Supporting Information. Guittar, J., D. Goldberg, K. Klanderud, A. Berge, M.R. Boixaderas, E. Meineri, J. Töpper, and V. Vandvik. 2020. Quantifying the roles of seed dispersal, filtering, and climate on regional patterns of grassland biodiversity. Ecology.

Appendix S1

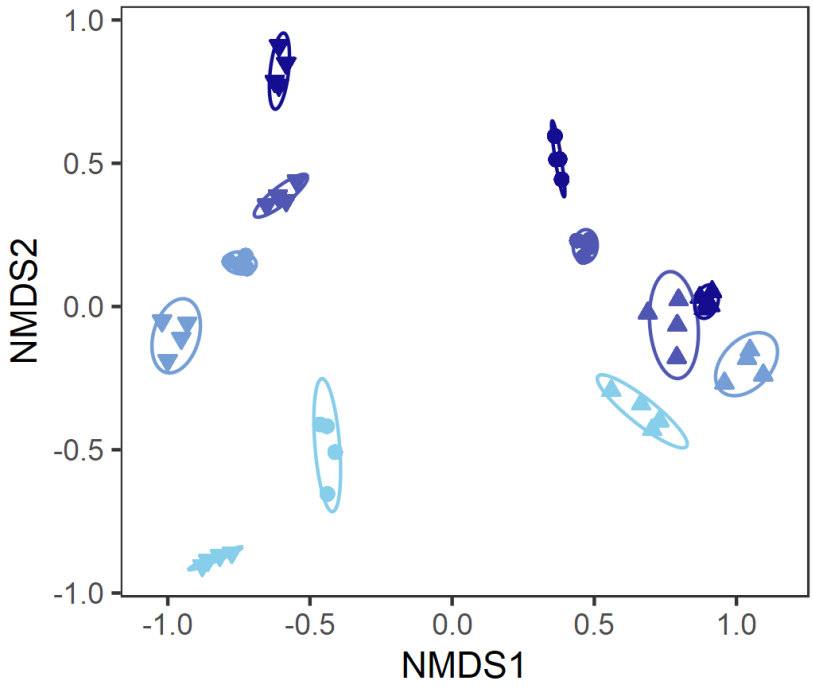

Figure S1. Compositional differences in adult vegetation over the four survey years at twelve sites. Compositional differences among sites are summarized using an NMDS ordination based on Bray-Curtis distance. Each shape represents a single community at a site for a given year, and each community comprises data from ten 25 x 25 cm plots. Note that within-site compositional differences over the four survey years are less variable than between-site differences, indicating that any potential compositional changes between survey years had little overall effect. Shapes and shadings are consistent with Fig. 1 and reflect approximate mean summer temperatures of 6 °C (triangle), 9 °C (circle), and 10.5 °C (inverted triangle) and annual precipitations` of 650 mm, 1300 mm, 2000 mm, and 2900 mm, from light blue to dark blue.

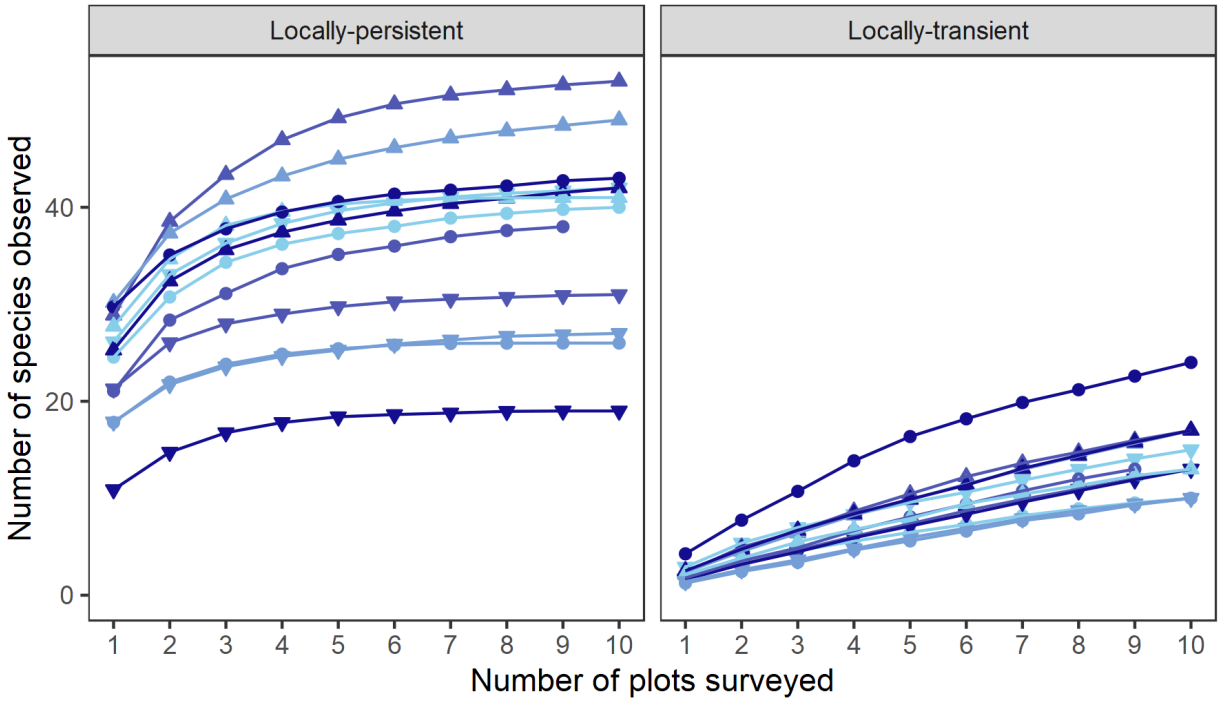

Figure S2. Rarefaction curves showing mean increases in observed species richness in the mature vegetation with sampling effort, grouped by local transient/persistent species status. Species occurrence data for each 25 x 25 cm plot were determined by pooling data from four annual vegetation surveys conducted at peak biomass at each site in 2009, 2011, 2012, and 2013. Species were considered locally-persistent if observed in any plot at a site in at least three of the four vegetation surveys, otherwise species were considered locally-transient. Rarefaction was performed 100 times, with the stepwise order of plots shuffled randomly each time. Colored shapes show mean values across the 100 replicates. Each line is a site. Shapes and shadings are consistent with Fig. 1 and reflect approximate mean summer temperatures of 6 °C (triangle), 9 °C (circle), and 10.5 °C (inverted triangle) and annual precipitations` of 650 mm, 1300 mm, 2000 mm, and 2900 mm, from light blue to dark blue.

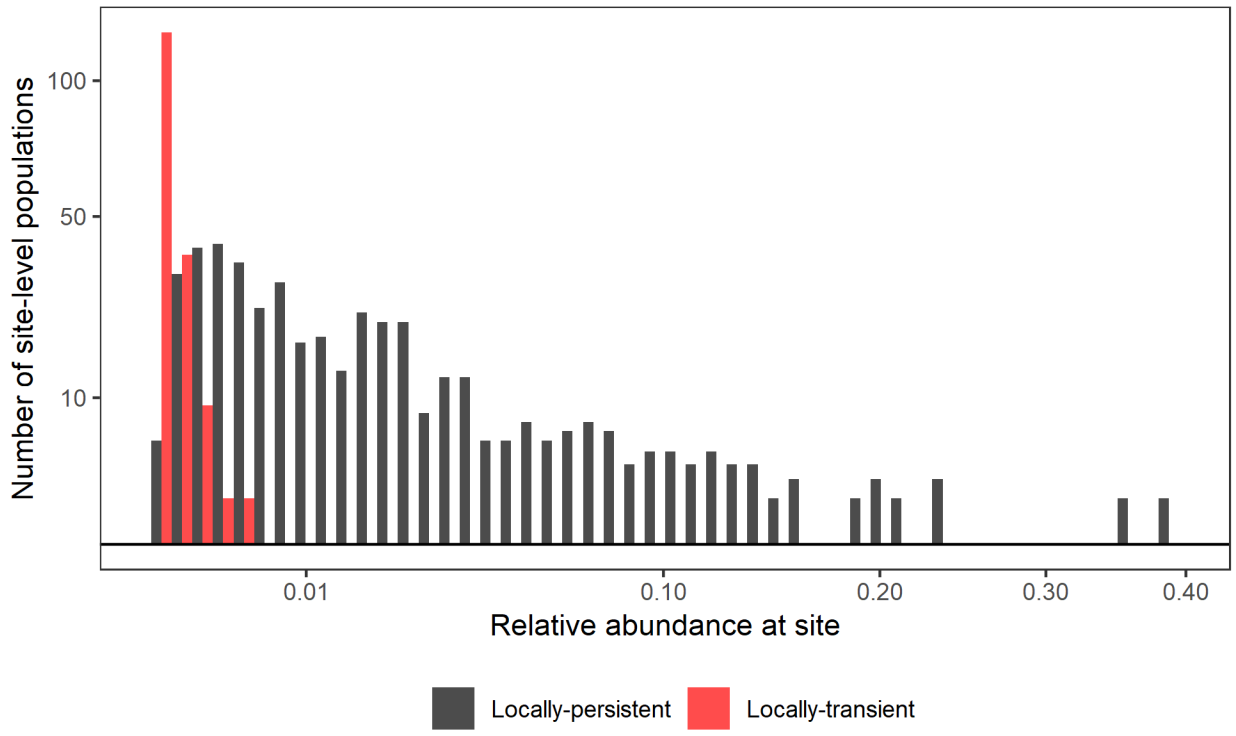

Figure S3. A histogram of local relative abundances of all species at each of all twelve sites, grouped and colored by locally-transient/locally-persistent species status, and plotted using square-root scales on both x and y axes. The combined relative abundances of all locally-transient species falls below 0.31% total site cover.

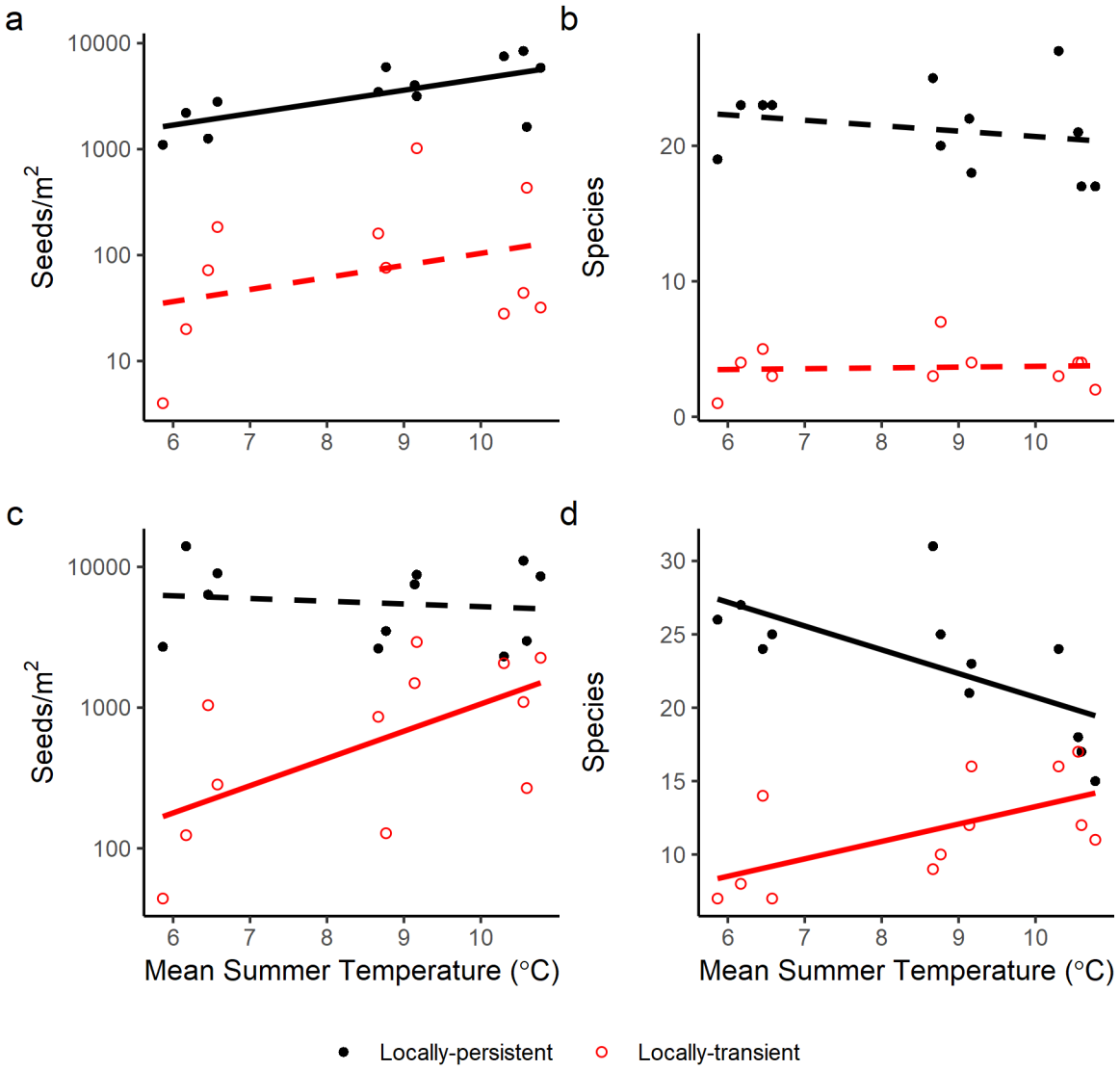

Figure S4. Seed density in the seed rain (a) and seed bank (c), and species richness in the seed rain (b) and seed bank (d), grouped by locally-transient/locally-persistent species status and plotted by mean summer temperature. Summer is defined as the four warmest months at each site. Solid lines are present when temperature was a significant predictor ($p < 0.05$) of $\log_{10}$-transformed seed density or species richness in a simple linear regression. A parallel set of regressions was performed using mean annual precipitation as the sole predictor, but no trends were even marginally significant (p-value was always > 0.1)

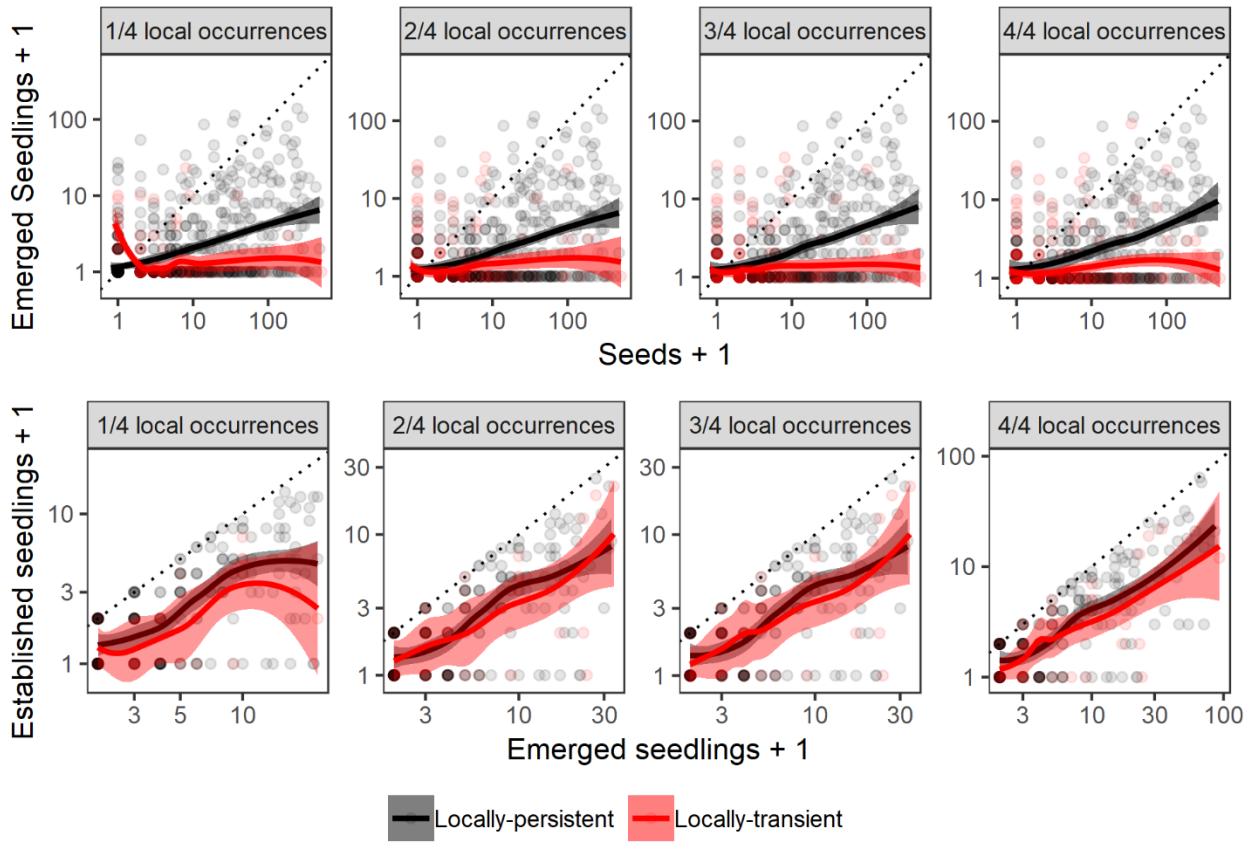

Figure S5. The abundances of emerged seedlings (top row of panels) and established seedlings (bottom row of panels) of species at individual sites, plotted by local seed number and local seedling number, respectively, and colored by local species status. Each column of panels reflects a version of the data for which a different cutoff for local persistent species status was used; from left to right, only species that occurred in the mature vegetation at a given site in one, two, three, or four of the four total annual surveys were considered "locally-persistent," and the remaining species (under each cutoff scenario) were considered "locally-transient." Each circle represents the presence/absence of one species at one site, and colored lines and shadings show LOESS smoothing functions and 95 % confidence intervals. Seed number is equal to the sum of seeds in the seed rain and seed bank. Abundances reflect the total number of individuals in four 25 x 25 cm subplots at each site. Count data are increased by one to include zeroes on a log

scale. Panels only show data falling within the observed window of locally-transient seed abundances and locally-transient seedling abundances under each cutoff scenario in order to focus on the comparison of locally-transient and locally-persistent species. These figures illustrate that regardless of the transient/persistent cutoff used, (1) emergence rates remained significantly lower for seeds of transient species than seeds of persistent species (top row of panels), and (2) establishment rates did not significantly differ among seedlings of transients and persistent species (bottom row of panels). Model selection and coefficient significance values were also effectively the same among the four scenarios (data not shown).

Table S1. Densities and species richness values within and across sites for each life stage. The density of "all individuals" includes unidentified seeds and seedlings. Density of adults is not shown because adults were measured by percent cover. Regional richness is not shown for locally-transient species because locally-transient/locally-persistent species status can vary by site, and thus cannot be summarized in this way across sites.

Stage	Density (per sq. m.)	Site richness	Regional richness
All individuals			
Seed Rain	4189 ± 2456	25 ± 4	94
Seed Bank	7715 ± 4045	35 ± 4	103
All Seeds	11905 ± 5041	43 ± 5	126
Emerged Seedlings	1459 ± 613	20 ± 5	82
Established Seedlings	415 ± 206	14 ± 4	65
Seeds and Seedlings	13778 ± 5567	46 ± 5	129
Adults	-	53 ± 13	144
All Stages	-	63 ± 11	158
Individuals of locally-transient species only			
Seed Rain	176 ± 296	3 ± 2	-
Seed Bank	1053 ± 970	12 ± 4	-
All Seeds	1229 ± 1132	14 ± 4	-
Emerged Seedlings	331 ± 418	4 ± 3	-
Established Seedlings	61 ± 94	2 ± 2	-
Seeds and Seedlings	1621 ± 1484	16 ± 5	-

Table S2. Numbers of individuals recorded, grouped by locally-transient/locally-persistent species status (top three rows). Then, locally-transient individuals are further grouped by the putative climate preferences of their species, i.e., the temperatures/precipitations of the nearest sites at which persistent adult populations are known to occur, relative the climates of the local sites. Percentages are of all individuals (top row). Individuals that could not be identified to species were not included.

	Seed rain		Seed bank		All seeds		Emerged		Established	
Species status	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
All individuals	12370	100	23014	100	35384	100	3039	100	1079	100
Locally-persistent	11852	95.8	19867	86.3	31719	89.6	2778	91.4	983	91.1
Locally-transient	518	4.2	3147	13.7	3665	10.4	261	8.6	96	8.9
Temperature of nearest persistent adult population										
Same	428	3.5	2061	9	2489	7	180	5.9	83	7.7
Cooler	16	0.1	356	1.5	372	1.1	41	1.3	2	0.2
Warmer	21	0.2	72	0.3	93	0.3	5	0.2	5	0.5
Unknown	53	0.4	658	2.9	711	2	35	1.2	6	0.6
Precipitation of nearest persistent adult population										
Same	154	1.2	1636	7.1	1790	5.1	155	5.1	58	5.4
Drier	51	0.4	441	1.9	492	1.4	62	2	28	2.6
Wetter	260	2.1	412	1.8	672	1.9	9	0.3	4	0.4
Unknown	53	0.4	658	2.9	711	2	35	1.2	6	0.6

Table S3. Standardized coefficients (z-scores) from different GLM models (columns) predicting numbers of established seedlings by species and site. In column headers, "Sp. status" refers to whether the species is locally-transient or locally-persistent, and "Sp. pref. temp./precip." refers to the nearest temperatures/precipitations at which we found the species to have a persistent adult population, which we used to infer the climate from which they likely dispersed. The predictor "Seedling no. (transformed)" refers to the numbers of emerged seedlings of each species at each site, normalized with Yeo-Johnson transformations (refer to Methods). Data consisted of all recorded emerged/established seedlings that could be identified to species. N is equal to 279, the number of unique seedling species-by-site combinations. Asterisks denote significance (*: $p < 0.05$, **: $p < 0.001$). Dashes denote predictors that were not included in a given model.

	Null model	Site climate	Site climate + Sp. status	Site climate + Sp. pref. temp.	Site climate + Sp. pref. precip.
ΔAIC	0	3.8	0.3	0.82	10.62
General predictors					
Seed no. (transformed)	**18.17	**18.02	**17.77	**17.78	**17.53
Local temp.	-	0.3	1.14	0.85	0.42
Local precip.	-	-0.37	0.07	-0.09	-0.5
Transient/Persistent predictors					
Transient	-	-	0.71	-	-
Transient * Local temp.	-	-	*-3.02	-	-
Transient * Local precip.	-	-	-1.4	-	-
Origin-based predictors					
Transients from similar temp.	-	-	-	-0.2	-
Transients from cooler into warmer	-	-	-	*-2.67	-
Transients from warmer into cooler	-	-	-	1.43	-
Transients from similar precip.	-	-	-	-	-0.92

Transients from drier into wetter	-	-	-	-	0.29
Transients from wetter into drier	-	-	-	-	0.01
Transients from unknown climates	-	-	-	-0.53	-0.51