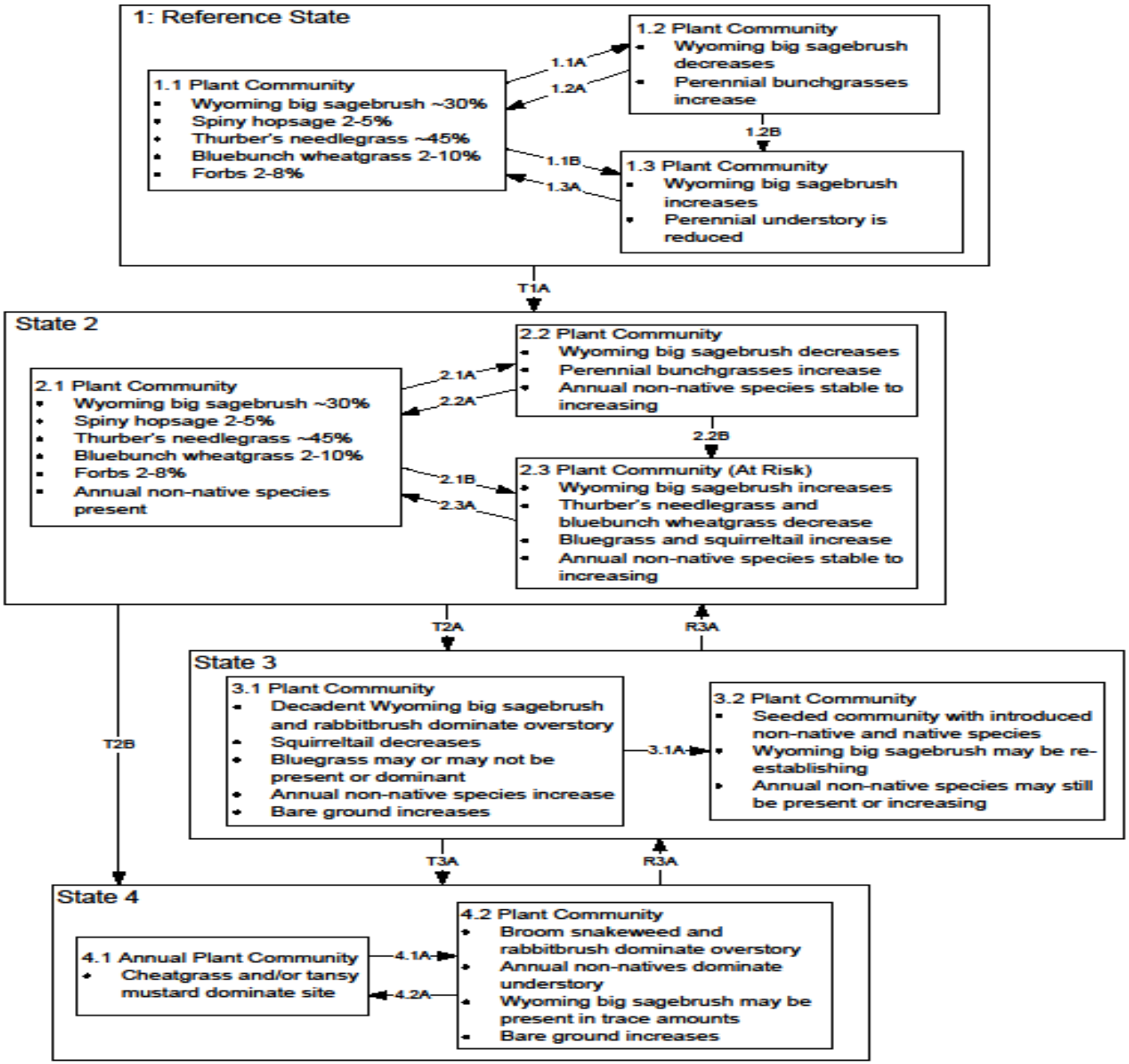
Synergistic Monitoring for Adaptive Management of Sagebrush Ecosystems


We Can’t Continue To Do
Nothing!

Group 1: Loamy 8-10



STM Applications
Wildfires and Preventative Land Treatments

J. Swanson, S. Swanson, K. McAdoo, B. Schultz, G. McCuin University of Nevada; UNR Cooperative Extension

And Tamzen

Ranches

What is most important to sage grouse?

- Required sagebrush habitats remain resistant and resilient
- At no time do populations lose too much essential habit

Photo by Gale Dypree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Mowing Wyoming Big Sagebrush (*Artemisia tridentata* ssp. wyomingensis) Cover Effects Across Northern and Central Nevada☆,☆☆

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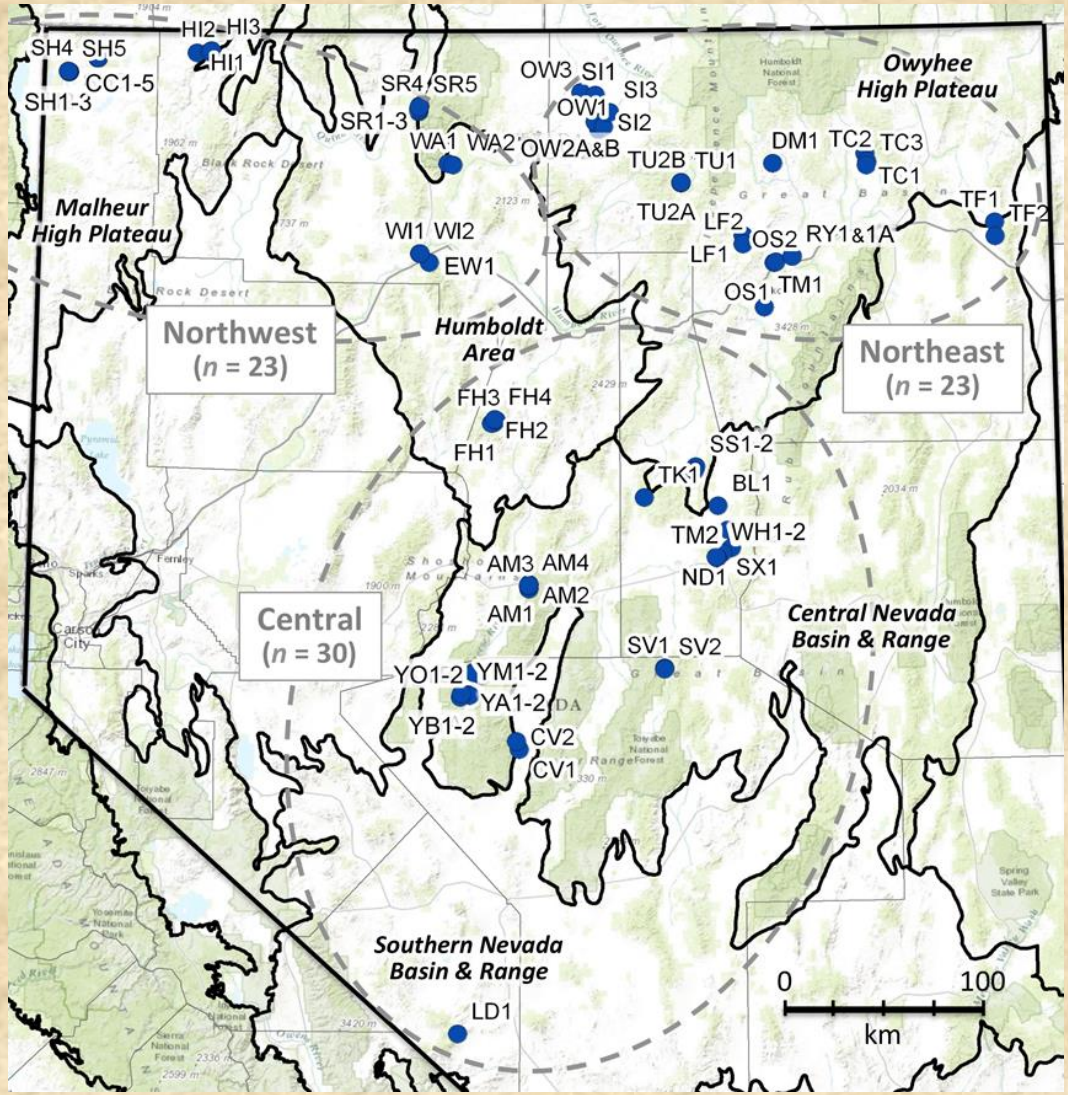
Ideally, Mowed areas will retain resilience and mowing will increase resistance



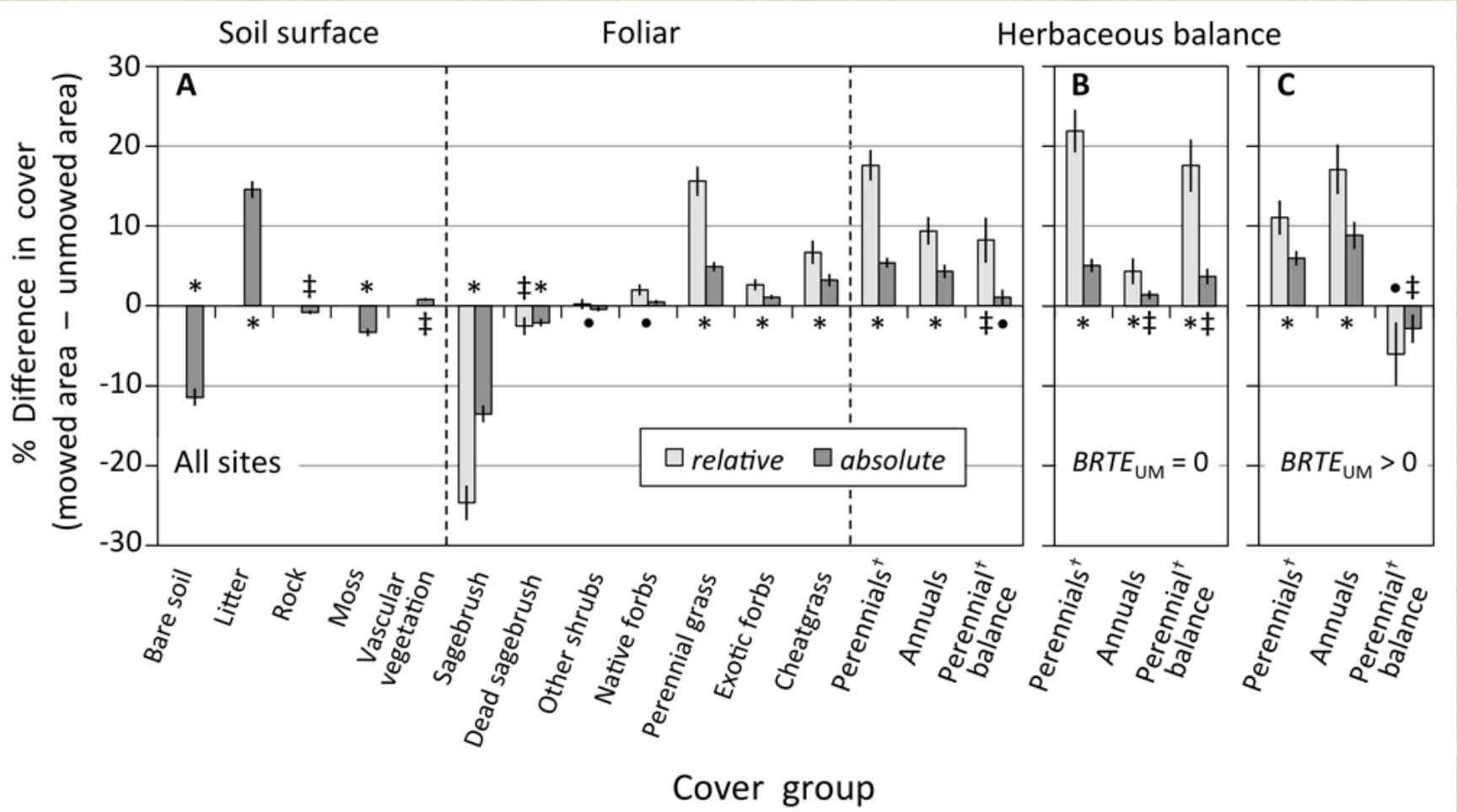
Locations of 76 study sites where mowing treatments were cover sampled with line-point-intercept transects

Figure 1. Locations of **76 mowing study sites** across northern and central Nevada, USA. Site labels are two letters plus one number (over-plotting sites indicated by '&' or '-' within a label). The dashed ellipses group sites by region and survey year: **northwest (2011), central (2012), northeast (2010)**. Five major land resource areas **(MLRAs), bounded in black,** contain study sites (from west to east): Malheur High Plateau (MHP, n = 13), Humboldt Area (HBT, n = 14), Central Nevada and Southern Nevada Basin and Range (B&R, n = 27, pooled in analyses because only 1 site in the latter), and Owyhee High Plateau (OHP, n = 22). County lines are in light grey.

Questions

1. Which cover groups differed significantly or correlated between unmowed and mowed areas?

2. Are sagebrush and herbaceous cover in unmowed areas predictive of the herbaceous response to mowing?
3. What characteristics of unmowed areas best predict the perennial-annual herbaceous balance after mowing and its difference
from unmowed to mowed areas?
4. Of the continuous variables key in predicting the herbaceous response to mowing, did any operate as thresholds?



Difference in soil surface and foliar cover, and the herbaceous cover balance, from unmowed to mowed areas

Figure 2. The mean percent difference (± 1 SE) in soil surface and foliar cover, and the herbaceous cover balance, from unmowed to mowed areas at all 76 sites (A). The mean difference in the herbaceous balance is also shown for sites subdivided by whether cheatgrass was absent (B, BRTEUM = 0, n = 46) or present (C, BRTEUM > 0, n = 30) in their unmowed areas. For foliar cover responses, the relative cover (RC) equaled absolute cover (AC) divided by the total vascular cover at an unmowed or mowed area. For pooled perennials (native forbs plus perennial grass), a dagger (†) indicates that a few native annual forbs were included. Paired t tests (i.e., one sample t) compared mowed minus unmowed cover differences: *P ≤ 0.0014 (0.05/m, m = 37), ‡0.0014 < P ≤ 0.050, •P > 0.050 (a symbol centered between two means indicates both share the same significance level).

Pairwise correlations between the percent cover of the four herbaceous types in unmowed and mowed areas at 76 Nevada sites.

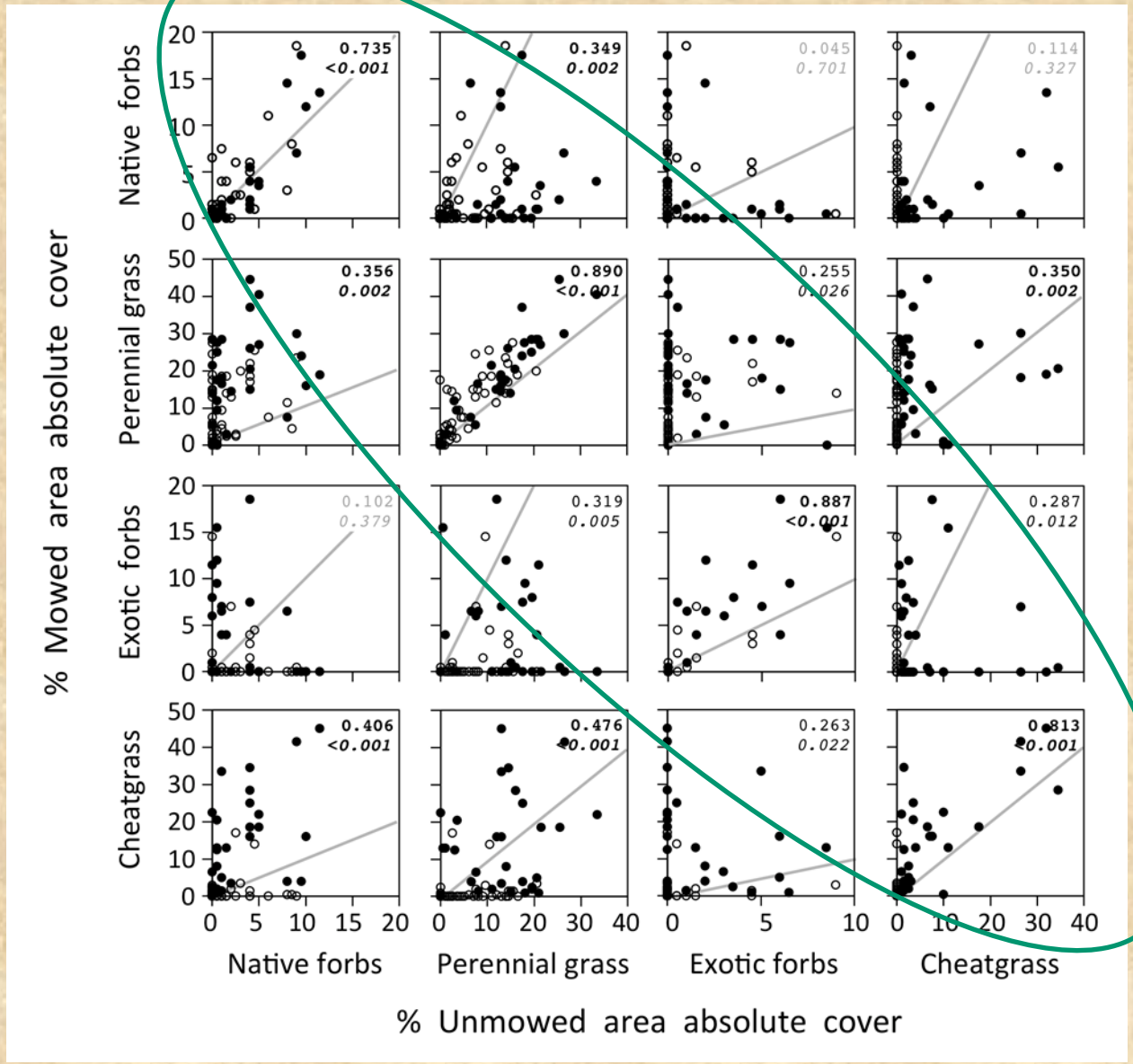


Figure 3. Pairwise correlations between the percent cover of the four herbaceous types in unmowed and mowed areas at 76 Nevada sites. The shading of points indicates whether a site's unmowed area lacked cheatgrass (open) or had cheatgrass (solid). Correlations based on all sites (Spearmans' □ and P, in italics) are highlighted as follows: bold black P ≤ 0.0031 (0.05/m, m = 16), black 0.0031 < P ≤ 0.05, grey P > 0.05. Grey lines indicate the one-to-one cover ratio.

Correlations (Spearman's rho) between three measures of sagebrush in unmowed areas & A. herbaceous cover in paired mowed areas and B. difference in herbaceous cover between paired mowed and unmowed areas.

	Sagebrush in unmowed areas		
	Absolute cover	**Relative cover**	**Mean size**
A. Mowed area absolute cover			
Native forbs	-0.270	**-0.513**	**0.413**
Perennial grass	-0.062	**-0.507**	0.302
Exotic forbs	**-0.362**	**-0.427**	0.165
Cheatgrass	-0.220	**-0.526**	**0.571**
B. Difference in cover (mowed–unmowed)			
Native forbs	0.016	0.037	-0.146
Perennial grass	**0.386**	0.311	-0.113
Exotic forbs	-0.082	-0.104	0.224
Cheatgrass	-0.144	**-0.320**	**0.369**

grey $P > 0.05$, black $P \leq 0.05$, and **bold black** $P \leq 0.0008$

Questions

1. Which cover groups differed significantly or correlated between unmowed and mowed areas?

2. Are sagebrush and herbaceous cover in unmowed areas predictive of the herbaceous response to mowing?

3. What characteristics of unmowed areas best predict the perennial-annual herbaceous balance after mowing and its difference
from unmowed to mowed areas?
4. Of the continuous variables key in predicting the herbaceous response to mowing, did any operate as thresholds?

Change in percent relative cover at 76 sites from the unmowed to the mowed areas (tail to tip of arrow) on three axes:

- **Some sagebrush remained on all but a few plots**
- **No or few annuals led to no or few annuals**

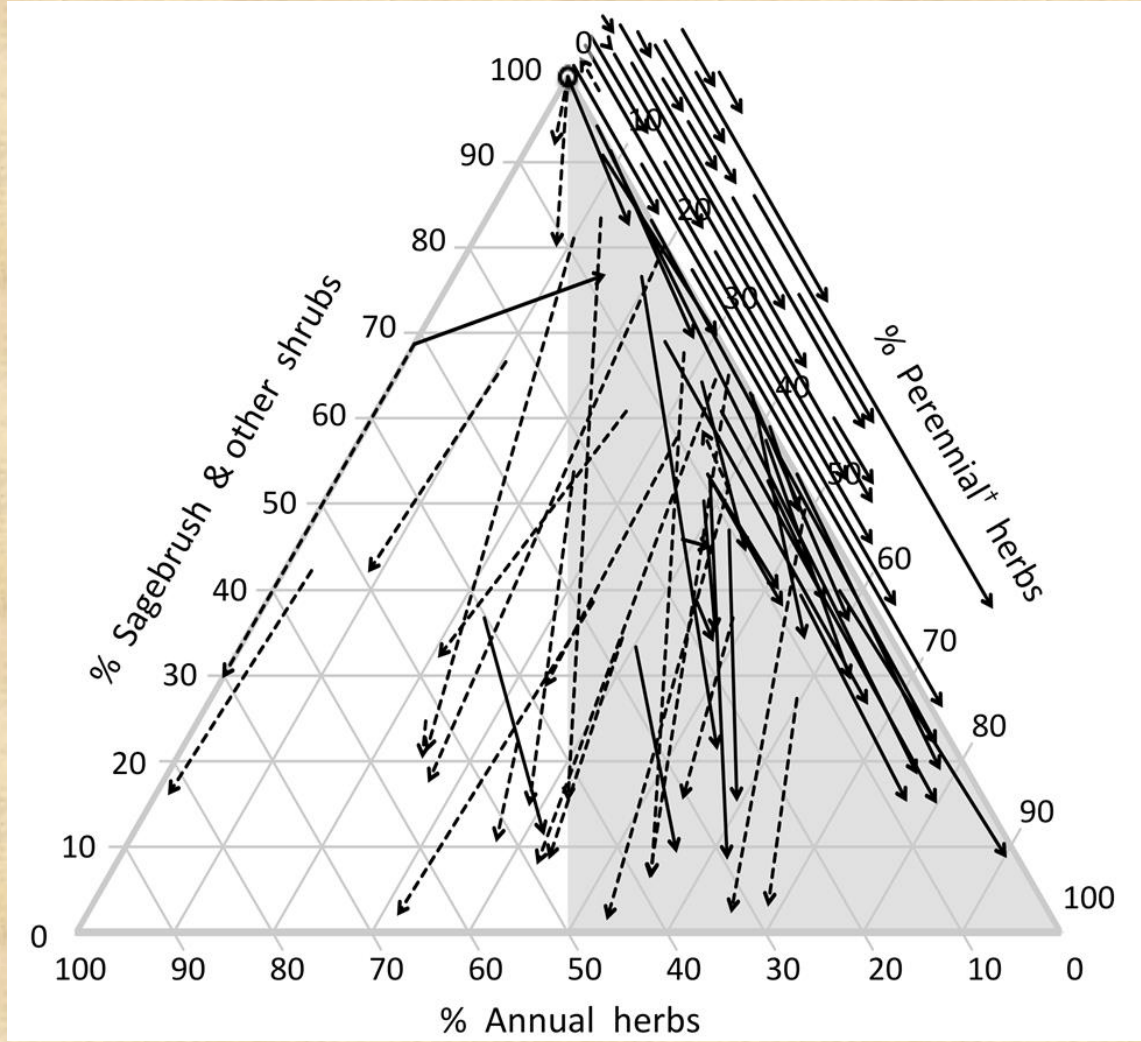
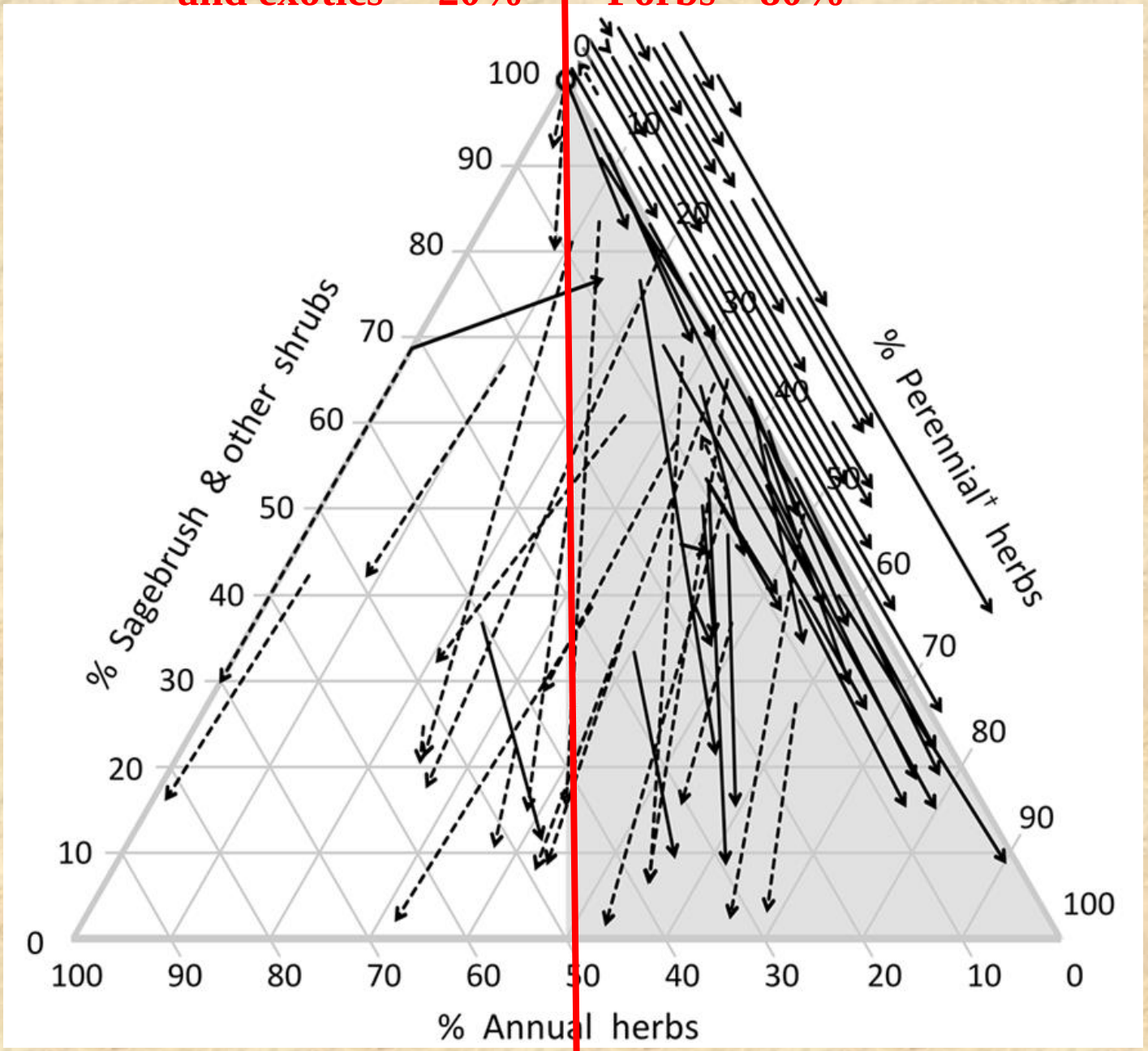


Figure 4. Change in percent relative cover at 76 sites from the unmowed to the mowed area (tail to tip of arrow) on three axes: shrubs, perennial herbs (native forbs and perennial grasses), and annual herbs (exotic forbs and cheatgrass). The dagger (†) indicates that a few native annual forbs were included with perennials. The shaded half of the triangle identifies areas where perennial herb cover was more abundant than annual herb cover (n = 61 unmowed areas [tails] and 57 mowed areas [tips]). Mowing decreased shrub cover for 72 of 76 sites (downward arrows). Solid arrows tend rightward (n = 51) and identify sites that gained perennial relative to annual herb cover from unmowed to mowed areas. Dashed arrows tend leftward (n = 24) and identify sites that lost perennial relative to annual herb cover. One site (circle at apex) had 100% shrubs in both unmowed and mowed areas. To avoid overplotting, arrows are offset right for 25 of the 26 sites with 0% annual herbs in both unmowed and mowed areas.

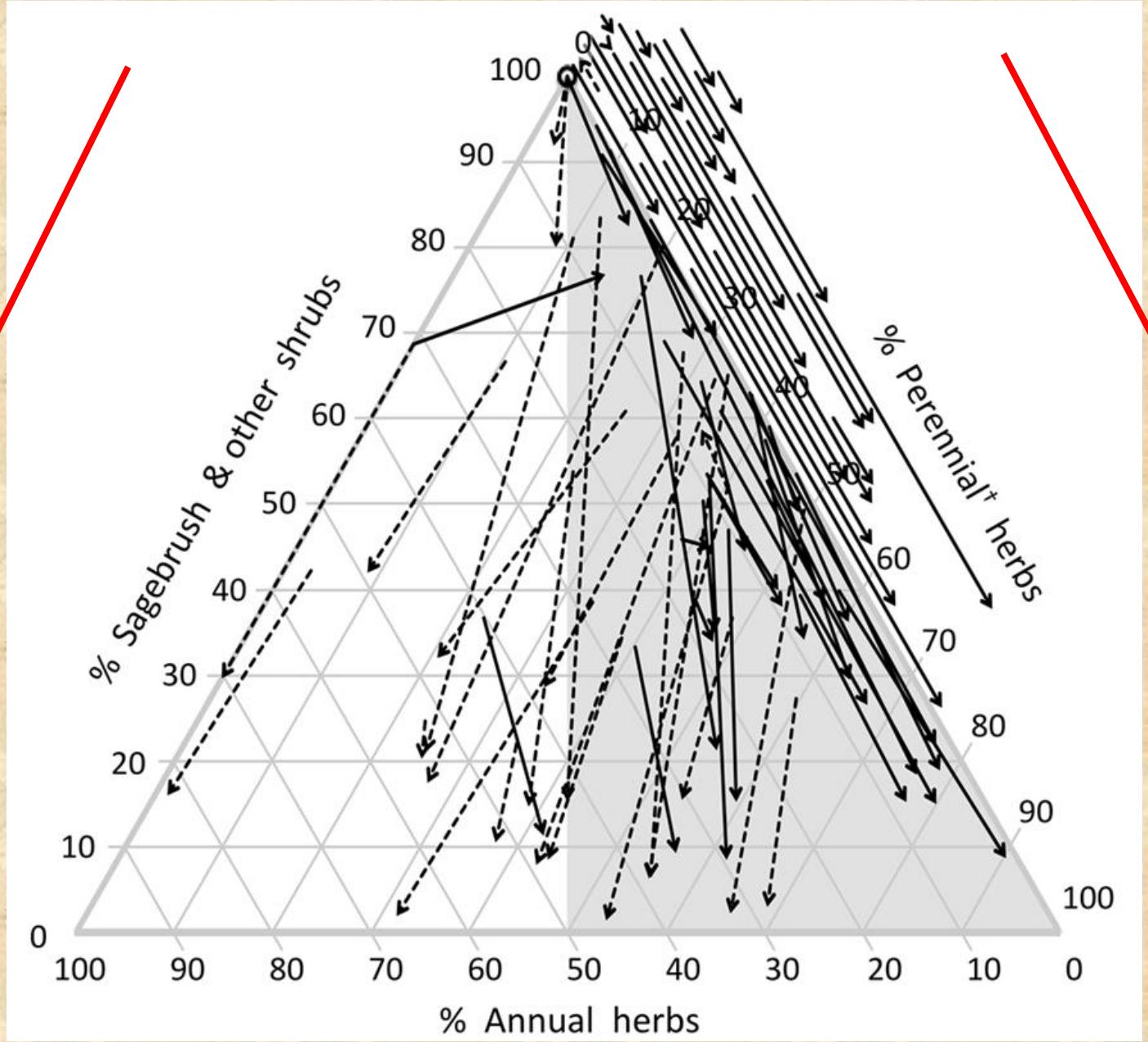
Mowed sites with more annuals and exotics ~ 20%

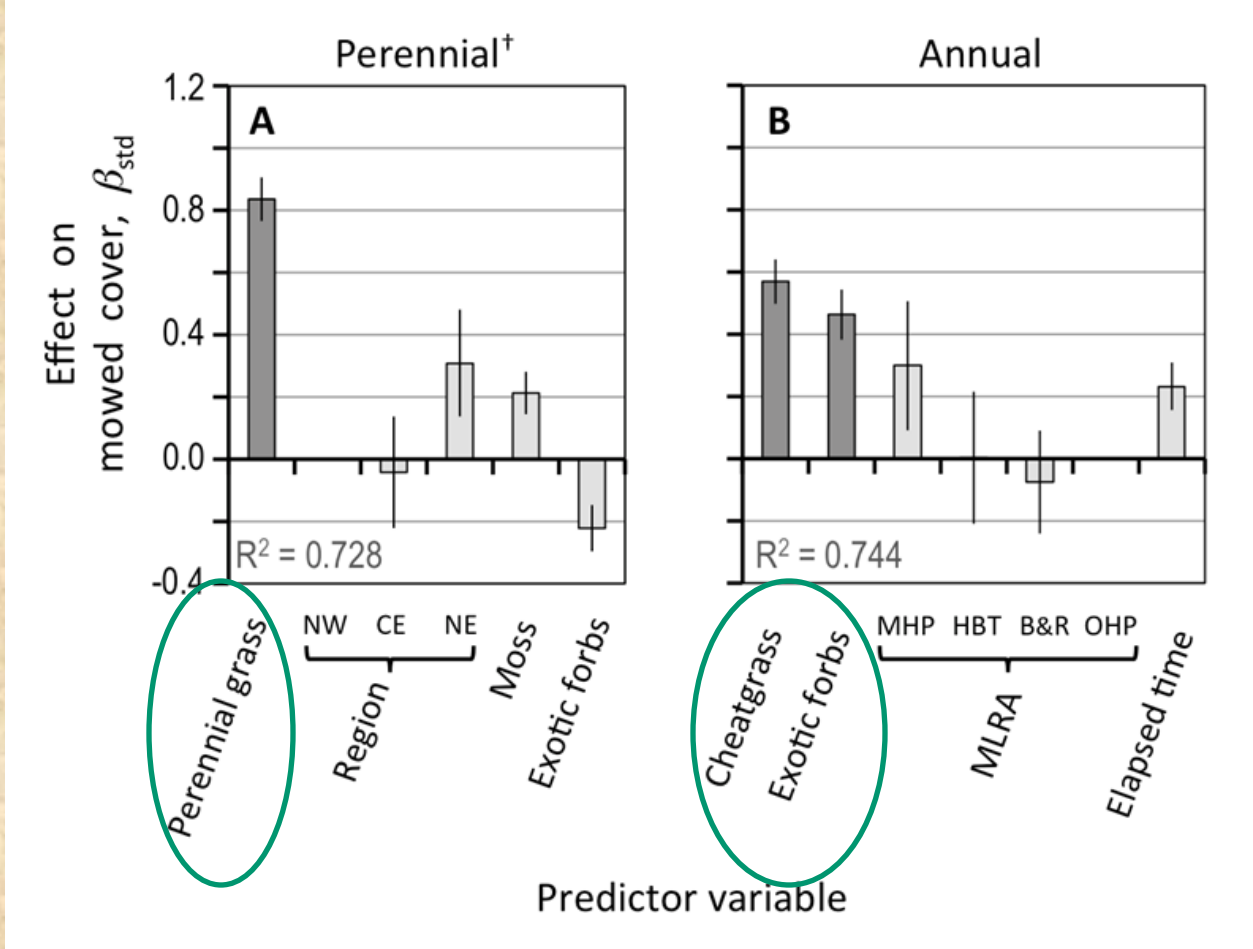
Mowed sites with more Perennials & Native Forbs ~ 80%



Annuals & exotics increased more ~ 25%

Perennials & Natives increased more ~ 75%





Characteristics of unmowed areas that best predict the herbaceous perennial (A) and annual (B) cover in mowed areas at 76 sites

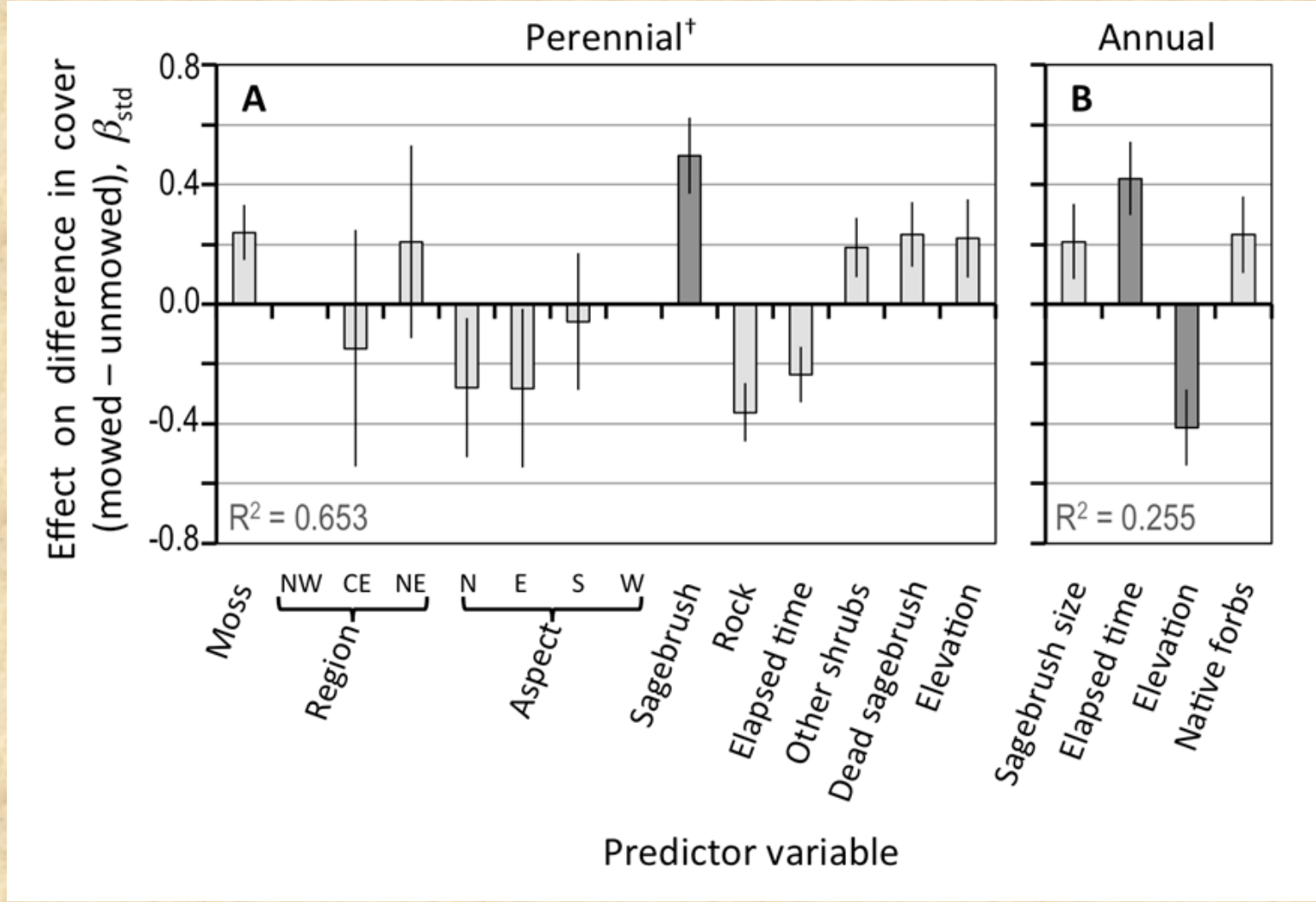
Figure 5. The cover and site characteristics of unmowed areas (std ± 1 SE) that best predict the herbaceous perennial (A) and annual (B) cover in mowed areas at 76 sites (final model R2 shown). The dagger (†) indicates that a few native annual forbs were included with perennials. The left-to-right order of bars reflects the sequence that predictors were selected, and predictors with std ≥ 0.4 in the lowest AICc model are darkly shaded. Categorical predictors (region, MLRA) were fit in one step with one level as a reference (e.g., = 0 for NW in A). Although a predictor could be removed during later steps if model fit improved, this did not occur for the models shown. Elapsed time is the years between mowing and site survey. Figure 1 defines the abbreviations for region and MLRA.

Questions

1. Which cover groups differed significantly or correlated between unmowed and mowed areas?
2. Are sagebrush and herbaceous cover in unmowed areas predictive of the herbaceous response to mowing?

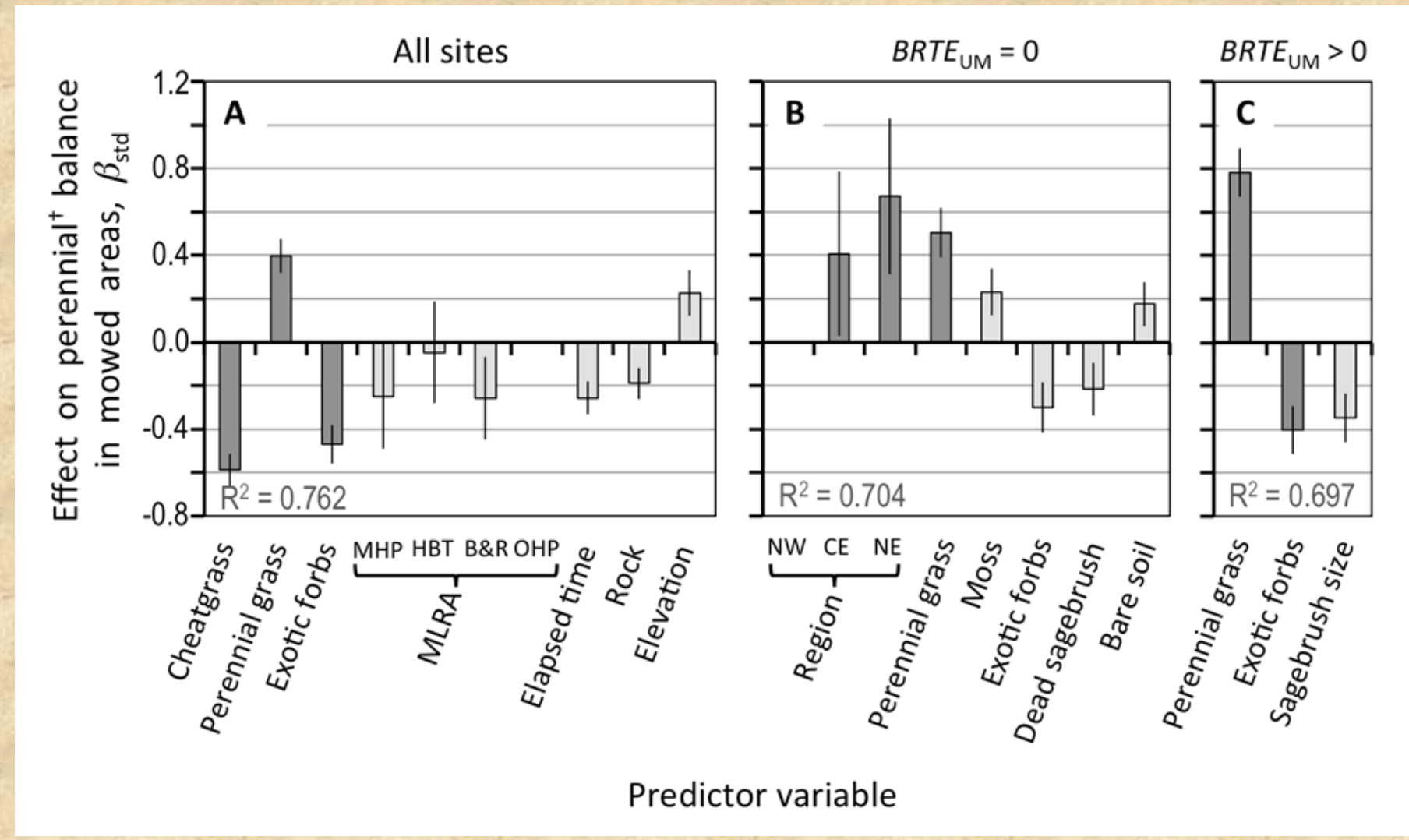
3. What characteristics of unmowed areas best predict the perennial-annual herbaceous balance after mowing and its difference from unmowed to mowed areas?

4. Of the continuous variables key in predicting the herbaceous response to mowing, did any operate as thresholds?



Characteristics of unmowed areas that best predict the difference in herbaceous perennial (A) and annual (B) cover from unmowed to mowed areas at 76 sites.

Figure 6. The cover and site characteristics of unmowed areas (std ± 1 SE) that best predict the difference in herbaceous perennial (A) and annual (B) cover from unmowed to mowed areas at 76 sites. The dagger (†) indicates that a few native annual forbs were included with perennials. Dark shading indicates std > 0.4 in the final, lowest AICc model (R2 shown). Figure 5 and the methods provide details on model fitting. Figure 1 defines the abbreviations for region.



Characteristics of unmowed areas that best predict the perennial balance in mowed areas

Figure 7. The cover and site characteristics of unmowed areas (std ± 1 SE) that best predict the perennial balance in mowed areas for: A) all sites (n = 76), B) sites without cheatgrass in unmowed areas (n = 40), and C) sites with cheatgrass in unmowed areas (n = 36). The perennial balance equals perennial minus annual cover († indicates that a few native annual forbs were pooled with perennials). Dark shading indicates std > 0.4 in the final, lowest AICc model (R2 shown). Figure 5 and the methods provide details on model fitting. Figure 1 defines the abbreviations for region and MLRA.

Pairwise Spearman correlations among continuous variables (unmowed relative cover) identified as the strongest predictors of herbaceous cover after mowing

	Moss	Sagebrush	Native forbs	Perennial grass	Exotic forbs	Cheat-grass
Sagebrush	**0.430**					
Native forbs	-0.239	**-0.523**				
Perennial grass	-0.216	**-0.666**	0.338			
Exotic forbs	-0.235	**-0.501**	0.070	0.360		
Cheatgrass	**-0.416**	**-0.510**	0.210	0.314	0.249	
Elapsed time	0.247	0.370	-0.146	-0.153	-0.267	-0.281
Bare soil	0.279	0.296	-0.238	-0.094	-0.040	**-0.464**
Litter	**-0.501**	**-0.414**	0.194	0.275	0.211	**0.601**
Rock	-0.113	0.113	0.138	-0.299	-0.187	-0.154
Sagebrush size	-0.292	**-0.524**	**0.505**	0.262	0.080	**0.583**

grey $P > 0.05$, black $P \leq 0.05$, and **bold black** $P \leq 0.0008$

Questions

1. Which cover groups differed significantly or correlated between unmowed and mowed areas?
2. Are sagebrush and herbaceous cover in unmowed areas predictive of the herbaceous response to mowing?
3. What characteristics of unmowed areas best predict the perennial-annual herbaceous balance after mowing and its difference from unmowed to mowed areas?

4. Of the continuous variables key in predicting the herbaceous response to mowing, did any operate as thresholds?

Four Factors acted as a threshold	
Cheatgrass absent	6 % Annual cover in mowed areas
Cheatgrass **present**	35 % Annual cover in mowed areas
Cheatgrass absent	18 % Difference in perennial balance
Cheatgrass present	-6 % Difference in perennial balance
Sagebrush cover ≤ 30%	14 % Difference in perennials
Sagebrush cover > **30%**	41 % Difference in perennials
Sagebrush size ≤ 0.2m^3	5 % Difference in annuals
Sagebrush size > **0.2m^3**	18 % Difference in annuals
Elevation ≤ 1600 m (5250 ft.)	5 % Difference in perennials
Elevation > **1600 m (5250 ft.)**	20 % Difference in perennials

Place fuel breaks where they will most likely provide protection of large vulnerable habitats, increased resilience, and decreased risk of shifting dominance to annuals.

Resilient locations have:

- **Herbaceous vegetation dominated by perennial grasses,**
- **Little cover of cheatgrass or other annuals, and**
- **Are dominated by sagebrush, especially if it is not too large.**

If not retaining resilience and increasing resistance, does mowing usefully break up fuel continuity?

Since we did not study the effect of fuel breaks we can only suggest IPM where cheatgrass is abundant. Tools include:

- Grazing,
- Herbicides, &
- Mowing

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Original Research

Plant Community Factors Correlated with Wyoming Big Sagebrush Site Responses to Fire☆,☆☆

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Locations of 51 fire study sites

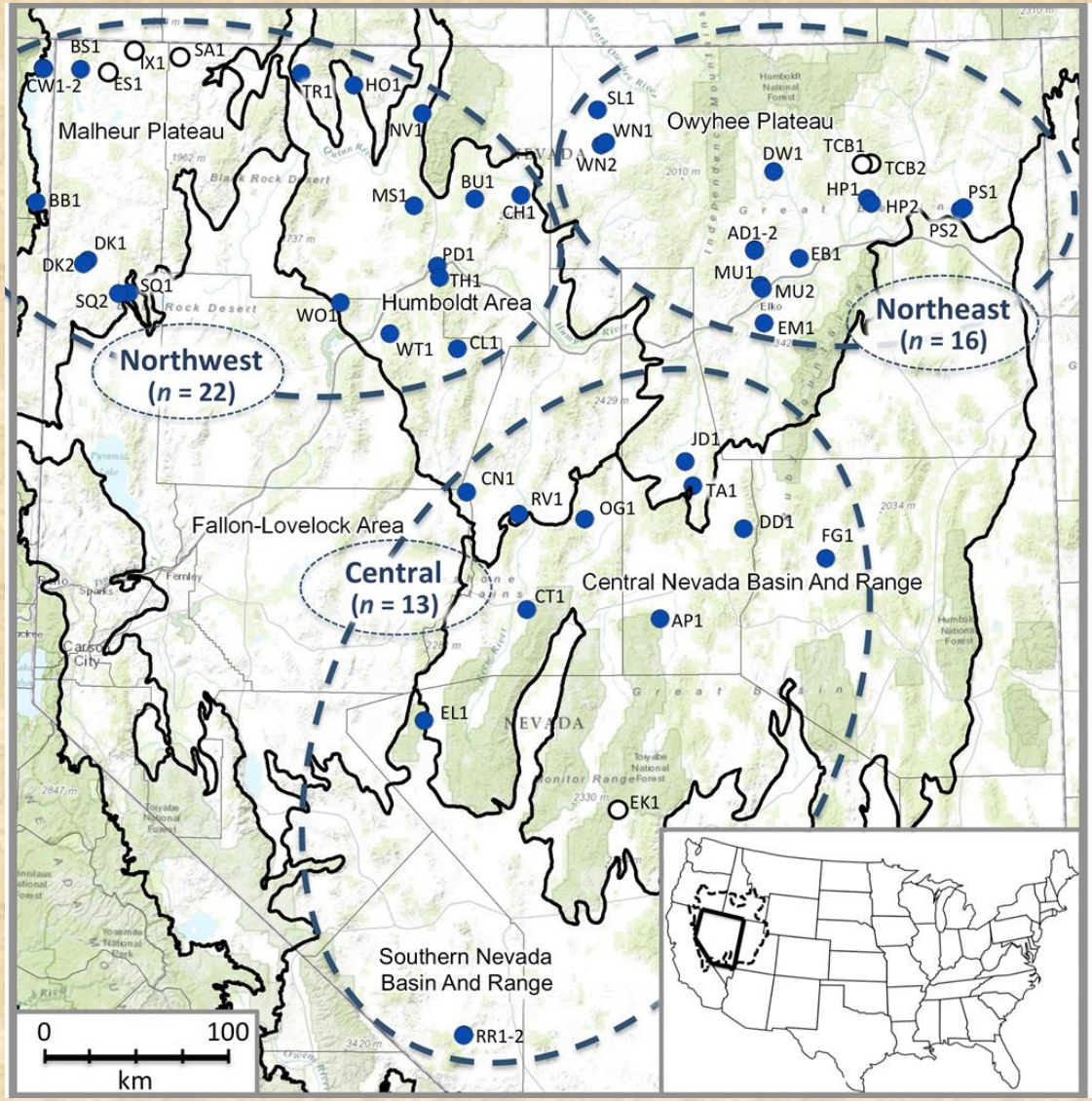
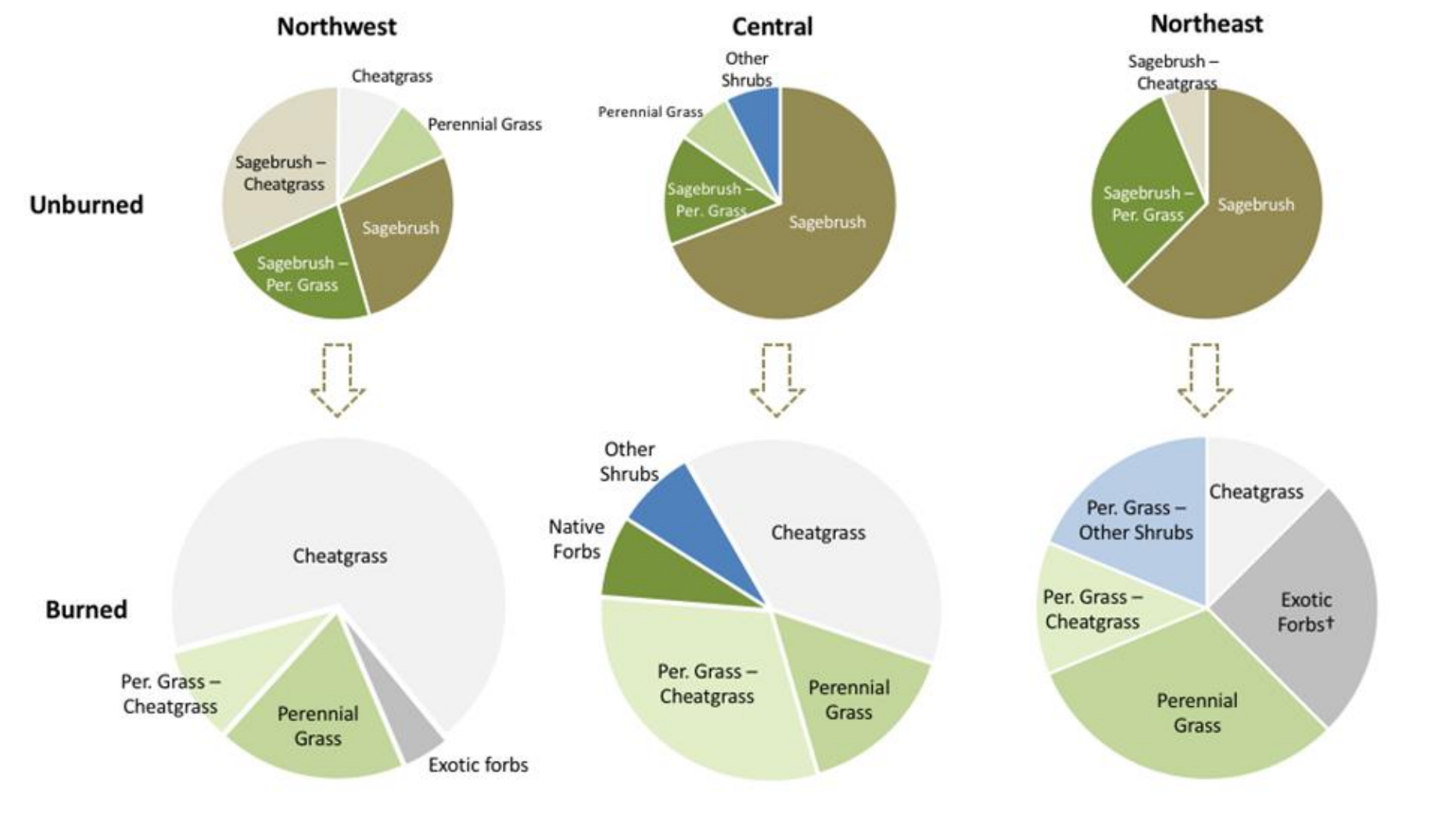


Figure 1. Locations of 51 fire study sites across northern and central Nevada and extreme northeastern California. Filled circles are wildfires and open circles prescribed burns (over-plotting indicated by a '-' within the site label). Dashed ellipses group sites by region and survey year: northwest (NW, 2011), central (CE, 2012), and northeast (NE, 2010). Five major land resource areas (MLRAs), bounded in black, contain study sites: Malheur High Plateau (n = 12), Humboldt Area (n = 12), Owyhee High Plateau (n = 17), and Central and Southern Nevada Basin and Range (n = 10, pooled in analyses because only 2 southern sites). County lines are light grey. Map inset shows the study area (solid line) within the range of sagebrush (Artemesia sp.) plant communities (dashed line) in the western United



Change in cover types with fire

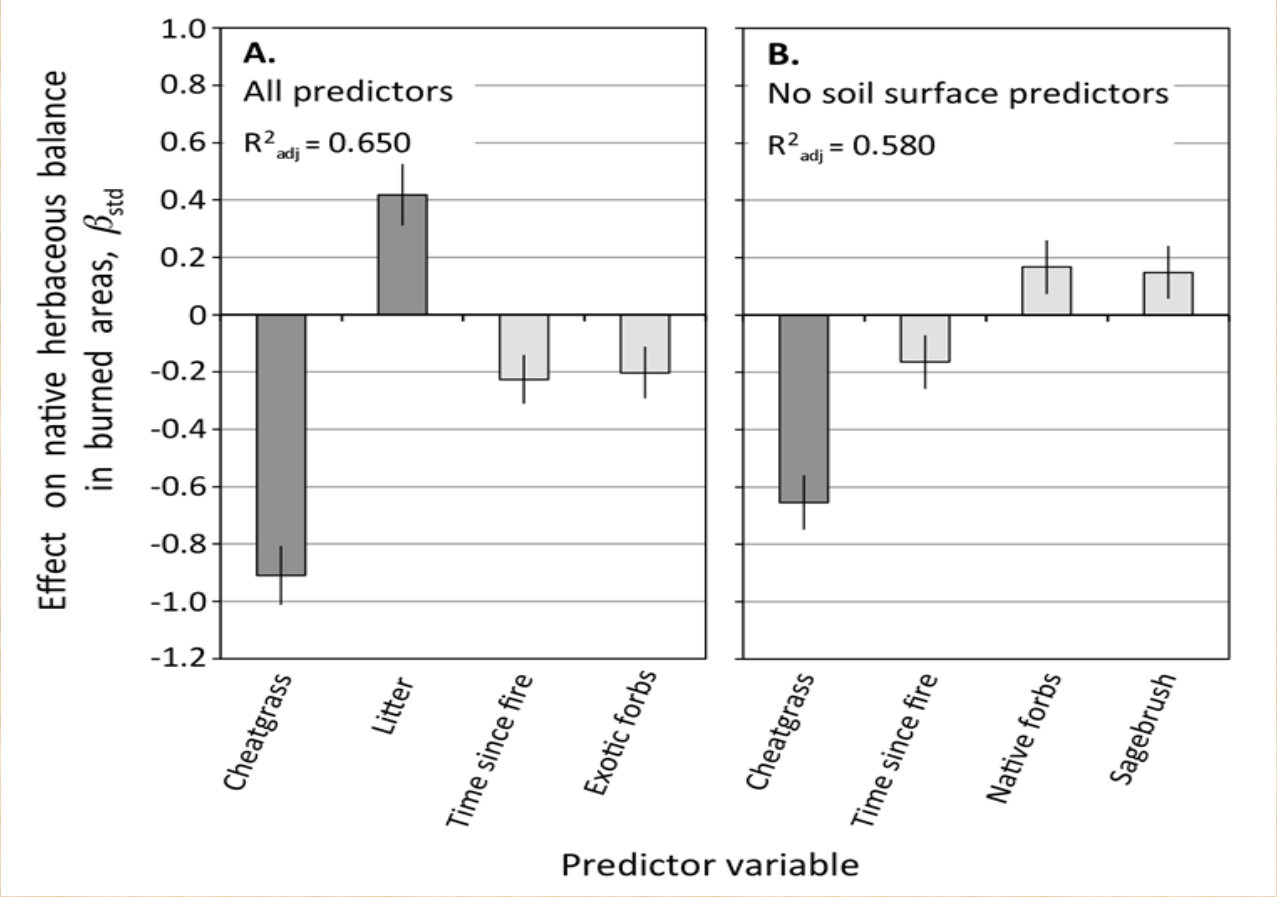
Figure 2. Proportion of sites dominated by each foliar functional group in unburned and burned areas in the regions described in Figure 1. We pooled cover groups that were codominant (i.e., were within ~5% absolute cover of each other and substantially exceeded other types). The dagger (†) indicates that other shrubs (rabbitbrush) were a prominent subdominant at two areas.

	Correlations with burned area variables			
Unburned area variables	**Positive**	ρ	**Negative**	ρ
Soil surface				
Bare Soil			**Litter**	**–0.528**
			Cheatgrass	–0.391
Litter	Cheatgrass	0.307	Bare soil	–0.457
			Rock	–0.371
Rock	Other shrubs	0.375	Bare soil	–0.292
			Exotic forbs	–0.274
Cryptogams	Bare soil	0.335	Litter	–0.327
			Cheatgrass	–0.319
			Other shrubs	–0.295
Live vascular vegetation	**Perennial grass**	**0.505**	Rock	–0.337
	$P \leq 0.05$ and **bold** $P \leq 0.0003$			

	Correlations with burned area variables			
Unburned area variables	**Positive**	ρ	**Negative**	ρ
Herbaceous foliar				
Native forbs	Live veg	0.307		
	Perennial grass	0.301		
Exotic forbs			Rock	–0.301
			Sagebrush	–0.330
Perennial grass	**Live vegetation**	**0.550**		
Cheatgrass	**Litter**	**0.679**	**Bare soil**	**–0.659**
			Perennial grass	–0.392
			Sagebrush size	–0.285
	$P \leq 0.05$ and **bold** $P \leq 0.0003$			

	Correlations with burned area variables			
Unburned area variables	**Positive**	ρ	**Negative**	ρ
Woody foliar				
Other shrubs	Rock	0.366		
Sagebrush				
Dead sagebrush			Other shrubs	–0.369
Sagebrush size	Litter	0.404	Bare soil	–0.402
	Cheatgrass	0.403		
	$P \leq 0.05$ and **bold** $P \leq 0.0003$			

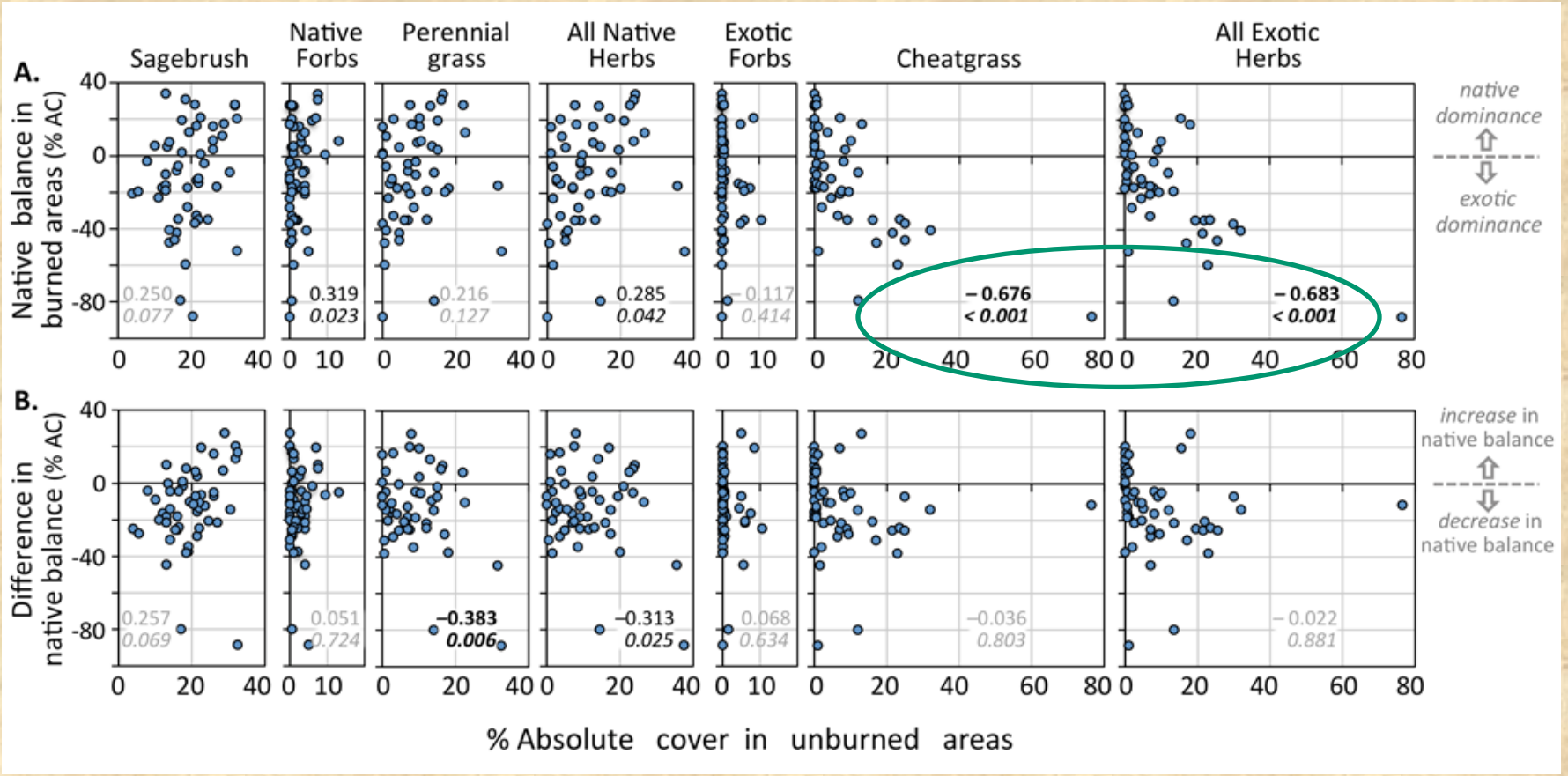
Unburned cheatgrass cover was a better predictor of the native herbaceous balance than native (perennial) grass cover



Best predictors of the native herbaceous balance (native minus exotic herbs) after fire

Figure 3. The cover and site characteristics of unburned areas that best predict (std ± 1 SE) the native herbaceous balance in burned areas as determined by stepwise multiple regression. Separate analyses were run that included all predictors (A) and excluded soil surface predictors (B; final model R2 shown). The left-to-right order of bars indicates the sequence that predictors were selected, and predictors with std ≥ 0.4 in the lowest AICC model are darkly shaded. Although predictors could be removed in later steps if model fit improved, this did not occur for the analyses shown.

No unburned site with cheatgrass cover > 15% escaped domination by exotics after fire



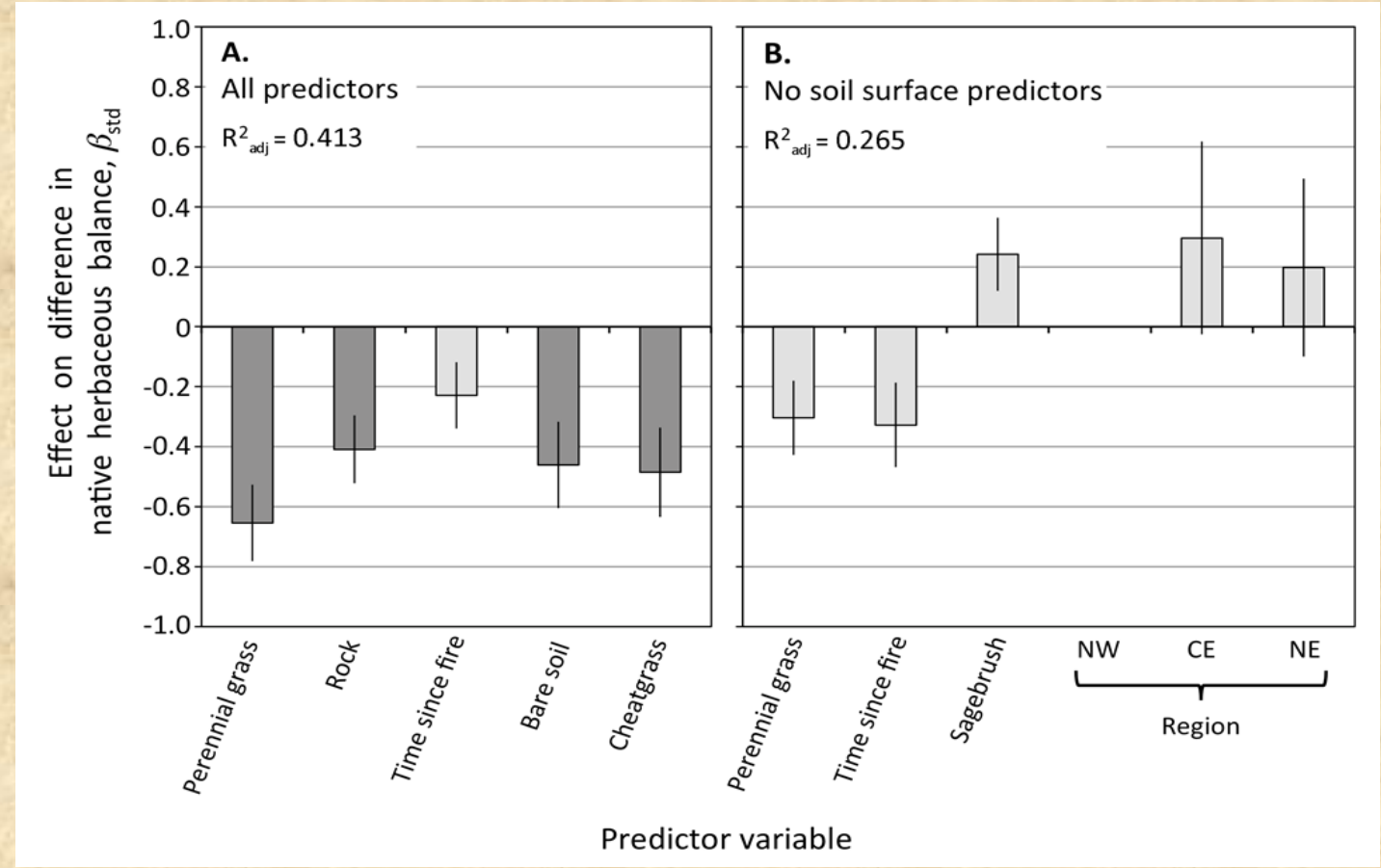
Correlations between **cover in unburned areas** and

A) The **native balance** in burned areas (native minus exotic herbs) and

B) The **difference in native balance** (burned minus unburned values).

Figure 4. Correlations between absolute cover values of sagebrush and herbaceous foliar groups in unburned areas and A) the native balance in burned areas (absolute cover of native minus exotic herbs) and B) the difference in native balance (burned minus unburned values). We show Pearson's r followed by the P-value in italics. Correlations are based on arcsine-squareroot transformed proportions as in the multiple regressions shown in Figures 2 and 3. Native cover equals native forbs plus perennial grass; exotic cover equals exotic forbs plus cheatgrass. We highlight values as follows: gray $P > 0.05$; black $P \leq 0.05$; bold black $P \leq 0.007$ (0.05/m, m = 7 tests per set).

More perennial grass in unburned areas predicted a greater shift toward exotic herbs, or loss of perennial herbs, after fire



Best predictors of the **difference in native herbaceous balance** (burned – unburned values) from stepwise multiple regression

Figure 5. The cover and site characteristics of unburned areas that best predict (□std ± 1 SE) the difference in native herbaceous balance (burned – unburned values) as determined by stepwise multiple regression. Separate analyses were run that included all predictors (A) and excluded soil surface predictors (B; final model R2 shown). The left-to-right order of bars indicates the sequence that predictors were selected, and predictors with □std ≥ 0.4 in the lowest AICC model are darkly shaded. Categorical predictors (Region) were fit in one step with one level as a reference (e.g., □ = 0 for NW in B; abbreviations and site groupings in Fig. 1). Elevation entered model (A) at step 4 (□std = 0.380) but was removed at the final step due to improved AICc.


Questions
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Comments
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