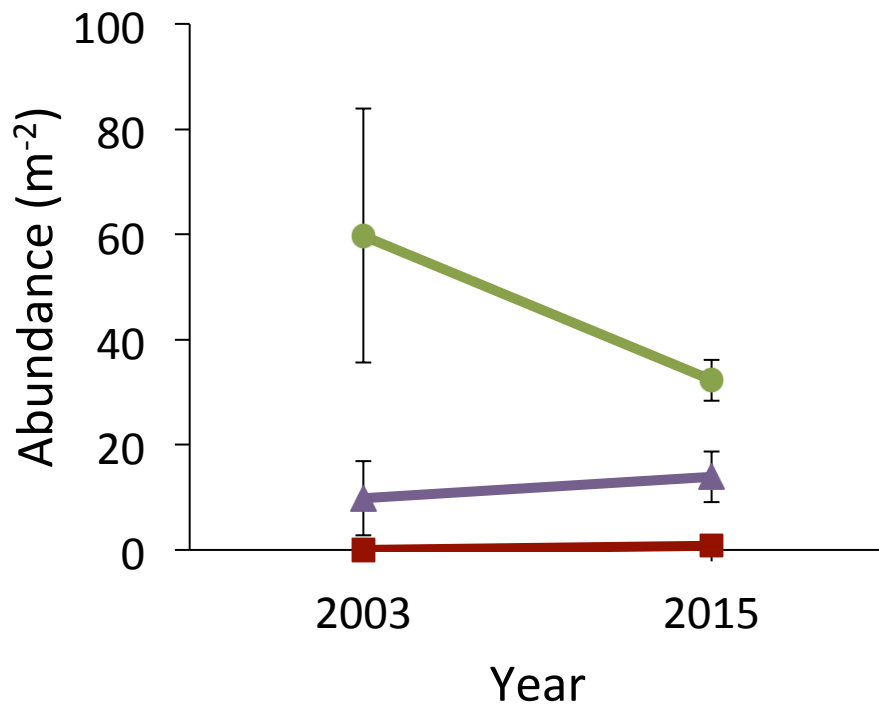


Hall Cushman

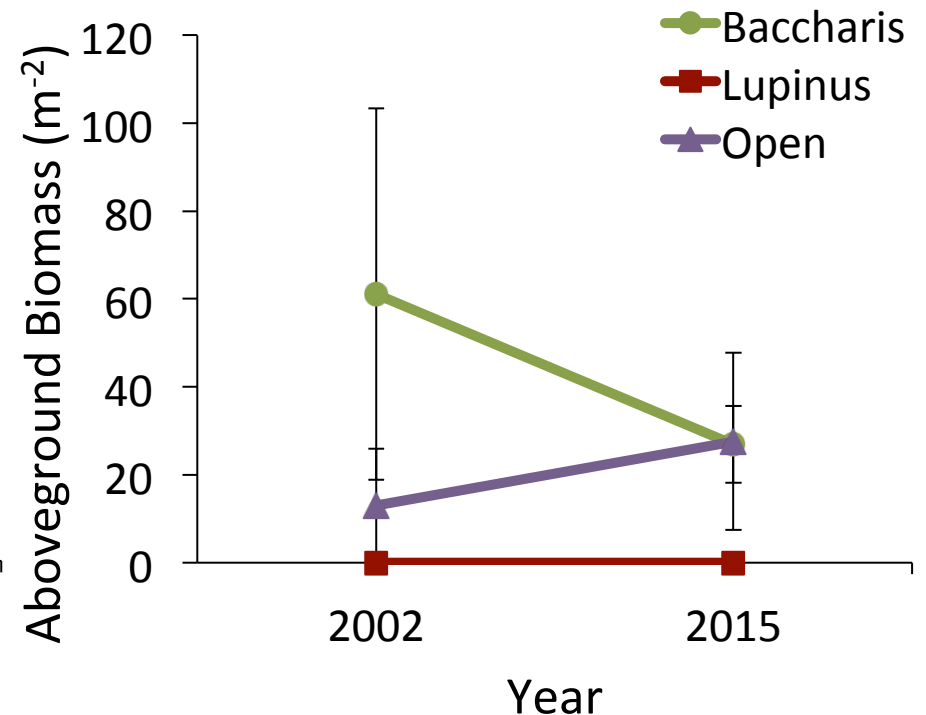
Holcus frequency (whole plot level)



Holcus abundance and biomass



Year $p=0.092$
Habitat $p<0.0001$
Y x H $p=0.001$



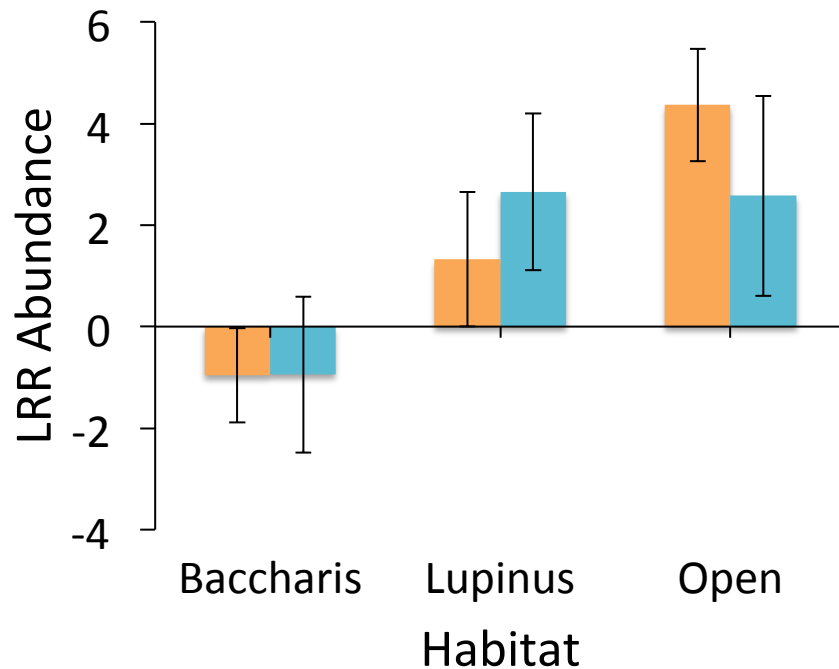
Year $p=0.12$
Habitat $p=0.007$
Y x H $p=0.29$

3. How do elk influence the trajectory of *Holcus* invasion?

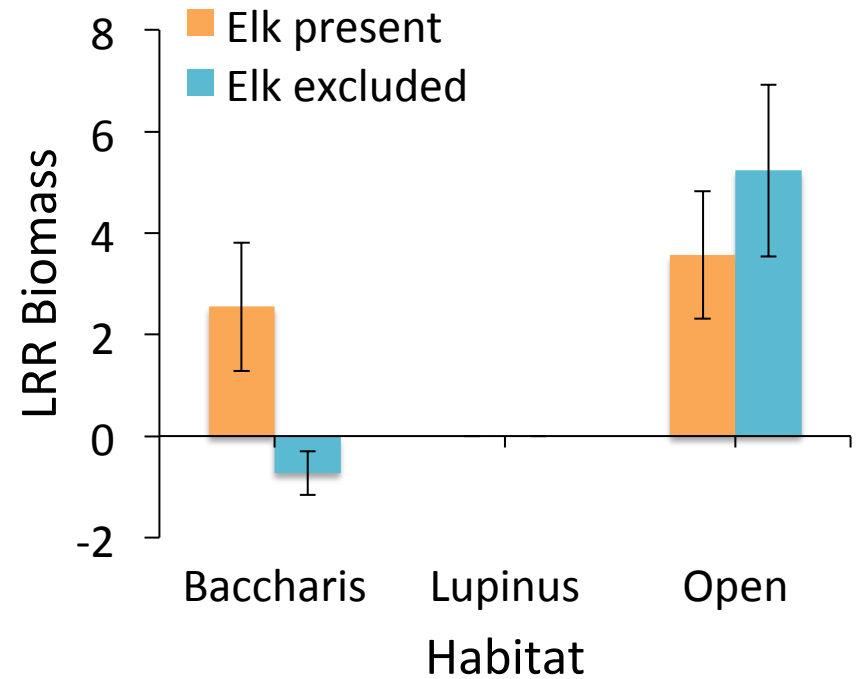
- Compare early data with those from 2015
 - Log response ratio: $LRR = \ln\left(\frac{2015}{2002}\right)$



Habitat-dependent invasion dynamics



Elk $p=0.90$
Habitat $p=0.031$
E x H $p=0.59$



Elk $p=0.57$
Habitat $p=0.002$
E x H $p=0.14$

Putting it all together

- Effects of elk on *Holcus*
 - ↓ abundance, cover and biomass
 - ↓ seedling recruitment (trend)
 - No Δ in elk effect since 2002
- *Holcus* invasion expanding
 - ↑ plot frequency
 - ↑ abundance, biomass
- Habitat-specific patterns
 - ↑ in open grasslands
 - No Δ in *Lupinus* grasslands
 - No Δ in *Baccharis* grasslands



Significance

- Influence of mammalian herbivores
 - Reintroduced native herbivores
 - Exotic plant populations
- Long-term experiment
- Range of habitats
- Management applications
 - Conservation and restoration



Acknowledgments

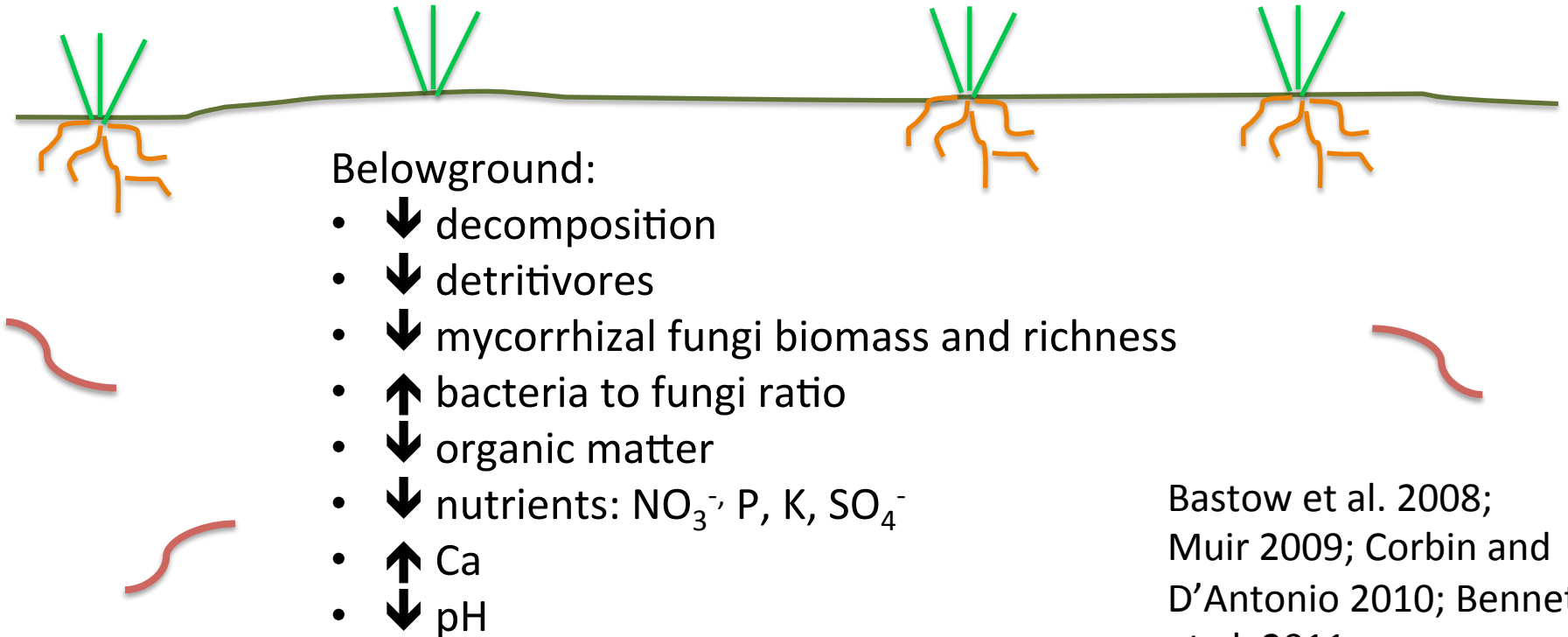
- Brent Johnson
- Comrades
 - Vanessa Dodge
 - Eric Cecil
 - Caprice Lee
 - Elias Lopez
 - Shiloh Vallenty
 - Dan Foley
- Funding
 - Milo Baker Chapter Native Plant Society
 - California Native Plant Society
 - Marin Chapter Native Plant Society
 - Sonoma State University



Above and Belowground Effects of *Holcus*

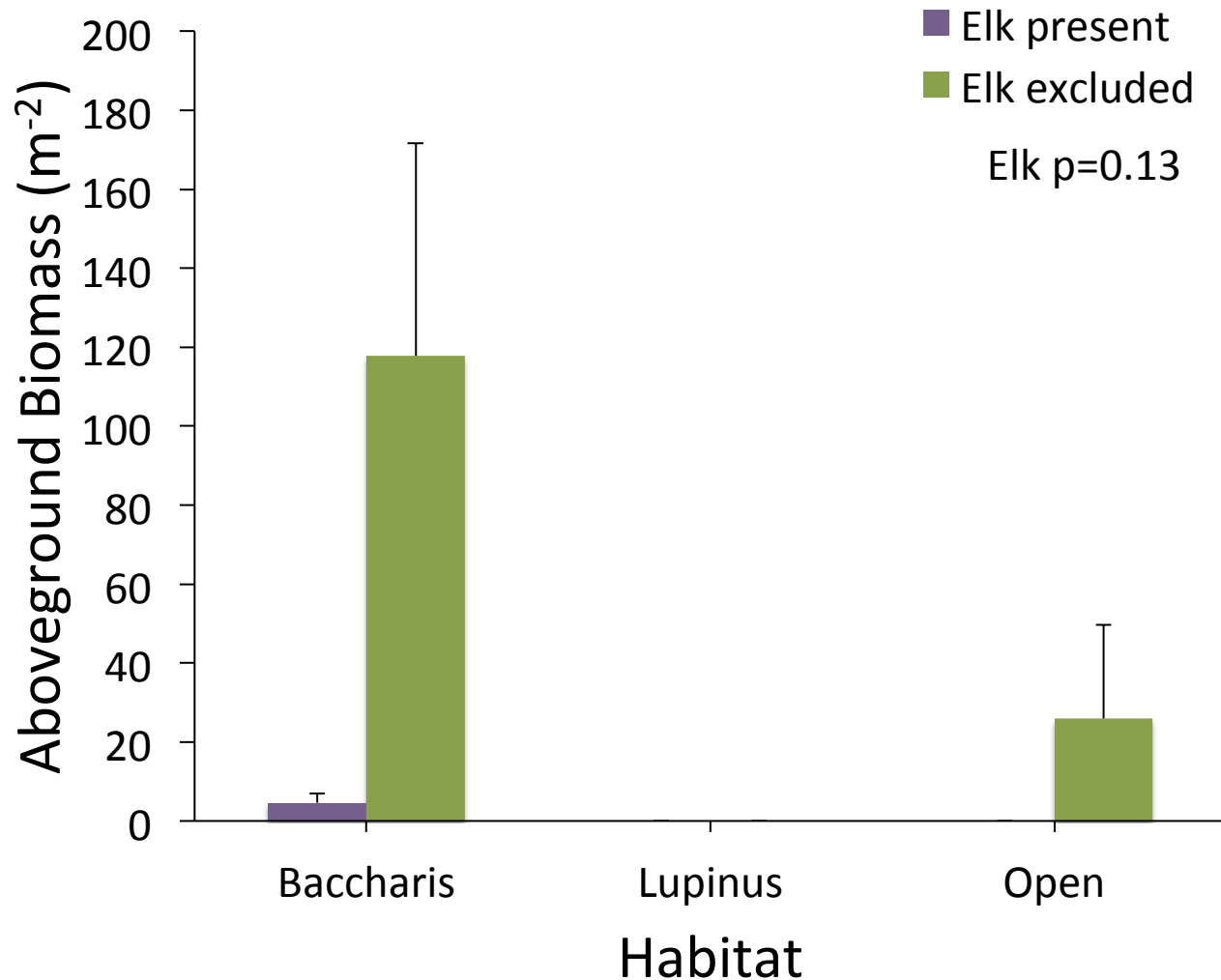
Aboveground:

- ↓ native species richness
- ↓ native forb germination, establishment, growth
- ↑ standing litter

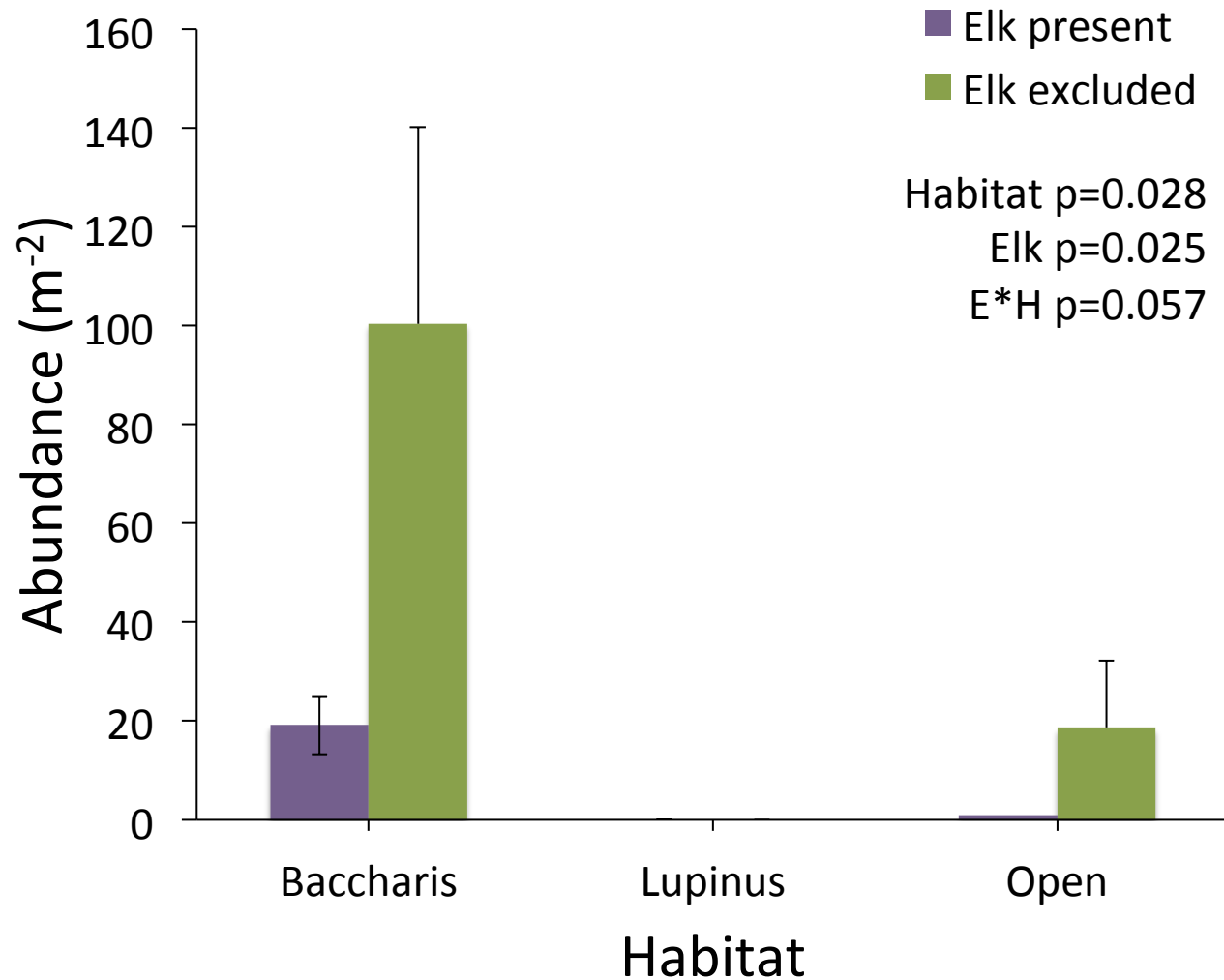


Bastow et al. 2008;
Muir 2009; Corbin and
D'Antonio 2010; Bennet
et al. 2011

2002 Aboveground Biomass



2003 Abundance



Frequency

