Table S1. *Populus fremontii* collection information. We sampled leaf material and recorded geographic coordinates for 453 individual trees at 58 sampling locations throughout the southwestern US and northwestern México for genomic analysis. Latitude and longitude represent site means (North American Datum 1983 coordinate system).

Sampling location	Region	Site ID	Sample size (*n*)	Latitude	Longitude
Presa el Molinito	México	A	5	29.209509	-110.729978
Aliso & Wood Canyon Creeks	CA	AAVWCW	5	33.541433	-117.736583
Agua Fria River	AZ	ACAAFR	5	34.236500	-112.098567
South Fork American River	CA	ALCSFA	5	38.803178	-120.909905
El Rayon	México	B	5	29.716004	-110.576465
Amargosa River, Beatty	NV	BBNBTY	5	36.908835	-116.754439
Clear Creek, Bullpen	AZ	BCEBUL	12	34.539720	-111.696600
Bill Williams River	AZ	BLHBWR	5	34.276762	-114.056059
Baer Creek, Layton	UT	BLUBCU	5	41.025100	-111.918510
Aurora	México	C	5	29.574928	-110.130366
Cibola National Wildlife Refuge	AZ	CBLCWR	5	33.363128	-114.701780
Palo Verde Ecological Reserve	AZ	CBUPVE	5	33.695717	-114.501597
Cottonwood Creek	CA	CCACCC	6	40.374864	-122.283527
Corning Creek	CA	CCOCRN	5	39.925465	-122.223639
Cave Creek	AZ	CCUCAV	7	33.890000	-111.951000
Citadel Wash, Little Colorado River	AZ	CLFLCR	11	35.613000	-111.319000
Cads Crotch	UT	CPUCAD	6	37.266779	-111.906819
Coyote Creek	CA	CSJCYT	6	37.278826	-121.804032
Carson River	NV	CSSCAR	6	39.287469	-119.240370
Mittry Lake, Yuma	AZ	CYUMTL	4	32.869694	-114.476672
Huépac	México	D	5	29.893426	-110.221022
Durango	México	Durango	5	24.012614	-104.492626
Arizpe	México	E	5	30.339434	-110.161876
Cucurpe	México	F	5	30.340113	-110.706744
Fremont River	UT	FCUFRE	6	38.274301	-111.084869
Fish Creek	AZ	FTFFCA	6	33.538617	-111.274333
Magdalena	México	G	5	30.625795	-110.979590
Gila River, Eden	AZ	GEDGRE	5	32.972722	-109.916698
Gila River, Safford	AZ	GSFGRS	5	32.965227	-109.309788
Hog Creek, Hog Springs Picnic Area	UT	HHUHOG	5	37.961527	-110.494506
Hobbs Pond, Layton	UT	HLUHPU	5	41.097770	-111.926930
Jack Rabbit, Little Colorado River	AZ	JLAJAK	12	34.960000	-110.436000
Keams Canyon	AZ	KKHOPI	10	35.811520	-110.169580
Kern River	CA	KWEKRN	6	35.672660	-118.327436
Willow Creek, Kingman	AZ	KWFWIL	11	35.143000	-113.542840
Muddy Creek	UT	MMCMUD	5	37.277458	-112.689254
Rattlesnake Canyon	AZ	MRNRAT	12	34.783050	-111.613720

Muley Twist	UT	MTUMTC	5	37.848650	-111.030573
New River, Phoenix	AZ	NRVNEW	16	33.947660	-112.136170
Owens Valley	CA	OBCOWV	6	37.281940	-118.334401
San Luis Ray	CA	OBRSLR	6	33.264917	-117.233983
Ogden River, Ogden	UT	OOUORU	6	41.235900	-111.933110
Putah Creek	CA	PDAPUT	6	38.527173	-121.794660
Sonoita Creek, Patagonia	AZ	PSASON	17	31.533758	-110.765454
Roosevelt Lake	AZ	RRARLN	5	33.795117	-111.255367
Steep Creek, The Gulch, Burr Trail	UT	SBUBGS	6	37.860553	-111.311855
San Juan River, Bluff	UT	SBUSJB	6	37.273264	-109.556586
Scacramento River	CA	SCOSAC	6	39.208535	-121.984810
San Luis, Colorado River	AZ	SCTMEX	13	32.527020	-114.803690
Palm Springs Tram	CA	SPSPST	5	33.844250	-116.597317
Lower Truckee River	NV	TLRLTN	6	39.509220	-119.651311
Santa Cruz River, Tumacacori	AZ	TSETUM	18	31.565745	-111.045160
San Pedro River, Charleston	AZ	TSZSAN	19	31.610062	-110.167571
Dripping Springs Campground	CA	VTEDSC	5	33.453500	-116.969317
Hassyampa River, Wickenburg	AZ	WHYHAS	17	33.906933	-112.675167
Weber River, Odgen	UT	WOUWRU	6	41.157497	-111.991251
West Walker River	CA	WTLWWC	6	38.660089	-119.539252

Table S2. Predictor variables, including prevailing Spring wind direction, bioclimatic, and topographic variables.

Wind	Description	Source
Mean Spring wind velocity U vectors (UGRD) Mean Spring wind velocity V vectors (VGRD)	Wind vectors represent ten year averages (1979-1989) of February-May monthly means, measured 10m aboveground.	Mesinger et al. (2006); NCEP North American Regional Reanalysis (NARR); https://rda.ucar.edu/datasets/ds608.0/
WorldClim v2		
Temperature seasonality (BIO4) Maximum temperature of the warmest month (BIO5) Minimum temperature of the coldest month (BIO6) Mean temperature of the coldest quarter (BIO11) Mean annual precipitation (BIO12) Mean precipitation of the driest month (BIO14) Precipitation seasonality (CV) (BIO15) Mean precipitation of the driest quarter (BIO17) Mean precipitation of the coldest quarter (BIO19)	Bioclimatic variables represent thirty year averages (1970-2000) of means, maximums, minimums, and variation.	Fick & Hijmans (2017); http://worldclim.org/version2
ClimateNA		
Hargreave's climatic moisture index (CMD) Degree-days above 5°C (DD5) Summer precipitation (PPT_SM; June-August) Spring precipitation (PPT_SP; March-May) Winter precipitation (PPT_WT; December-February) Summer heat moisture index (SHM; mean warmest month temperature/(mean summer precip./1000)) Continentality (TD; difference between mean coldest month and mean warmest month temperatures; °C)	Variables represent thirty year averages for the years 1981-2010.	Hamann et al. (2013), AdaptWest Project (2015); https://adaptwest.databasin.org
Topographic Indices		
Topographic Wetness Index (TWI)	Derived from USGS SRTM DEM (2004)	Boehner et al. (2002); calculated in SAGA GIS
Heat Load Index (HLI)		McCune et al. (2002)

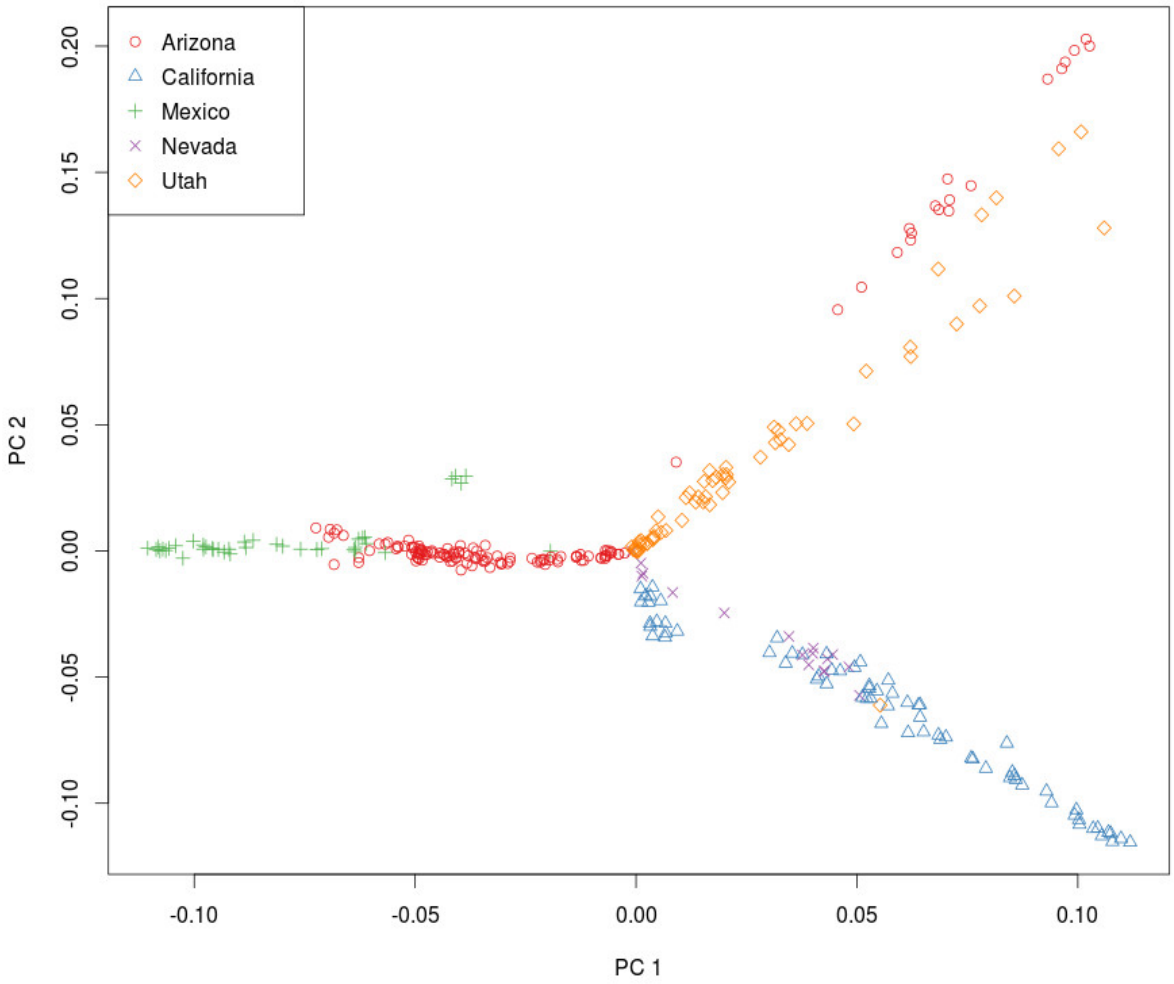

Figure S1. Principal component analysis (PCA) of *P. fremontii* genetic structure. The first 32 eigenvectors explained 40.15% of total variance (PC1 = 5%, PC2 = 4.5%). Data were subset to one random SNP per locus, resulting in 8,637 SNPs across 322 samples.

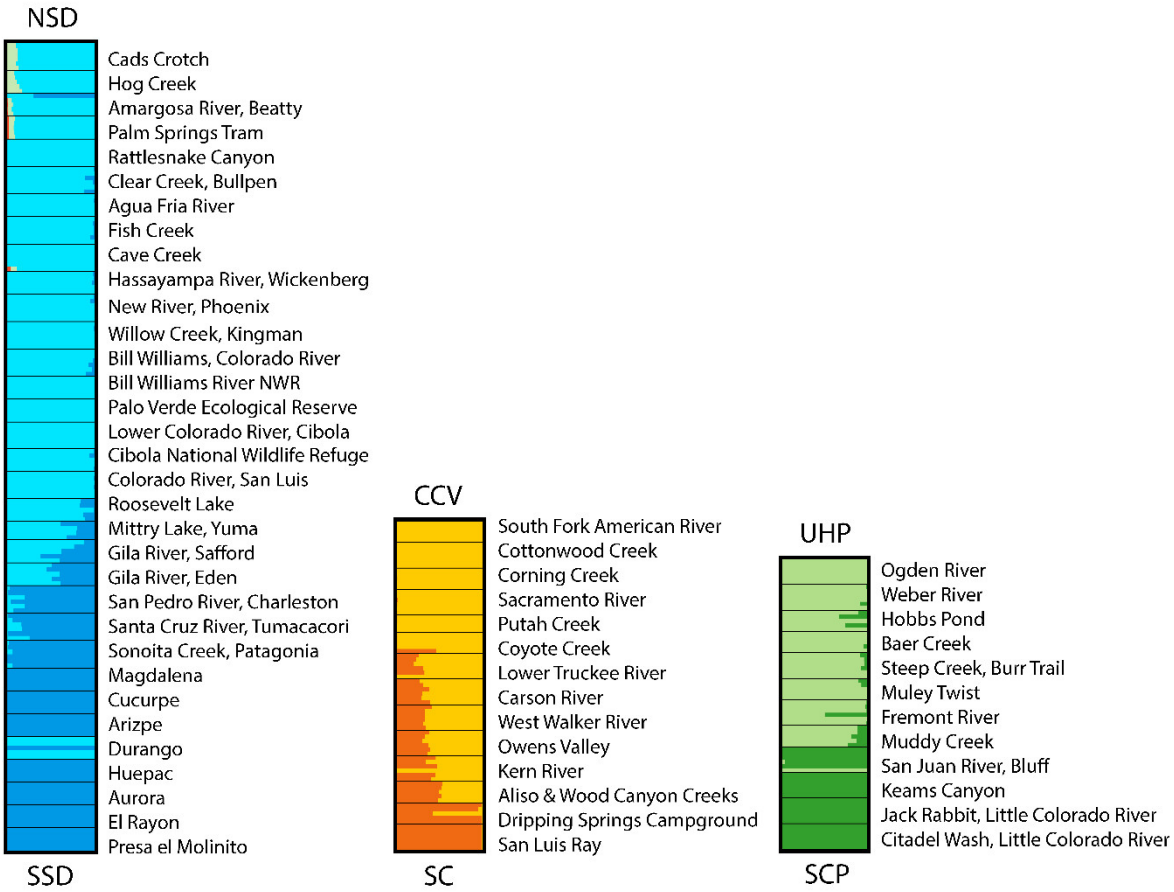

Figure S2. Hierarchical analysis of population genetic structure revealed secondary differentiation within each of the three primary ecotypes ($K = 6$). NSD = Northern Sonoran Desert, SSD = Southern Sonoran Desert, CCV = Central California Valley, SC = Southern California, UHP = Utah High Plateau, SCP = Southern Colorado Plateau.

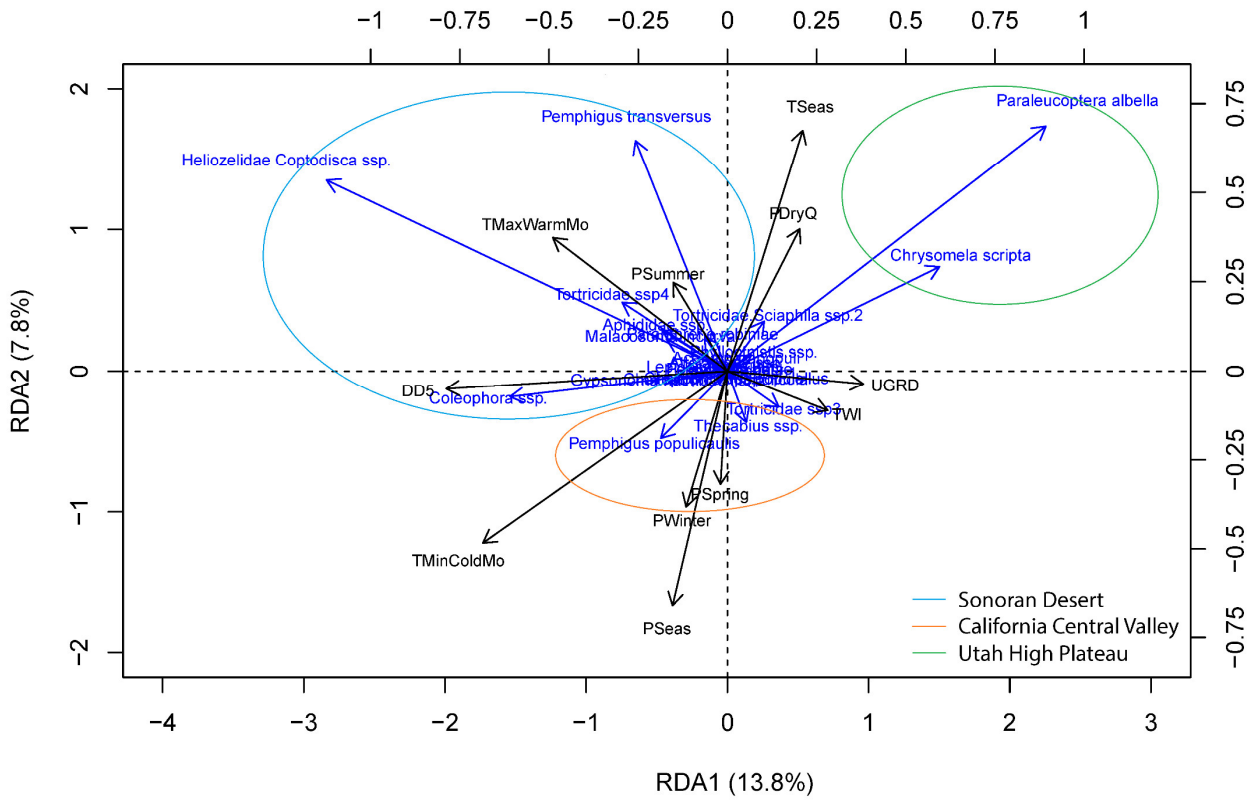

Figure S3. Twenty-five percent of the variation in the leaf modifying arthropod community is explained as a function of environment (RDA $R^2_{adj} = 0.248$, $p = 0.001$). Many species appear to be generalists present across all ecotypes, however several species emerged as specialists uniquely associated with specific ecotypes.