Supplementary Materials

Table S1. Descriptive data across willow sexes and streams on the Pumice Plain of Mount St. Helens. Values represent averages and standard errors. Connectivity is a relative measure based on current outputs from Circuitscape and is treated here as unitless [56]. Entries with a sample size of 1 do not have standard errors. NA values indicate lack of sampling at a particular site. Sample sizes (n) are listed on different levels of each parameter given that sample sizes varied across willow sex and stream identity. Overall taxa richness here describes dependent community richness for all individual willow samples. Taxa richness for subsequent analyses varied depending on subsets used for different parameter suites. Abbreviations: C:N molar ratio is %C divided by %N and standardized by the molecular weights of C and N, %CT is percent condensed tannins, and SLA is a standardized measure for specific leaf area.

Data Descriptor	Overall Taxa Richness	Landscape Parameter	Litter Chemistry Parameters				Leaf Area Parameter
		Connectivity (n)	%C (n)*	%N	C:N	%CT	SLA (mm² mg⁻¹; n)
Across willow sexes							
Female	3.27 ± 0.08	0.30 ± 0.02 (191)	46.80 ± 0.26 (16)	1.26 ± 0.18	61.91 ± 8.89	13.29 ± 1.95	13.49 ± 0.87 (56)
Male	3.08 ± 0.09	0.22 ± 0.02 (144)	46.95 ± 0.25 (15)	1.17 ± 0.21	71.69 ± 10.27	14.74 ± 2.38	12.91 ± 0.79 (53)
Across streams							
Camp	3.68 ± 0.23	0.16 ± 0.02 (19)	47.25 (1)	2.21	24.93	2.47	NA
Clear	3.42 ± 0.23	0.27 ± 0.02 (12)	NA	NA	NA	NA	NA
Forsyth	4.00 ± 0.20	0.31 ± <0.01 (39)	46.47 ± 0.07 (4)	2.20 ± 0.10	24.80 ± 1.17	5.28 ± 0.83	NA
Geo-W	2.84 ± 0.10	0.22 ± 0.01 (116)	47.05 ± 0.25 (19)	0.89 ± 0.13	78.81 ± 7.16	16.71 ± 1.46	13.04 ± 0.70 (70)
Goose	3.20 ± 0.15	0.16 ± <0.01 (35)	46.69 ± 0.39 (6)	1.31 ± 0.41	69.20 ± 19.41	14.44 ± 4.98	17.07 ± 0.54 (29)
Redrock	2.82 ± 0.17	0.06 ± <0.01 (44)	NA	NA	NA	NA	NA
Willow	3.39 ± 0.13	0.54 ± 0.06 (70)	45.87 (1)	1.83	29.23	6.21	3.21 ± 0.15 (10)

*all sample sizes were consistent across chemical parameters

Table S2. Results of Akaike's Information Criteria (AIC) model selection for our taxa richness generalized linear models (GLMs). We tested all relevant combinations of parameter interactions and included the five best models for each parameter set below, except for the leaf area set which only included two factors. Bold text and ΔAIC = 0.000 indicate the best model. Abbreviations: k is the number of parameters including the error estimate, L is the log-likelihood measure, AIC is the ranking measure, and ΔAIC is the change in AIC fit from the best model.

Parameters	k	L	AIC	ΔAIC
Landscape Models (n = 335)				
Connectivity and Stream	**3**	**-498.826**	**1015.653**	**0.000**
Connectivity, Willow Sex, Stream, and Connectivity by Willow Sex	5	-498.110	1018.220	2.567
Connectivity, Willow Sex, and Stream	4	-499.503	1019.005	3.352
Willow Sex and Stream	3	-502.911	1023.823	8.170
Connectivity and Willow Sex	3	-520.831	1049.661	34.008
Litter Chemistry Models (n = 31)				
%N, %CT, and Weevils	**4**	**-40.386**	**90.771**	**0.000**
%N and %CT	3	-41.789	91.578	0.807
%N, %CT, and Willow Sex	4	-41.869	93.737	2.966
%C, %N, and %CT	4	-42.671	95.343	4.572
%C and %N	3	-43.716	95.433	4.662
Leaf Area Models (n = 109)				
Specific Leaf Area and Willow Sex	**3**	**-162.167**	**332.333**	**0.000**
Leaf Area, Willow Sex, and Leaf Area by Willow Sex	4	-171.006	352.013	19.680

Table S3. EM (estimated marginal) means analysis for the stream factor of our taxa richness vs. landscape generalized linear model (Table 1; df = 327). Grouping codes indicate overlaps (same letter is no difference) between levels of the stream factor. Letters were generated using Tukey's HSD multiple comparisons. Abbreviations: SE is the standard error of the EM mean while lower and upper CLs are the confidence limits of the EM mean based on the SE.

Stream	EM Mean	SE	Lower CL	Upper CL	Group
Redrock	2.672	0.169	2.339	3.005	a
Geo-W	2.799	0.010	2.603	2.996	a
Goose	3.119	0.182	2.760	3.478	ab
Clear	3.419	0.308	2.814	4.025	abc
Willow	3.582	0.146	3.295	3.870	bc
Camp	3.607	0.246	3.123	4.092	bc
Forsyth	4.030	0.171	3.694	4.366	c

Table S4. Results of Akaike's Information Criteria (AIC) model selection for our community dissimilarity permutational MANOVAs (PERMANOVAs). We tested all relevant combinations of parameter interactions and included the five best models for each parameter set below, except for the leaf area set which only included two factors. One-parameter models were not included due to lower explanatory value. Bold text and ΔAIC = 0.000 indicate the best model. Abbreviations: C:N molar ratio is %C divided by %N and standardized by the molecular weights of C and N, k is the number of parameters including the error estimate, L is the log-likelihood measure, AIC is the ranking measure, and ΔAIC is the change in AIC fit from the best model.

| Parameters	k	L	AIC	ΔAIC
Landscape Models (n = 335)				
Connectivity, Willow Sex, and Stream	**4**	**-909.464**	**1046.270**	**0.000**
Connectivity, Willow Sex, Stream, and Connectivity by Willow Sex	5	-910.340	1047.394	1.124
Connectivity and Stream	3	-904.233	1049.501	3.231
Willow Sex and Stream	3	-903.726	1050.007	3.737
Connectivity and Willow Sex	3	-834.059	1119.675	73.231
Litter Chemistry Models (n = 31)				
%N and %CT	**3**	**-92.689**	**19.765**	**0.000**
%N, %CT, and Weevils	4	-93.937	20.516	0.751
%C, %N, C:N, and %CT	5	-95.602	20.852	1.087
%C and %N	3	-91.344	21.110	1.345
%C, %N, and %CT	4	-93.004	21.449	1.684
Leaf Area Models (n = 109)				
Specific Leaf Area and Willow Sex	**3**	**-282.286**	**235.071**	**0.000**
Leaf Area, Willow Sex, and Leaf Area by Willow Sex	4	-283.804	235.553	0.482

Table S5. Pairwise results from the stream factor of our landscape PERMANOVA test (Table 2). Contrasts indicate which stream levels were compared for each row. Bolded rows indicate significant effects at $\alpha = 0.05$. A Bonferroni correction method adjusted p-values for pairwise comparisons (Martinez Arbizu 2020). Abbreviations: SS is sum of squares, R^2 is the correlation coefficient, F is a pseudo-F test statistic, and p is the null model probability parameter.

Contrast 1	Contrast 2	SS	F	R^2	p-adjusted
Redrock	**Geo-W**	**0.314**	**8.887**	**0.053**	**0.021**
Redrock	**Willow**	**0.712**	**23.931**	**0.176**	**0.021**
Redrock	**Camp**	**0.384**	**14.431**	**0.191**	**0.021**
Redrock	**Clear**	**0.233**	**9.968**	**0.156**	**0.021**
Redrock	**Forsyth**	**0.405**	**14.891**	**0.155**	**0.021**
Redrock	**Goose**	**0.482**	**15.744**	**0.170**	**0.021**
Geo-W	**Willow**	**0.212**	**5.876**	**0.031**	**0.021**
Geo-W	**Camp**	**0.157**	**4.225**	**0.031**	**0.032**
Geo-W	**Clear**	**0.416**	**11.443**	**0.083**	**0.021**
Geo-W	Forsyth	0.117	3.254	0.021	0.147
Geo-W	**Goose**	**0.214**	**5.630**	**0.036**	**0.021**
Willow	Camp	0.083	2.694	0.030	0.147
Willow	**Clear**	**0.575**	**19.740**	**0.198**	**0.021**
Willow	Forsyth	0.060	1.950	0.018	0.194
Willow	Goose	0.095	2.867	0.027	0.147
Camp	**Clear**	**0.317**	**14.737**	**0.337**	**0.021**
Camp	Forsyth	0.066	2.383	0.041	0.147
Camp	Goose	0.053	1.615	0.030	0.194
Clear	**Forsyth**	**0.404**	**16.454**	**0.251**	**0.021**
Clear	**Goose**	**0.369**	**12.266**	**0.214**	**0.021**
Forsyth	Goose	0.106	3.314	0.044	0.147

Table S6. Results of our SIMPER analysis for community member contributions to dissimilarity for the stream and willow sex factors of our landscape PERMANOVA test (Table 2). Contrasts indicate which stream levels were compared for each row. Stream contrasts only appeared if there was a pairwise difference found (Table S5). Values for community members (Weevil, Sawfly, Mite, Tent, Chrys, and Chew) are scaled contributions to dissimilarity within a stream contrast, divided by the maximum contribution for that contrast. Bolded values are ≥0.500 of the maximum contribution for each contrast. Relative contributions of endophytes, rust, aphids, and other caterpillars never exceeded 0.499 for any contrast and were thus not included here for simplicity. Stream contrasts are listed top-down from closest to farthest geographical distance. Abbreviations: Tent is tent caterpillars, Chrys is chrysomelid beetles, and Chew is any member of the chewing guild not explicitly included here.

Contrast 1	Contrast 2	Weevil	Sawfly	Mite	Tent	Chrys	Chew
				Stream Comparisons			
Redrock	Forsyth	**0.544**	**0.717**	**0.573**	***1.000**	0.412	0.417
Geo-W	Camp	**0.717**	**0.747**	0.274	***1.000**	0.072	**0.586**
Geo-W	Clear	**0.959**	0.493	0.301	**0.724**	***1.000**	**0.935**
Geo-W	Goose	**0.714**	**0.532**	0.482	***1.000**	0.077	**0.894**
Redrock	Willow	**0.585**	**0.663**	0.491	***1.000**	0.000	0.473
Camp	Clear	**0.938**	**0.575**	0.106	**0.645**	***1.000**	**0.775**
Forsyth	Clear	***1.000**	**0.502**	0.454	**0.570**	**0.707**	**0.744**
Willow	Clear	***1.000**	0.360	0.398	**0.588**	**0.870**	**0.744**
Redrock	Clear	**0.904**	**0.581**	0.156	**0.745**	***1.000**	**0.836**
Clear	Goose	***1.000**	0.261	0.272	**0.647**	**0.957**	**0.679**
Willow	Geo-W	**0.663**	**0.675**	**0.679**	***1.000**	0.079	0.351
Redrock	Geo-W	***1.000**	***1.000**	0.425	**0.944**	0.092	**0.540**
Redrock	Camp	0.484	**0.523**	0.049	***1.000**	0.000	0.450
Redrock	Goose	**0.595**	**0.570**	0.266	***1.000**	0.000	**0.725**
				Willow Sex Comparison			
Female	Male	**0.844**	**0.765**	**0.586**	***1.000**	0.250	**0.589**

*1.000 is the maximum contribution to community dissimilarity between contrasts in any comparison
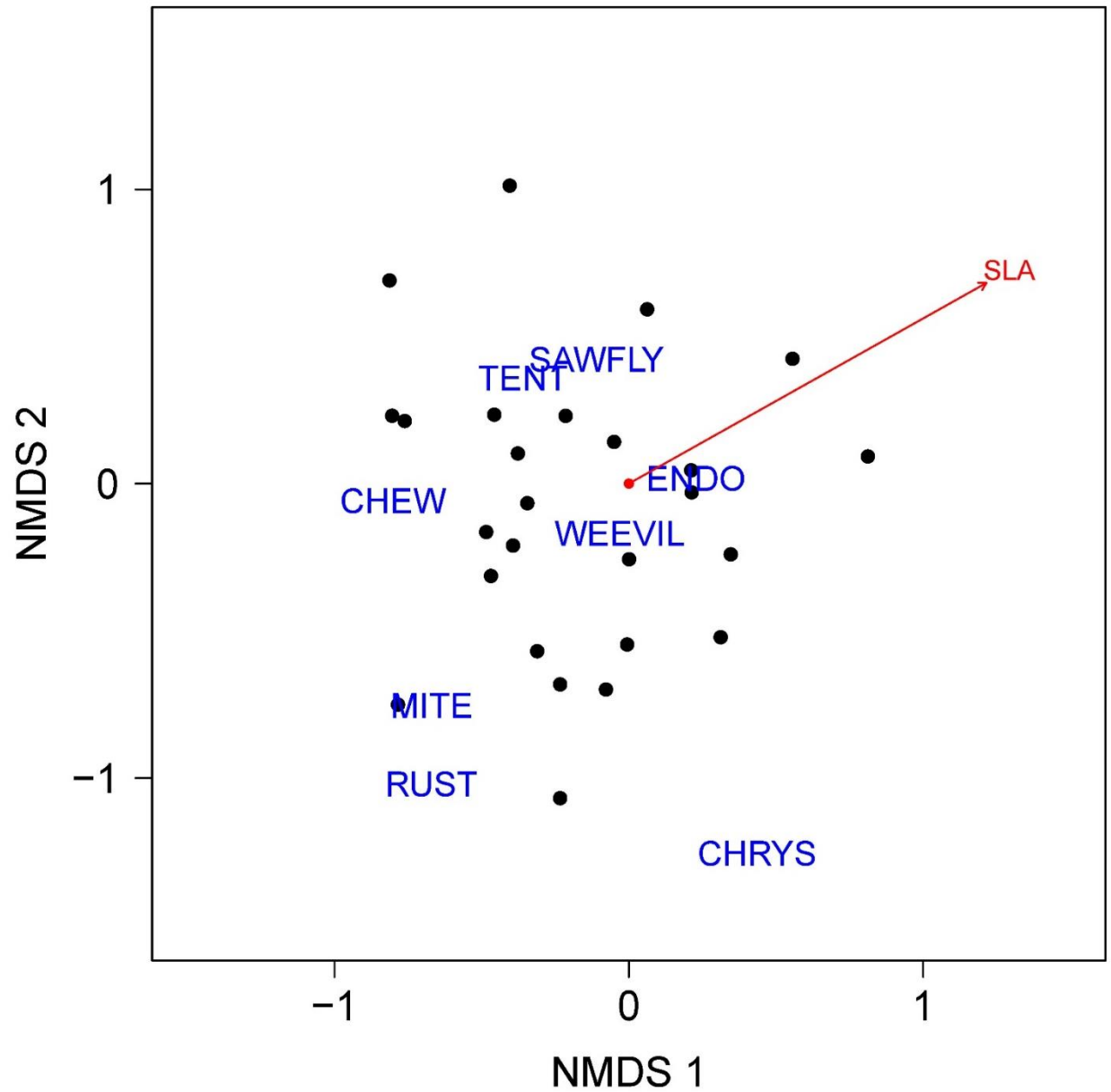
Figure S1. NMDS analysis (four-dimensional) examining dependent-community dissimilarity on tagged willow shrubs for our leaf area parameters. Blue words are centroids for the 8 observed community members related to leaf area. Relative length of the SLA (specific leaf area) vector indicates strength of effect on related community members. To find the best NMDS outputs, we sequentially increased the number of dimensions until stress was reduced to <0.1, based on 999 iterations and 200 random starts. Abbreviations: CHEW represents unidentified chewing guild arthropods, CHRYS represents chrysomelid beetles, ENDO represents endosymbiont organisms on willows, RUST represents fungi creating leaf rust on willow leaves, and TENT represents tent caterpillars.

References (from main text)

56. Hall, K.R.; Anantharaman, R.; Landau, V.A.; Clark, M.; Dickson, B.G.; Jones, A.; Platt, J.; Edelman, A.; Shah, V.B. Circuitscape in Julia: Empowering dynamic approaches to connectivity assessment. *Land* **2021**, *10*, 301. https://doi.org/10.3390/land10030301