Supplemental tables and figures

2025-09-16

Includes all supplemental tables and figures to accompany "Precipitation moderates the effect of native shrubs on invasive buffelgrass (*Pennisetum ciliare*) growth in the Sonoran Desert while local topography has less influence" by Ossanna et al. (2026).

Tables

Table S1. Actual values averaged by year

Actual values of variables measured, averaged across all plots for each year (to contextualize year-to-year change values used in analyses). Precipitation measured in mm, buffelgrass density measured in individuals per m^2, and cover measured in percent.

		Buffelgrass				Native vegetation	
Year	Precipitation	Total culms	Repro culms	Density	Cover	Shrub cover	Herb cover
2020	222	24 ± 19	12 ± 13	3.8 ± 1.5	39 ± 19	18 ± 12	5.9 ± 10.5
2021	362	38 ± 33	14 ± 16	8 ± 7.6	40 ± 21	13 ± 8	9.9 ± 8.7
2022	264	53 ± 40	26 ± 25	6.8 ± 4.1	35 ± 17	12 ± 10	5.1 ± 6.4
2023	250	129 ± 80	53 ± 35	3 ± 1.5	39 ± 13	22 ± 13	2.6 ± 2.7

Table S2. Total culms model

Model-averaged coefficients of the buffelgrass culm count model calculated from two top models (response variable: year-to-year change in total number of culms). Marginal R^2 = 0.144–0.147; conditional R^2 = 0.386–0.391.

Coefficient	Estimate	Std. Error	Adjusted SE	z value	Pr(>|z|)
Intercept	9.9154	7.6168	7.6243	1.301	0.1934
Aspect, N	-9.0486	13.5056	13.5188	0.669	0.5033
Aspect, S	-5.2854	10.4379	10.4482	0.506	0.6129
Aspect, SW	18.6775	13.5127	13.5260	1.381	0.1673
Aspect, W	2.4818	10.3979	10.4081	0.238	0.8115
Change in BG density	-8.0732	1.4381	1.4395	5.608	<2e-16***
Change in herb cover	0.7489	1.1107	1.1118	0.674	0.5006
Change in shrub cover	5.8469	1.0880	1.0891	5.369	1e-07***
Plot slope	-1.0905	1.5290	1.5302	0.713	0.4761
Previous year precipitation	-3.5216	1.5449	1.5464	2.277	0.0228*
Change in BG density * Previous year precip	3.9087	1.8024	1.8042	2.167	0.0303*
Change in herb cover * Previous year precip	2.3452	1.1330	1.1341	2.068	0.0386*
Change in shrub cover * Previous year precip	-6.6136	1.1385	1.1396	5.803	<2e-16***

Table S3. Reproductive culms model

Model-averaged coefficients of the buffelgrass reproductive culm count model calculated from five top models (response variable: year-to-year change in number of reproductive culms). Marginal R^2 = 0.147–0.155; conditional R^2 = 0.318–0.333.

Coefficient	Estimate	Std. Error	Adjusted SE	z value	Pr(>|z|)
Intercept	11.9587	3.7727	3.7764	3.167	0.00154**
Aspect, N	-6.9282	6.6088	6.6152	1.047	0.29495
Aspect, S	-9.2787	5.0959	5.1009	1.819	0.06890
Aspect, SW	14.1600	6.6084	6.6149	2.141	0.03230*
Aspect, W	-3.2396	5.0709	5.0759	0.638	0.52332
Change in BG density	-2.5706	0.8613	0.8621	2.982	0.00286**
Change in herb cover	2.7259	0.6647	0.6653	4.097	4.18e-05***
Change in shrub cover	1.3680	0.6467	0.6473	2.113	0.03458 *
Plot slope	1.4751	0.9336	0.9345	1.578	0.11447
Previous year precipitation	-0.8645	0.8951	0.8960	0.965	0.33463
Change in BG density * Previous year precip	-1.4539	1.1143	1.1151	1.304	0.19231
Change in herb cover * Previous year precip	-0.4236	0.6304	0.6308	0.672	0.50188
Change in shrub cover * Previous year precip	-0.1940	0.4939	0.4943	0.392	0.69476

Table S4. Plot density model

Model-averaged coefficients of the buffelgrass plot density model calculated from five top models (response variable: year-to-year change in plot density [individuals per m^2]). Marginal R^2 = 0.360–0.389; conditional R^2 = 0.423–0.458.

Coefficient	Estimate	Std. Error	Adjusted SE	z value	Pr(>|z|)
Intercept	5.82503	1.50245	1.51693	3.840	0.000123***
Aspect, N	-2.41140	2.51069	2.53560	0.951	0.341594
Aspect, S	-5.92643	2.03290	2.05289	2.887	0.003891**
Aspect, SW	-3.04473	2.66856	2.69492	1.130	0.258559
Aspect, W	-5.18841	1.94872	1.96798	2.636	0.008379**
Change in herb cover	0.31353	0.53761	0.54133	0.579	0.562468
Change in shrub cover	0.90282	0.59483	0.60077	1.503	0.132900
Plot slope	0.03471	0.35617	0.35966	0.097	0.923116
Previous year precipitation	4.80511	0.66377	0.67028	7.169	< 2e-16***
Change in herb cover * Previous year precip	0.10806	0.34178	0.34354	0.315	0.753096
Change in shrub cover * Previous year precip	1.33254	0.60515	0.61121	2.180	0.029243*

Table S5. Plot cover model

Model-averaged coefficients of the buffelgrass plot cover model calculated from six top models (response variable: year-to-year-change in plot cover [%]). Marginal R^2 = 0.243–0.246; conditional R^2 = 0.284–0.289.

Coefficient	Estimate	Std. Error	Adjusted SE	z value	Pr(>|z|)
Intercept	11.12057	3.64886	3.68561	3.017	0.002550**
Aspect, N	-10.44430	6.00828	6.06872	1.721	0.085250
Aspect, S	-12.62234	4.91518	4.96467	2.542	0.011008*
Aspect, SW	-8.89160	6.52070	6.58642	1.350	0.177019
Aspect, W	-12.82015	4.67915	4.72628	2.713	0.006677**
Change in herb cover	0.61479	1.47871	1.49280	0.412	0.680459
Change in shrub cover	-3.48090	1.59733	1.61343	2.157	0.030970*
Plot slope	2.85609	1.63323	1.64969	1.731	0.083400
Previous year precipitation	6.77803	1.74402	1.76150	3.848	0.000119***
Change in herb cover * Previous year precip	-0.06964	1.01416	1.02438	0.068	0.945797
Change in shrub cover * Previous year precip	-0.22906	1.24320	1.25544	0.182	0.855228

Table S6. Seedling survival model

Model-averaged coefficients of the buffelgrass seedling survival model calculated from 15 top models (response variable: seedling survival [%]). Marginal R^2 = 0.666–0.695; conditional R^2 = 0.779–0.800.

Coefficient	Estimate	Std. Error	Adjusted SE	z value	Pr(>|z|)
Intercept	-1.26536	0.16964	0.17120	7.391	<2e-16***
BG density	0.23192	0.13779	0.13878	1.671	0.0947
Herb cover	0.18024	0.14112	0.14196	1.270	0.2042
Plot slope	0.04850	0.10134	0.10183	0.476	0.6338
Previous year precipitation	1.35339	0.15445	0.15586	8.683	<2e-16 ***
Shrub cover	-0.13375	0.11613	0.11673	1.146	0.2519
BG density * Previous year precip	0.03340	0.08605	0.08641	0.387	0.6991
Herb cover * Previous year precip	-0.15459	0.13977	0.14026	1.102	0.2704
Shrub cover * Previous year precip	-0.09849	0.10459	0.10493	0.939	0.3479

Figures

Figure S1

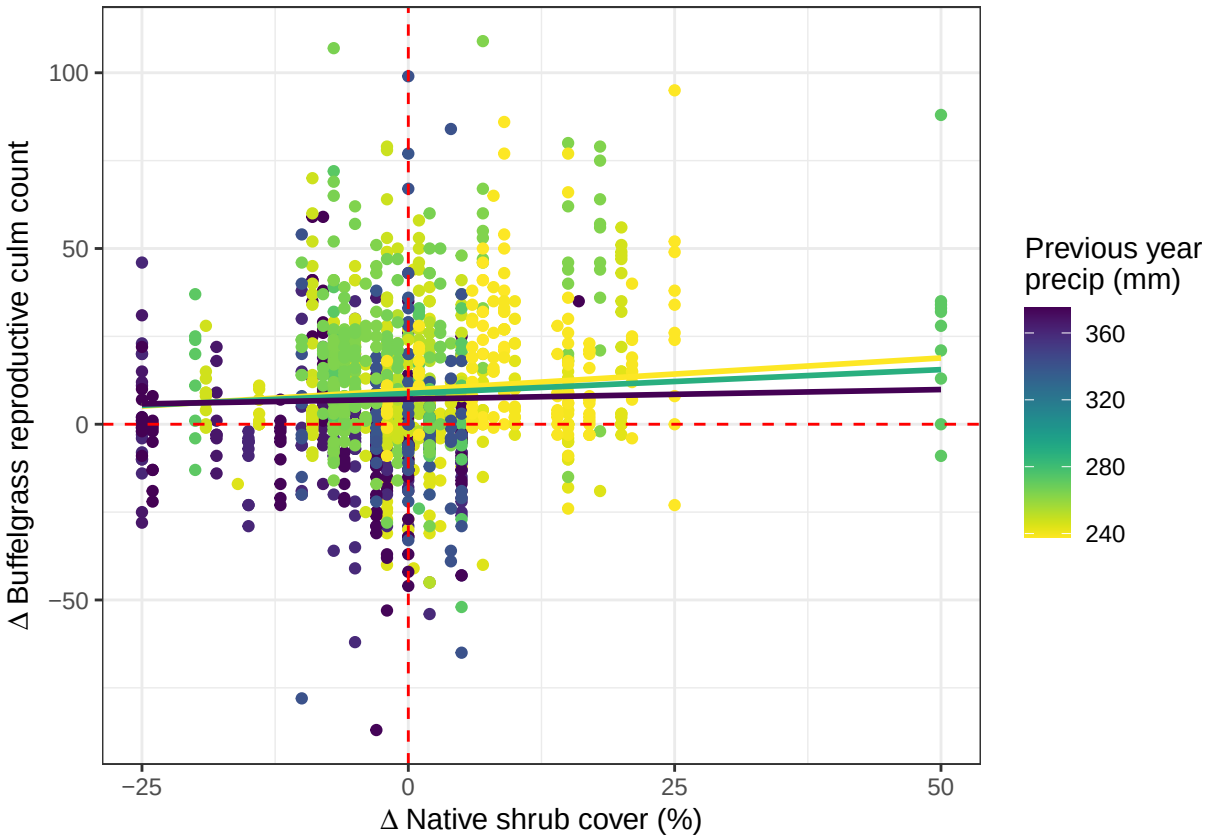

Figure S1. Effects of year-to-year change in native shrub cover on year-to-year change in reproductive buffelgrass culm count, moderated by precipitation. Colored lines represent model-predicted values under the wettest precipitation conditions experienced (purple line), the driest conditions (yellow line), and average conditions (green line). Vertical red dashed line indicates no change in shrub cover while horizontal line indicates no change in reproductive buffelgrass culm count.

Figure S2

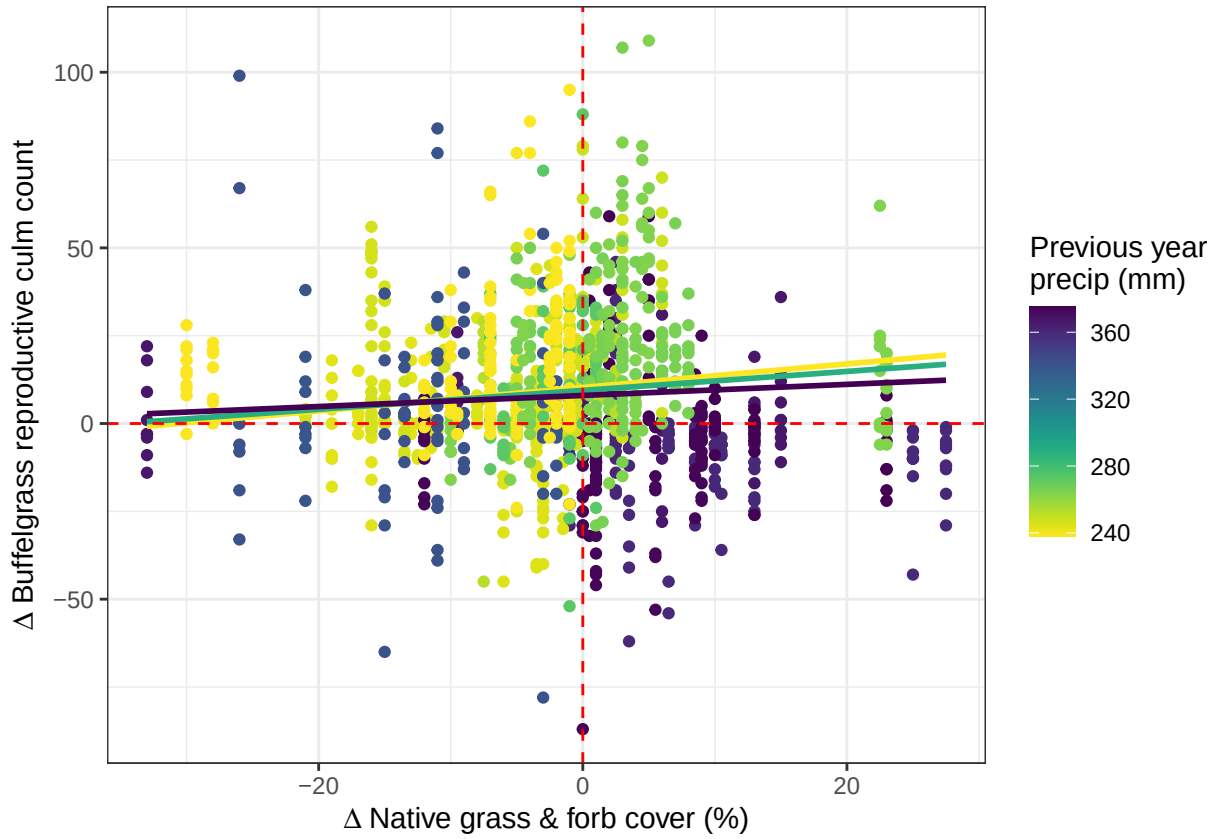

Figure S2. Effects of year-to-year change in native herbaceous (grass and forb) cover on year-to-year change in reproductive buffelgrass culm count, moderated by precipitation. Colored lines represent model-predicted values under the wettest precipitation conditions experienced (purple line), the driest conditions (yellow line), and average conditions (green line). Vertical red dashed line indicates no change in herb cover while horizontal line indicates no change in reproductive buffelgrass culm count.

Figure S3

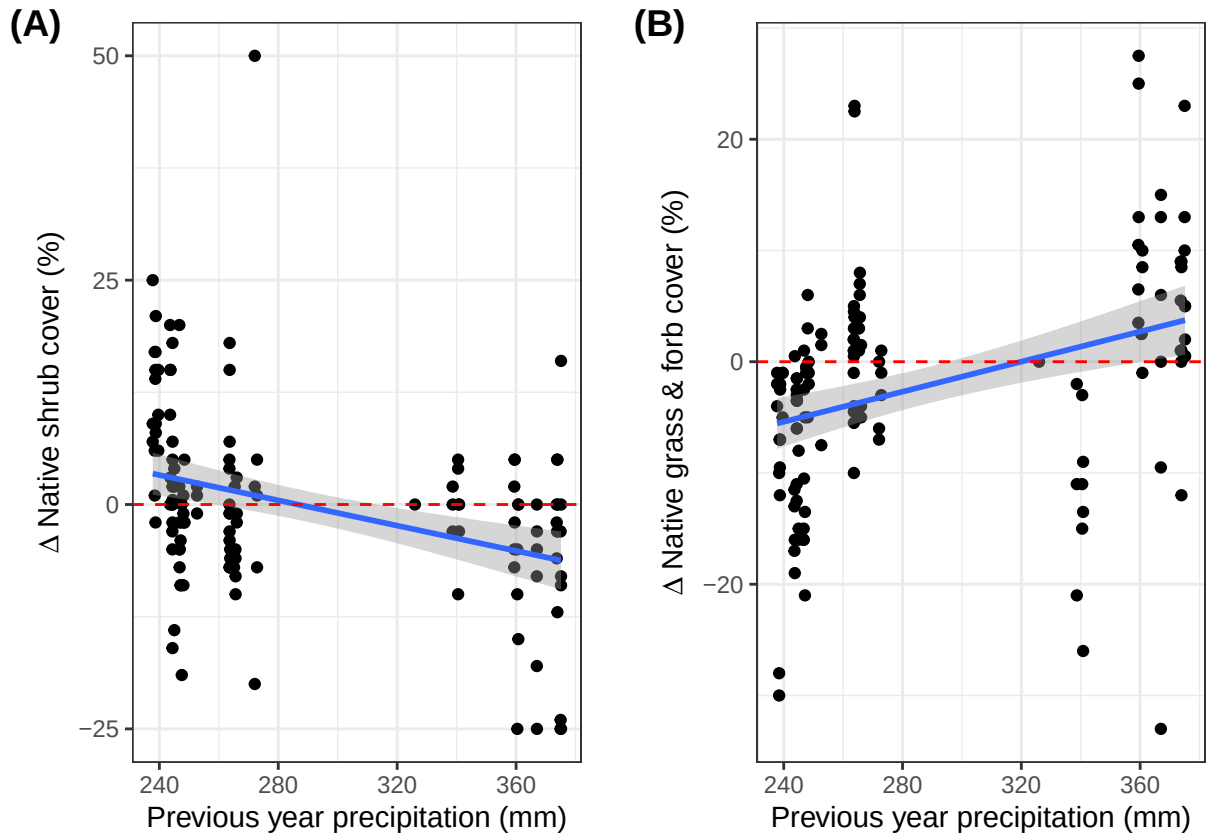

Figure S3. Simple linear regression of (A) change in native shrub cover and (B) change in native herbaceous cover as a function of the previous year's precipitation, pooling all sampling locations and times.

Figure S4

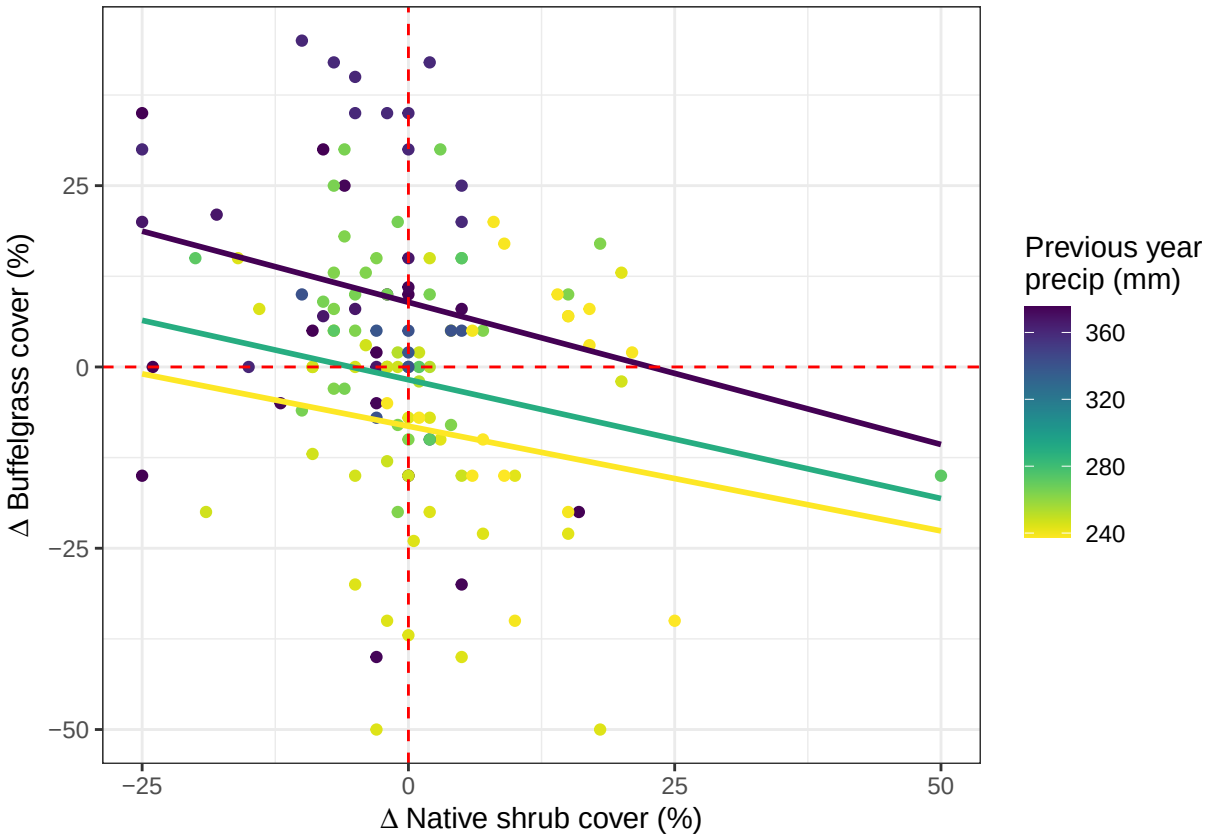

Figure S4. Effects of year-to-year change in native shrub cover on year-to-year change in buffelgrass plot cover, moderated by precipitation. Colored lines represent model-predicted values under the wettest precipitation conditions experienced (purple line), the driest conditions (yellow line), and average conditions (green line). Vertical red dashed line indicates no change in shrub cover while horizontal line indicates no change in buffelgrass cover.