

Supporting Information for:

**“Testing which axes of species differentiation underlie covariance of
phylogeographic similarity among montane sedge species”**

Richard G.J. Hodel
Rob Massatti
Sasha G.D. Bishop
L. Lacey Knowles

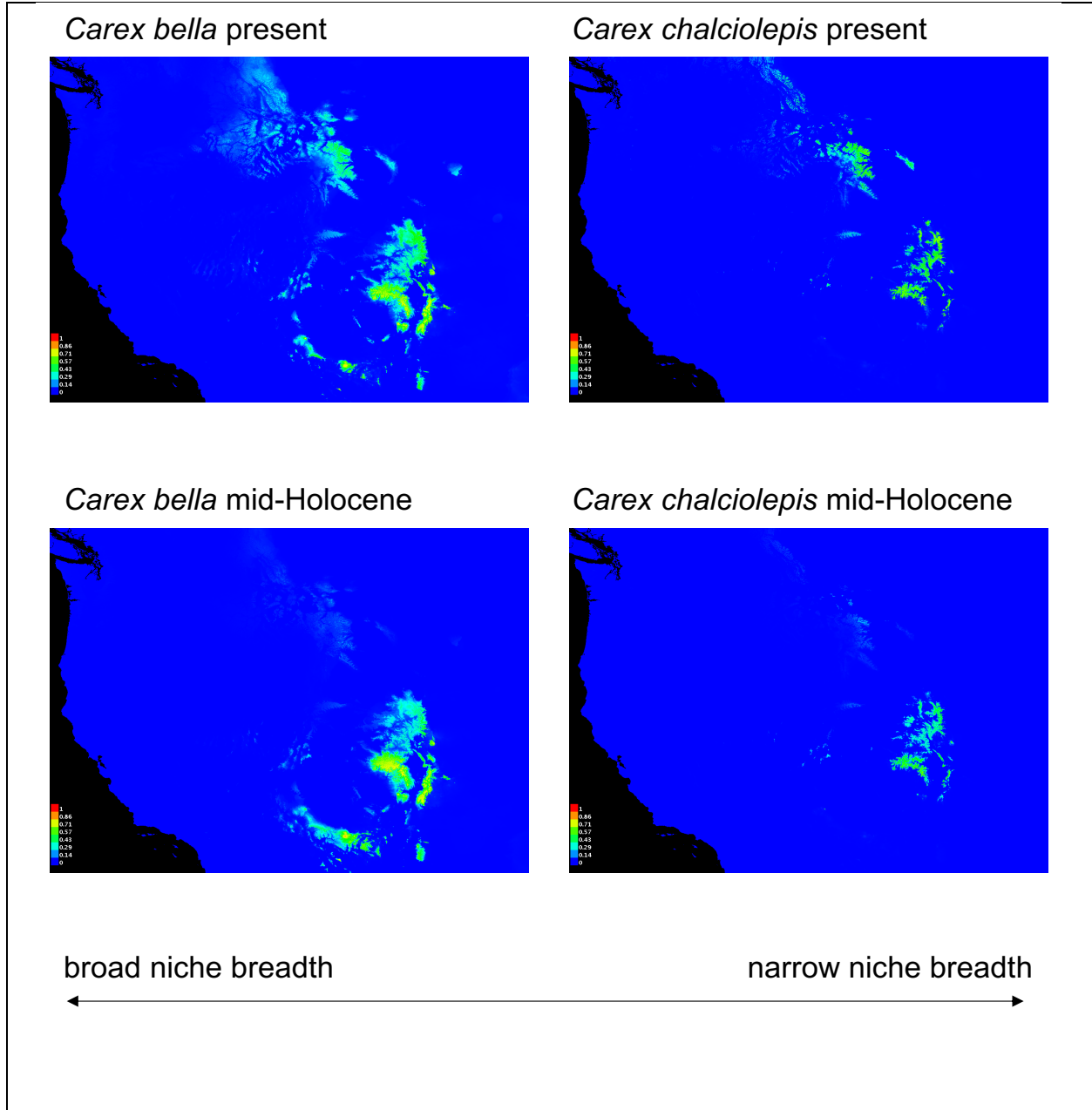
Table of Contents:

Supporting Methods	Page 2
Supporting Information Figure S1	Page 3
Supporting Information Figure S2	Page 5
Supporting Information Figure S3	Page 7
Supporting Information Figure S4	Page 8
Supporting Information Figure S5	Page 9
Supporting Information Table S1	Page 10
Supporting Information Table S2	Page 11
Supporting Information Table S3	Page 21
Supporting Information Table S4	Page 53

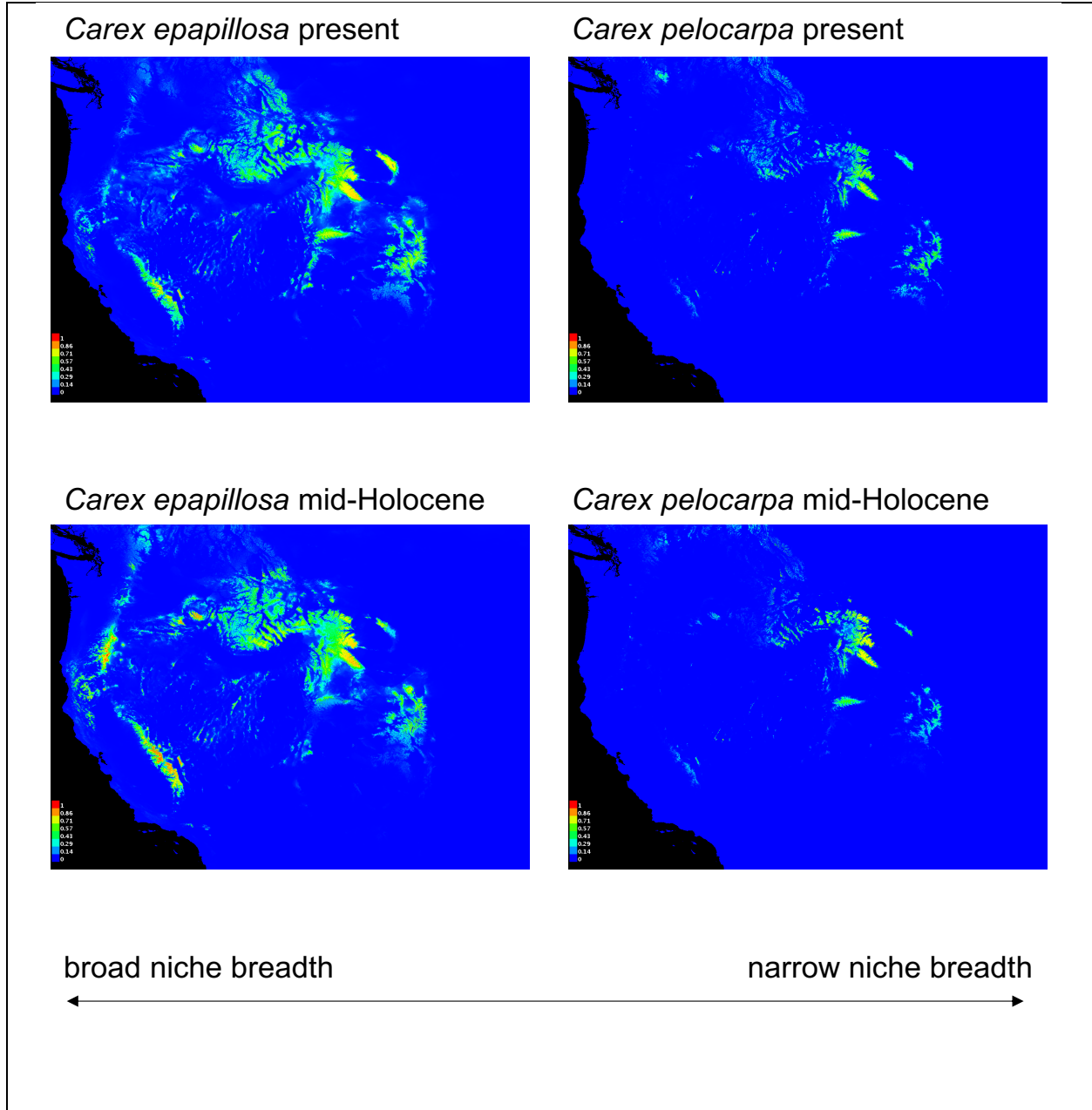
Supporting Methods

In two species, *C. bella* and *C. chalciolepis*, sequences were obtained from two separate libraries sequenced in different lanes. After running the assembly in ipyrad, we combined libraries using an iterative approach to maximize homologous loci retained, while minimizing missing data. Using the VCF file outputted by ipyrad, we filtered the library with more individuals and more loci in vcftools to require a maximum missing data per site (0% for *C. bella*, and 30% for *C. chalciolepis*) and a minimum minor allele count of two. The lower maximum missing data cutoff was used for *C. bella* because the vast majority of loci removed were filtered out using the minor allele cutoff filter in this species. We then identified the locus ID for each of the retained loci and used those to query the other library with fewer individuals and fewer loci. After identifying the loci that were also present in the second smaller library, we again filtered the loci in the second library. As *C. epapillosa* and *C. pelocarpa* sequences were obtained from a single library, this procedure was not followed for them, but the loci in the assemblies were filtered by missing data (50% maximum missing data per site), and minor allele count (minimum of 2). We then filtered the resulting datasets by locus ID and retained only one SNP site per locus to minimize linked loci. Specifically, we incrementally increased the missing data threshold while verifying that relationships between individuals and populations remained consistent in genetic PCAs. The loci that passed all of the above filtering steps made up the final dataset for each species used in all subsequent analyses.

A.

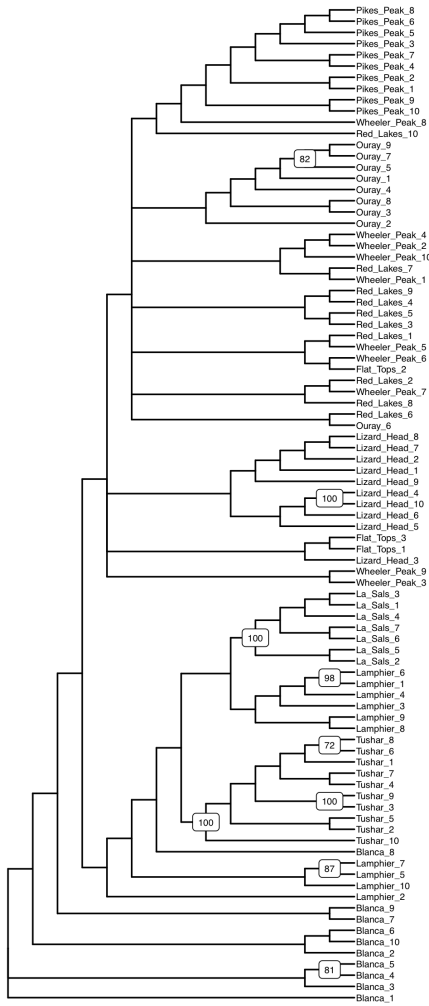


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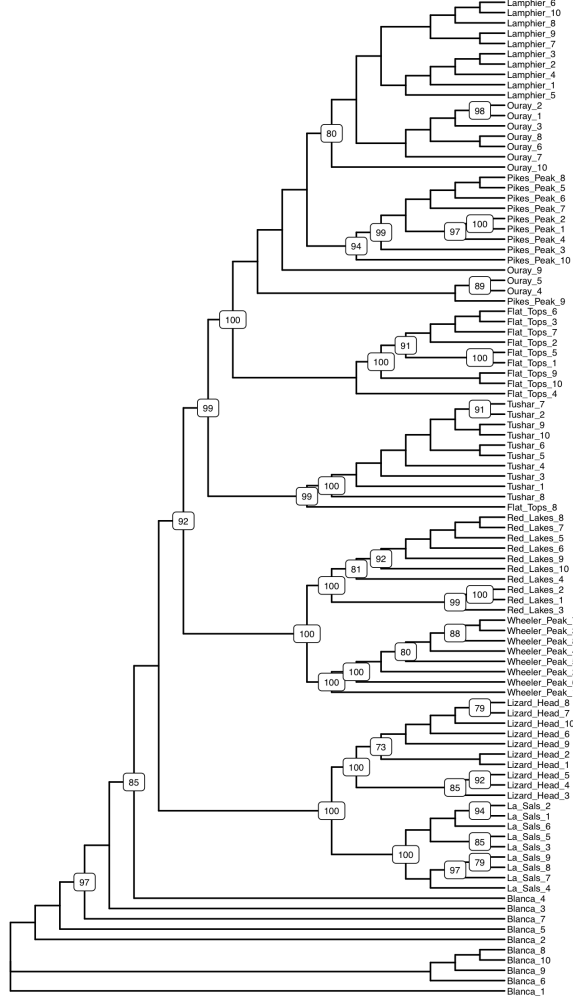


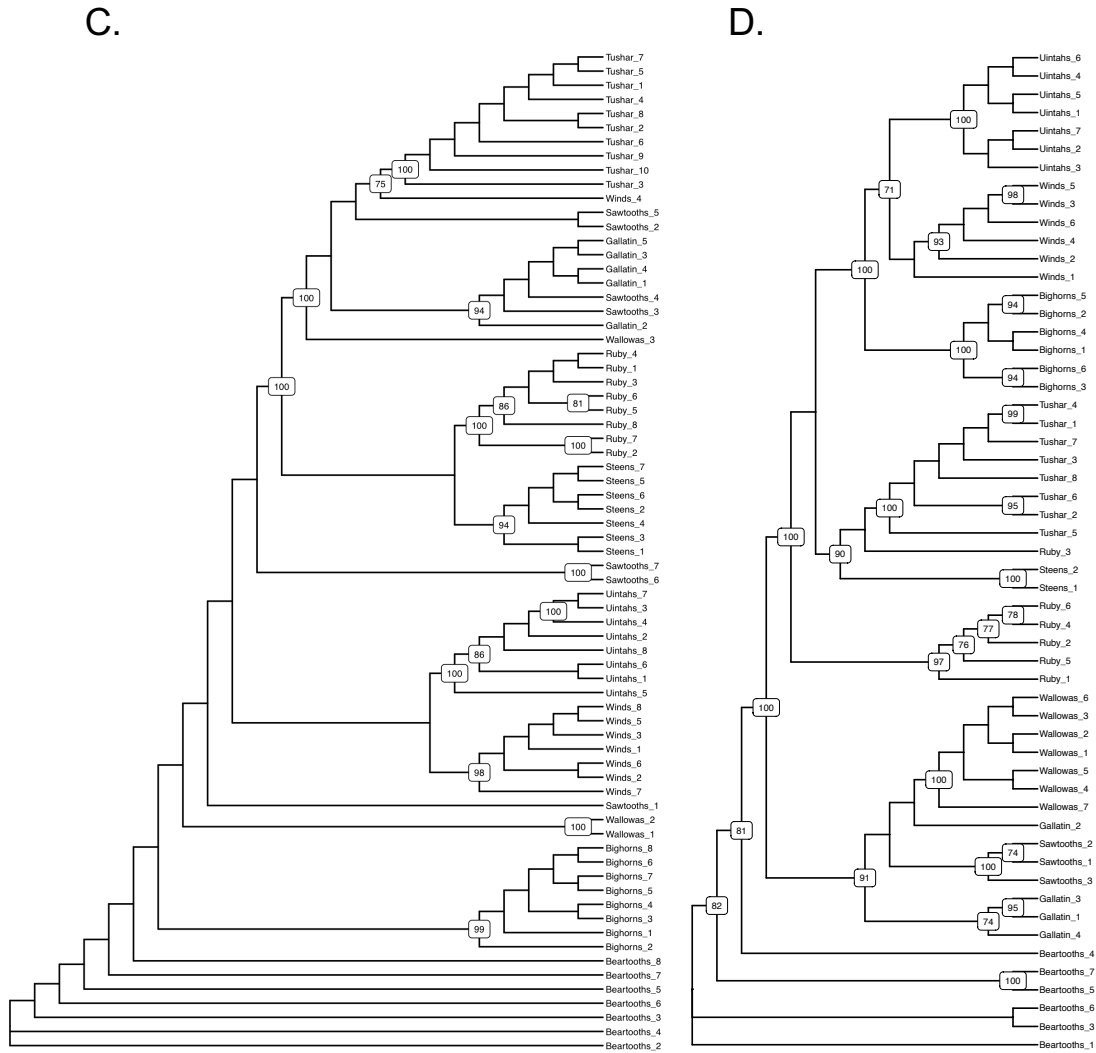
Supporting Information Figure S1. Ecological niche models for the A) two small-range species and B) two large-range species. In both A and B, the niche models for the present (top) were conducted in MAXENT v3.3.3 (Phillips et al. 2006) using 10,000 background points and 100 cross-validated replicates. Niche models were hindcast to the mid-Holocene using the CCSM4 climate projections (bottom). In A, habitat suitability maps are shown for *C. bella* (left) and *C. chalciolepis* (right) with warmer colors indicating more suitable habitat. In B, habitat suitability maps are shown for *C. epapillosa* (left) and *C. pelocarpa* (right) with warmer colors indicating more suitable habitat. The logistic habitat suitability scores can range from 0 to 1.

A.

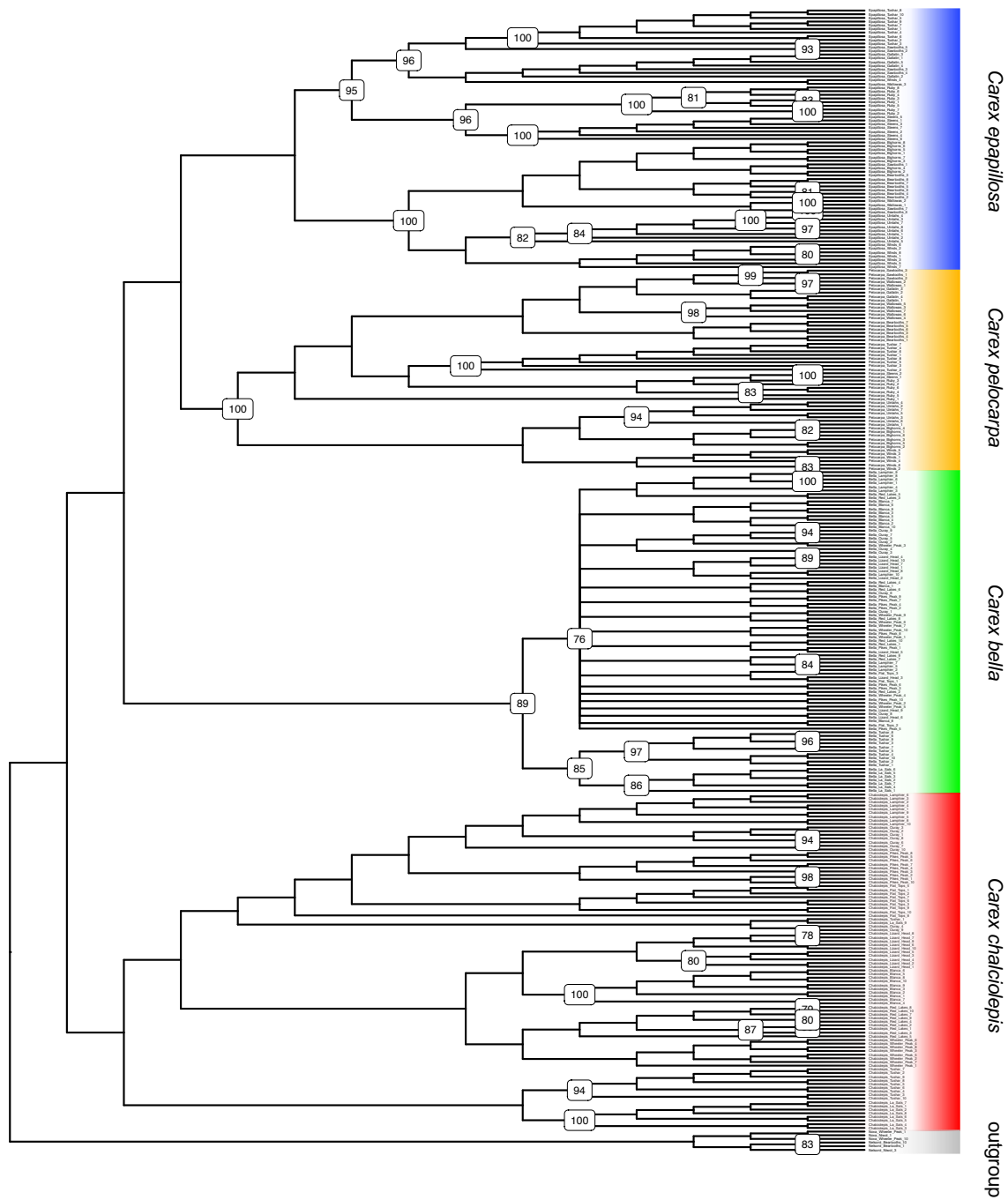


B.

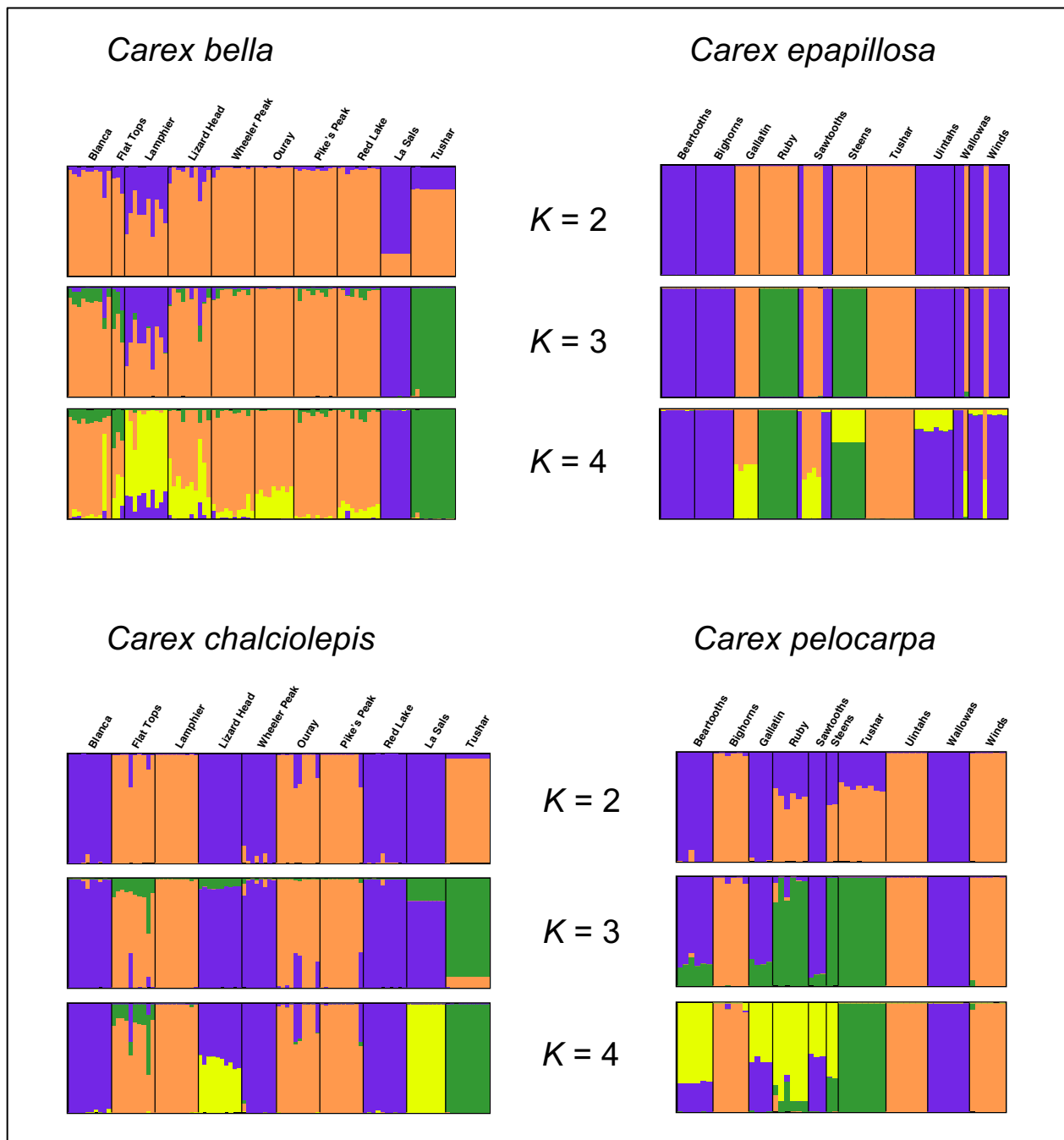




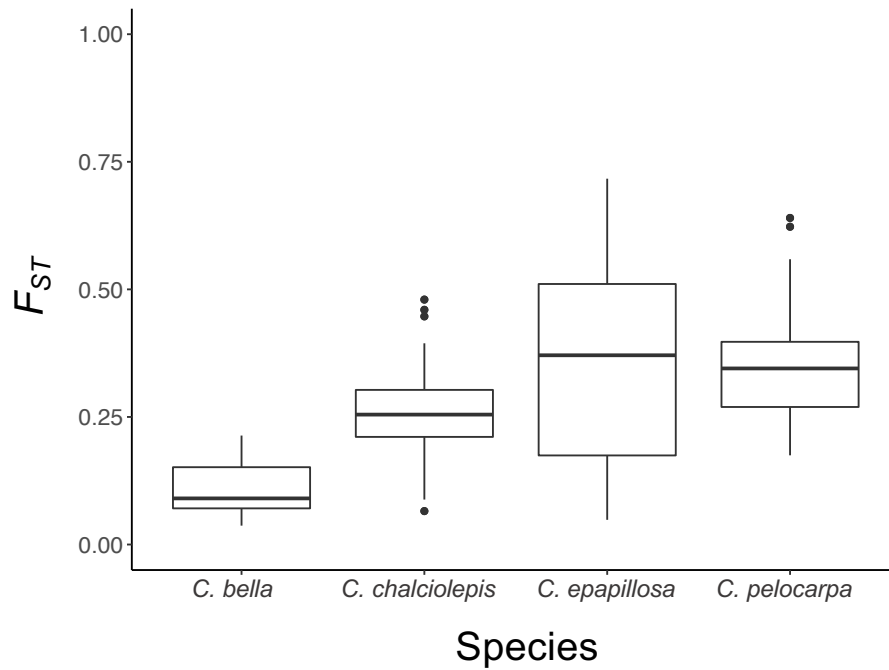
Supporting Information Figure S2. SVDQuartets trees for A) *Carex bella* constructed using 3,159 SNPs; B) *Carex chalciolepis* constructed using 7,134 SNPs; C) *Carex epapillosa* constructed using 5,093 SNPs; D) *Carex pelocarpa* constructed using 4,677 SNPs. Bootstrap support values are shown at nodes where support was greater than 70%. Branch lengths are not proportional.



Supporting Information Figure S3. SVDQuartets phylogeny for all four focal species rooted using an outgroup consisting of two other *Carex* species (*C. nelsonii* and *C. nova*; shaded in gray). Bootstrap support values are shown only at nodes where support was greater than 70% and branch lengths are not proportional.



Supporting Information Figure S4. STRUCTURE plots for the four *Carex* species. The small-range species are shown on the left and the large-range species are shown on the right. For each species, K values of 2-4 are displayed. For *C. bella*, the optimal K value was 3, for *C. chalciolepis* it was 4, and for the two large-range species, $K=2$ was optimal.



Supporting Information Figure S5. Box and whisker plots showing genetic differentiation (F_{ST}) for each of the four species. The box plot shows the median (black line), and 25% and 75% quartiles (lower and upper horizontal bounds of box, respectively), and the whiskers show 1.5*(interquartile range). Outliers are shown as small black circles.

Supporting Information Table S1. Sampling locations with mountain range, GPS coordinates, and elevation for *Carex bella*, *C. chalciolepis*, *C. epapillosa*, and *C. pelocarpa*. Samples were collected between June and August in 2011-2013. Voucher specimens, when available, will be accessioned into the University of Michigan Herbarium (MICH).

Sampling Location	Species	Mountain Range	Latitude	Longitude	Elevation (m)
Beartooths	epapillosa, pelocarpa	Beartooths	44.999982	-109.539955	3145
Bighorns	epapillosa, pelocarpa	Bighorns	44.215566	-107.07702	3418
Blanca	bella, chalciolepis	Sangres	37.607083	-105.475262	3317
Gallatin	epapillosa, pelocarpa	Gallatin	45.361755	-111.421292	2722
La Sals	bella, chalciolepis,	La Sals	38.434638	-109.243306	3275
Lamphier	bella	Sawatch	38.670268	-106.581733	3294
Lamphier	chalciolepis	Sawatch	38.677541	-106.606907	3784
Lizard Head	bella	San Juans	37.836785	-107.906128	3328
Lizard Head	chalciolepis	San Juans	37.824091	-107.934111	3615
Ouray	bella	Sawatch	38.428421	-106.248513	3747
Ouray	chalciolepis	Sawatch	38.372865	-106.242902	3322
Pike's Peak	bella	Pikes	38.873914	-105.111193	3130
Pike's Peak	chalciolepis	Pikes	38.840521	-105.038252	4072
Red Lakes	bella	San Juans	37.085197	-106.443519	3281
Red Lakes	chalciolepis	San Juans	37.098548	-106.462471	3495
Ruby	epapillosa, pelocarpa	Ruby Mtns	40.715424	-115.289567	2729
Sawtooths	epapillosa, pelocarpa	Sawtooths	43.947199	-115.03913	2708
Steens	epapillosa, pelocarpa	Steens	42.663605	-118.566786	2937
Tushar	bella, chalciolepis, epapillosa, pelocarpa	Tushar	38.401785	-112.438172	3582
Uintahs	bella, epapillosa,	Uintahs	40.722864	-110.353871	3399
Wallowas	epapillosa, pelocarpa	Wallowas	45.181334	-117.311301	2353
Wheeler Peak	bella, chalciolepis	Sangres	36.533894	-105.42972	3797
Winds	epapillosa, pelocarpa	Winds	42.63388	-108.967096	3353

Supporting Information Table S2. The RAD-Seq data collected and processed using ipyrad for *Carex bella*, *C. chalciolepis*, *C. epapillosa*, and *C. pelocarpa*. ‘Raw reads’ shows the number of reads assigned to each individual after demultiplexing (ipyrad step 1) and ‘filtered reads’ indicates the number of reads retained for each individual after filtering reads by quality score and removing adapters (ipyrad step 2). ‘Clusters’ reports how many clusters are present in each individual as raw reads are *de novo* clustered based on sequence similarity (ipyrad step 3). Clustered reads are used to estimate allele sequences, with counts per individual from this step shown in ‘consensus reads’ (ipyrad step 5). Finally, the consensus sequences are clustered across all samples to form loci (ipyrad step 6); the number of loci present in the alignment for each individual is displayed in “loci in assembly.” The column ‘individual’ contains the following abbreviations for species and sampling locations: bel = *C. bella*, cha = *C. chalciolepis*, epa = *C. epapillosa*, pel = *C. pelocarpa*, blan = Blanca, flat = Flat Tops, lamp = Lampier, liz = Lizard Head, nmex = Wheeler Peak, our = Ouray, pike = Pike’s Peak, red = Red Lakes, sal = La Sals, tus = Tushar, bear = Beartooths, big = Bighorns, gall = Gallatin, rub = Ruby, saw = Sawtooths, steen = Steens, uin = Uintahs, wall = Wallowas, wind = Winds.

Individual	Raw reads	Filtered reads	Clusters	Consensus reads	Loci in assembly
bel_blan_1	1818663	1816357	94560	43013	35664
bel_blan_2	1792778	1789734	92255	43095	35842
bel_blan_3	1111251	1109431	80524	26794	21247
bel_blan_4	2238209	2235092	106724	48118	40420
bel_blan_5	1741121	1738412	87695	37822	31088
bel_blan_6	1452277	1450187	83693	32535	26344
bel_blan_7	1024889	1023476	68889	22878	18128
bel_blan_8	1442765	1440348	94960	34917	13331
bel_blan_9	1343913	1342035	68324	29356	24343
bel_blan_10	1361525	1359520	70517	30520	25322
bel_flat_1	1937713	1935193	84976	41648	34749
bel_flat_2	433146	432719	42005	8317	6094
bel_flat_3	1771774	1768553	80227	36527	30243
bel_lamp_1	909833	908689	70836	20636	15806
bel_lamp_2	1631707	1629491	88854	35806	29405
bel_lamp_3	2022660	2019761	87668	42746	35731
bel_lamp_4	1755988	1753533	83874	37574	31144
bel_lamp_5	613907	613089	58220	16143	12551
bel_lamp_6	1524402	1522415	86766	37976	31276
bel_lamp_7	992785	991284	75066	22008	17265
bel_lamp_8	1717081	1714578	88305	39739	33016

bel_lamp_9	1497852	1495525	87413	38751	32130
bel_lamp_10	729147	727978	73490	20615	15855
bel_liz_1	1765635	1762236	85434	36579	30052
bel_liz_2	932495	931041	76336	20768	15885
bel_liz_3	1210264	1208098	78310	25768	20411
bel_liz_4	1514462	1512459	93121	33282	27056
bel_liz_5	1093814	1091890	79681	27459	21965
bel_liz_6	1025115	1023309	84220	31613	25598
bel_liz_7	1400476	1398585	87279	39794	32728
bel_liz_8	1177826	1176278	77948	27162	21457
bel_liz_9	672046	671022	62927	13661	9894
bel_liz_10	1119662	1117641	77113	32666	26575
bel_nmex_1	542010	541290	58518	13794	10447
bel_nmex_2	545564	544620	62469	15001	11626
bel_nmex_3	456367	455702	52310	12435	9569
bel_nmex_4	349831	349388	56368	9043	6548
bel_nmex_5	157192	156908	34820	4745	3511
bel_nmex_6	889931	888927	71713	24149	19457
bel_nmex_7	507368	506546	55990	15758	12386
bel_nmex_8	82168	82025	33368	2497	1730
bel_nmex_9	792015	790907	72450	23484	18647
bel_nmex_10	351824	351309	52957	11630	8866
bel_our_1	1602916	1599985	83865	35232	28930
bel_our_2	1484062	1481688	86994	30998	25042
bel_our_3	1619448	1617332	85009	34353	28091
bel_our_4	1763831	1761619	89072	40327	33425
bel_our_5	924915	923622	71361	19295	14790
bel_our_6	1295998	1293648	83468	33863	27607
bel_our_7	1336493	1334610	82068	32809	26660
bel_our_8	1647857	1645428	88316	41540	34599
bel_our_9	1168454	1166747	84083	30567	24693
bel_pike_1	1344543	1342423	88197	34885	28092
bel_pike_2	1167150	1165154	78521	26208	20761
bel_pike_3	802888	801558	72565	19845	15410
bel_pike_4	1619943	1617533	101736	41629	34485
bel_pike_5	771603	770447	73660	17258	12969

bel_pike_6	782720	781753	70186	19559	15389
bel_pike_7	1043676	1042275	80551	31039	25028
bel_pike_8	956696	955312	66613	24964	20478
bel_pike_9	782193	781060	79312	22307	17402
bel_pike_10	1311966	1310277	116006	49425	29386
bel_red_1	1674555	1671942	78044	31306	25237
bel_red_2	1335916	1334017	73165	25041	19731
bel_red_3	2490452	2486384	92999	44428	37045
bel_red_4	1542757	1540617	79412	31518	25541
bel_red_5	1795642	1793351	88791	38835	32043
bel_red_6	817389	816112	55172	18705	14593
bel_red_7	735737	734235	65636	17027	12665
bel_red_8	1105650	1104145	76011	24739	19437
bel_red_9	1203903	1202146	74546	25613	20116
bel_red_10	677379	676592	57094	12917	9410
bel_sal_1	1146310	1145176	85823	32701	26416
bel_sal_2	1267409	1266132	85072	33418	27200
bel_sal_3	908568	907527	79738	29046	23249
bel_sal_4	1422856	1421595	87933	42079	35080
bel_sal_5	1680629	1678973	96201	42342	34652
bel_sal_6	1222556	1221269	96196	33286	26648
bel_sal_7	1327986	1326664	87897	39799	32821
bel_tus_1	721061	720391	79771	21838	16850
bel_tus_2	1046460	1045426	73085	26631	21203
bel_tus_3	1050451	1049367	73557	27798	22213
bel_tus_4	1161320	1160123	77780	28096	22466
bel_tus_5	1225734	1224651	104666	38025	30783
bel_tus_6	1292038	1290791	76361	33158	27094
bel_tus_7	1344306	1342902	86357	40183	33068
bel_tus_8	1423648	1422281	84095	39134	32229
bel_tus_9	1404246	1402934	76356	33081	26967
bel_tus_10	1460673	1459362	92706	37457	30394
cha_blan_1	3442131	3434625	146632	88386	76296
cha_blan_2	3906720	3895063	147425	91828	79523
cha_blan_3	2291775	2289121	234338	47013	37219
cha_blan_4	2795462	2788786	132639	76266	65330

cha_blan_5	1871360	1867244	132089	65827	55551
cha_blan_6	3656540	3649343	148204	90926	78631
cha_blan_7	2575585	2569978	143403	81919	70379
cha_blan_8	3015330	3009948	141557	84571	72767
cha_blan_9	4017612	4010952	143377	90799	78630
cha_blan_10	4076740	4067817	152719	95969	82988
cha_flat_1	2560304	2558001	148135	49670	40646
cha_flat_2	1743563	1741593	131157	42820	34942
cha_flat_3	2535203	2532926	143989	45216	36913
cha_flat_4	2478410	2476137	155202	52740	41751
cha_flat_5	2748266	2745583	150749	52336	43273
cha_flat_6	2721125	2718853	135583	48939	40345
cha_flat_7	2631544	2628732	141757	52629	43526
cha_flat_8	2385746	2383376	206074	52275	33918
cha_flat_9	2987024	2984150	144117	53189	43760
cha_flat_10	2899315	2896747	146673	54526	45195
cha_lamp_1	2908302	2902592	138939	79538	67984
cha_lamp_2	3182965	3176292	147734	85360	73658
cha_lamp_3	4109068	4102923	140345	85866	73905
cha_lamp_4	4578082	4570320	146304	92677	79349
cha_lamp_5	3665535	3658745	137475	87452	75104
cha_lamp_6	2538803	2536884	81184	28638	22223
cha_lamp_7	393899	393543	30607	4549	3111
cha_lamp_8	1678851	1677324	64463	14451	10345
cha_lamp_9	1032306	1031483	56820	10303	7138
cha_lamp_10	1409702	1408518	64937	15252	10986
cha_liz_1	3335568	3332252	96713	31506	24370
cha_liz_2	4515034	4501366	109886	43762	35172
cha_liz_3	5264803	5255620	146624	93537	80897
cha_liz_4	4333851	4320845	134256	87521	75449
cha_liz_5	5994315	5984420	139328	94875	81228
cha_liz_6	1174462	1173434	65182	12073	8276
cha_liz_7	1503281	1502002	65279	13138	9239
cha_liz_8	1468703	1467318	60050	12710	8988
cha_liz_9	1412847	1411476	62386	12019	8416
cha_liz_10	1325535	1324367	64558	14264	10125

cha_nmex_1	2117831	2116084	140217	54287	45020
cha_nmex_2	2007451	2005267	146585	49123	40461
cha_nmex_3	1736202	1734384	139383	45361	37217
cha_nmex_4	2609954	2607836	148258	57527	47675
cha_nmex_5	1598228	1597084	137475	41243	33377
cha_nmex_6	1807955	1806050	130685	45930	37994
cha_nmex_7	1393183	1392234	132843	40022	32299
cha_nmex_8	1375317	1374228	136361	45173	36949
cha_our_1	5400220	5389947	159896	100348	86708
cha_our_2	3388919	3381029	144370	91901	79228
cha_our_3	4718674	4710446	157752	87982	75727
cha_our_4	2433489	2427889	143824	76206	62349
cha_our_5	2479460	2473294	114751	54825	44070
cha_our_6	2038040	2036073	70429	19610	14620
cha_our_7	2020067	2018306	80147	22974	17297
cha_our_8	1992178	1990483	72738	19963	14839
cha_our_9	1672681	1671490	68153	12301	8268
cha_our_10	1019418	1018424	56169	11150	7887
cha_pike_1	2570797	2567323	122787	55632	46375
cha_pike_2	2260748	2258725	116770	39580	32216
cha_pike_3	2563724	2561206	132723	44053	36069
cha_pike_4	2701168	2697928	133628	46392	38188
cha_pike_5	2813389	2810091	133407	51808	43015
cha_pike_6	2044171	2041702	139213	44524	35847
cha_pike_7	2780692	2776942	158834	56152	46061
cha_pike_8	2553426	2550382	122764	52332	43697
cha_pike_9	2455653	2453253	141013	49654	39462
cha_pike_10	2251950	2248875	116274	48912	40691
cha_red_1	1659679	1658653	104985	42060	34053
cha_red_2	1927313	1926330	100804	43150	35072
cha_red_3	1784634	1783619	105359	45578	37224
cha_red_4	1579894	1578585	66527	15003	10874
cha_red_5	664186	663745	40922	6219	4233
cha_red_6	375578	375292	25885	3924	2769
cha_red_7	730115	729636	44834	6574	4392
cha_red_8	1774070	1772707	67780	16732	12055

cha_red_9	1286596	1285429	50224	9778	6910
cha_red_10	1416846	1415633	60182	12397	8717
cha_sal_1	1328004	1326676	77246	28538	22294
cha_sal_2	1374940	1373615	90081	34137	27166
cha_sal_3	1679931	1678204	84839	32988	26163
cha_sal_4	1819144	1817480	88724	44281	36346
cha_sal_5	1885815	1884001	93310	43590	35809
cha_sal_6	1957939	1956034	91483	42511	34647
cha_sal_7	1965204	1963379	89177	48811	40510
cha_sal_8	2041530	2039710	98054	42682	33058
cha_sal_9	2079392	2077369	94775	49324	40858
cha_tus_1	280608	280364	22788	5641	3852
cha_tus_2	1573319	1571900	82429	37825	30585
cha_tus_3	1705652	1704042	72645	35197	28473
cha_tus_4	1785083	1783549	84714	34783	27721
cha_tus_5	1771238	1769672	74784	32867	26247
cha_tus_6	1868762	1867114	80229	36714	29615
cha_tus_7	2010940	2009024	93267	48000	39640
cha_tus_8	2203887	2201822	92473	45275	37433
cha_tus_9	2274919	2272884	86436	41302	33634
cha_tus_10	2899528	2896816	97516	55471	46406
epa_bear_2	930854	930478	63443	15918	12604
epa_bear_3	1002814	1002447	62491	15191	11973
epa_bear_4	1050272	1049945	56416	13751	10967
epa_bear_5	1141934	1141495	71787	18964	15010
epa_bear_6	1212381	1211945	69124	17881	14097
epa_bear_7	1309767	1309212	68449	18296	14562
epa_bear_8	1529436	1528811	79180	28083	22373
epa_big_1	1056464	1055953	45071	13021	10471
epa_big_2	1204737	1204266	68075	18259	14740
epa_big_3	1227631	1227144	46728	13025	10526
epa_big_4	1593335	1592616	68932	19669	15790
epa_big_5	1643071	1642536	50403	16986	13688
epa_big_6	1776059	1775330	64540	19944	16145
epa_big_7	1783148	1782451	68878	21081	17088
epa_big_8	1866157	1865443	74086	22617	18392

epa_gall_1	972936	972532	56075	15843	12554
epa_gall_2	1032244	1031798	61275	18063	14516
epa_gall_3	1051286	1050714	62925	17834	14160
epa_gall_4	1384784	1384151	69963	23771	18862
epa_gall_5	1450879	1450094	73581	24914	19783
epa_rub_1	1198105	1197605	60551	15461	12328
epa_rub_2	1208695	1208142	64096	15803	12393
epa_rub_3	1207150	1206611	76249	17256	13393
epa_rub_4	1211205	1210573	64470	19568	15301
epa_rub_5	1582739	1582111	65963	19439	15314
epa_rub_6	1652136	1651413	73257	24856	19574
epa_rub_7	1689984	1689279	76121	23087	18057
epa_rub_8	2026162	2025362	79119	30715	23937
epa_saw_1	632292	632022	56485	14598	11802
epa_saw_2	702965	702561	59055	15238	12169
epa_saw_3	727611	727270	54739	13856	11013
epa_saw_4	905632	905098	57054	16024	12854
epa_saw_5	999335	998821	66145	18753	14730
epa_saw_6	1194857	1194297	65278	16897	13389
epa_saw_7	1242661	1242096	65679	17347	13660
epa_steen_1	198279	198167	30629	7981	6609
epa_steen_2	330462	330288	49143	11291	9193
epa_steen_3	1171904	1171437	62987	15588	12290
epa_steen_4	1197698	1197059	71398	21353	16619
epa_steen_5	1203390	1202858	67619	19105	14970
epa_steen_6	1429594	1428906	69528	21801	17238
epa_steen_7	1484253	1483649	64131	19403	15363
epa_tus_1	759252	758904	59918	14426	11766
epa_tus_10	1677820	1677041	77022	22684	18266
epa_tus_2	838357	838009	61296	15000	12039
epa_tus_3	890649	890286	63743	14504	11859
epa_tus_4	1026108	1025709	62406	14882	11902
epa_tus_5	1114157	1113572	67746	18019	14590
epa_tus_6	1172032	1171432	69852	18781	14956
epa_tus_7	1266592	1265981	73045	20646	16774
epa_tus_8	1282014	1281390	72051	19192	15340

epa_tus_9	1500892	1500190	73164	21162	16674
epa_uin_1	1156761	1156342	62577	15247	12061
epa_uin_2	1364266	1363651	63780	17621	14088
epa_uin_3	1378295	1377791	77574	17570	13700
epa_uin_4	1385063	1384575	69274	16966	13561
epa_uin_5	1470665	1470054	72030	19226	15203
epa_uin_6	1720451	1719741	72376	19132	15226
epa_uin_7	1739603	1738989	80802	17732	13779
epa_uin_8	2720006	2718931	92314	33901	25590
epa_wall_1	1315539	1314956	75435	23294	18347
epa_wall_2	1324267	1323696	78509	23013	18236
epa_wall_3	2647350	2645974	85165	41254	31481
epa_wind_1	371534	371338	50406	12000	9789
epa_wind_2	722436	722129	63212	16622	13444
epa_wind_3	876490	876128	70896	19301	15528
epa_wind_4	970979	970509	69271	19360	15530
epa_wind_5	1137210	1136670	67120	17754	14197
epa_wind_6	1147365	1146900	61732	19080	15612
epa_wind_7	1204080	1203613	71428	23114	18661
epa_wind_8	1422020	1421320	78346	24917	19806
pel_bear_1	893732	893224	64424	14993	11431
pel_bear_3	1284719	1284031	76530	20705	15972
pel_bear_4	1710336	1709328	89080	33897	27824
pel_bear_5	1962957	1961863	75297	23951	19100
pel_bear_6	2429742	2428357	85574	32996	27008
pel_bear_7	2648334	2646908	92922	36698	29982
pel_big_1	939169	938607	66697	17232	13158
pel_big_2	2104835	2103377	91713	45630	38564
pel_big_3	1400170	1399369	77178	27795	22578
pel_big_4	1745356	1744334	84618	37074	30836
pel_big_5	1773819	1772779	80958	33114	27479
pel_big_6	2206011	2204475	84180	37214	31225
pel_gall_1	1515495	1514559	72175	29195	24028
pel_gall_2	1727742	1726622	84324	39658	33453
pel_gall_3	1810070	1808990	84033	42522	35971
pel_gall_4	1875721	1874539	82964	37571	31563

pel_rub_1	1071259	1070542	64078	17360	12740
pel_rub_2	1336561	1335737	79738	27827	22308
pel_rub_3	1384234	1383414	69978	24481	19616
pel_rub_4	1810409	1809282	87170	38167	30374
pel_rub_5	2029647	2028329	87945	40582	33627
pel_rub_6	2333389	2331832	101484	51324	40229
pel_saw_1	1266222	1265525	67752	21515	16963
pel_saw_2	1274466	1273667	73508	23719	18669
pel_saw_3	1733466	1732460	88837	41293	34221
pel_steen_1	1877664	1876391	91576	36585	29947
pel_steen_2	1883374	1882200	89961	32995	26901
pel_tus_1	630104	629750	58850	11791	9063
pel_tus_2	634019	633622	66017	12481	8396
pel_tus_3	718292	717849	67569	13555	10287
pel_tus_4	932431	931768	72834	17950	13940
pel_tus_5	1028041	1027428	66741	14026	10701
pel_tus_6	1100568	1099847	69647	16843	12962
pel_tus_7	1508830	1507995	75613	19617	15300
pel_tus_8	1736802	1735727	80931	30489	24848
pel_uin_1	1101683	1101105	101126	27330	21826
pel_uin_2	1517353	1516350	83991	24067	18966
pel_uin_3	1578323	1577293	77716	31479	26057
pel_uin_4	1602673	1601767	79517	27602	22209
pel_uin_5	2035132	2033822	88589	39153	32500
pel_uin_6	2054926	2053532	89027	36275	30050
pel_uin_7	2085069	2083626	84164	39425	33142
pel_wall_1	1208441	1207697	52250	16687	13087
pel_wall_2	1494151	1493272	66135	26066	21245
pel_wall_3	1813991	1812894	74029	28309	23083
pel_wall_4	1980255	1978887	88216	36641	30418
pel_wall_5	2252171	2250767	89270	43833	36698
pel_wall_6	2354313	2352740	83082	34375	28458
pel_wall_7	2381782	2380305	86460	42958	36378
pel_wind_1	1385037	1384291	82034	26412	21252
pel_wind_2	1732708	1731643	81161	37770	31733
pel_wind_3	2486588	2484864	92463	37950	31551

pel_wind_4	2632931	2631437	87303	38637	32349
pel_wind_5	2639822	2638294	94571	50750	43121
pel_wind_6	2987505	2985400	97288	48046	40869

Supporting Information Table S3. The GPS coordinates of all field and herbarium specimens used to generate the environmental PCAs for each species (shown in Fig. 4). Georeferenced herbarium specimens were collected from SEINet (swbiodiversity.org/seinet/) and the Consortium of Pacific Northwest Herbaria (pnwherbaria.org) and vetted by R. Massatti.

Species	Longitude	Latitude
<i>Carex bella</i>	-105.475262	37.607083
<i>Carex bella</i>	-107.121798	40.016661
<i>Carex bella</i>	-106.581733	38.670268
<i>Carex bella</i>	-107.906128	37.836785
<i>Carex bella</i>	-105.42972	36.533894
<i>Carex bella</i>	-106.242902	38.372865
<i>Carex bella</i>	-105.111193	38.873914
<i>Carex bella</i>	-106.443519	37.085197
<i>Carex bella</i>	-109.243306	38.434638
<i>Carex bella</i>	-112.438172	38.401785
<i>Carex bella</i>	-109.843	32.6408
<i>Carex bella</i>	-109.843	32.6408
<i>Carex bella</i>	-109.8437	32.6409
<i>Carex bella</i>	-109.863	32.65
<i>Carex bella</i>	-109.863	32.65
<i>Carex bella</i>	-109.863	32.65
<i>Carex bella</i>	-109.8498	32.6502
<i>Carex bella</i>	-109.8598	32.6507
<i>Carex bella</i>	-109.8904	32.6791
<i>Carex bella</i>	-109.863	32.69
<i>Carex bella</i>	-109.863	32.69
<i>Carex bella</i>	-109.8598	32.694
<i>Carex bella</i>	-109.894	32.694
<i>Carex bella</i>	-109.8715	32.7017
<i>Carex bella</i>	-109.8872	32.7017
<i>Carex bella</i>	-109.8715	32.7017
<i>Carex bella</i>	-109.9623	32.7081
<i>Carex bella</i>	-105.8096	33.37409
<i>Carex bella</i>	-105.8096	33.37409
<i>Carex bella</i>	-105.8096	33.37409
<i>Carex bella</i>	-105.8096	33.37409
<i>Carex bella</i>	-105.8083	33.375
<i>Carex bella</i>	-105.805	33.39489
<i>Carex bella</i>	-105.8037	33.4016

<i>Carex bella</i>	-105.762	33.4417
<i>Carex bella</i>	-105.736875	33.460989
<i>Carex bella</i>	-105.736875	33.460989
<i>Carex bella</i>	-105.736875	33.460989
<i>Carex bella</i>	-105.736875	33.460989
<i>Carex bella</i>	-105.736875	33.460989
<i>Carex bella</i>	-105.736875	33.460989
<i>Carex bella</i>	-105.768673	33.464041
<i>Carex bella</i>	-105.768673	33.464041
<i>Carex bella</i>	-109.56359	33.90559
<i>Carex bella</i>	-109.56359	33.90559
<i>Carex bella</i>	-109.563	33.9059
<i>Carex bella</i>	-109.563	33.9059
<i>Carex bella</i>	-109.56222	33.90611
<i>Carex bella</i>	-109.56401	33.90616
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<i>Carex bella</i>	-109.5634	33.9062
<i>Carex bella</i>	-109.5634	33.9062
<i>Carex bella</i>	-109.6059	33.9152
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<i>Carex bella</i>	-109.506	33.9597
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<i>Carex bella</i>	-109.711	34.017
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<i>Carex bella</i>	-111.690556	35.283333
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<i>Carex bella</i>	-111.684361	35.325306
<i>Carex bella</i>	-111.68547	35.32579
<i>Carex bella</i>	-111.6785	35.3258
<i>Carex bella</i>	-111.6785	35.3258
<i>Carex bella</i>	-111.6785	35.3258
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<i>Carex bella</i>	-111.677	35.3258
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<i>Carex pelocarpa</i>	-109.5156	42.9603
<i>Carex pelocarpa</i>	-109.5518	43.02
<i>Carex pelocarpa</i>	-109.497	43.0254
<i>Carex pelocarpa</i>	-109.6531	43.0458
<i>Carex pelocarpa</i>	-109.6547	43.0619
<i>Carex pelocarpa</i>	-109.635	43.0764
<i>Carex pelocarpa</i>	-109.5084	43.0876
<i>Carex pelocarpa</i>	-109.6331	43.1017
<i>Carex pelocarpa</i>	-109.6131	43.1158
<i>Carex pelocarpa</i>	-109.5736	43.1253
<i>Carex pelocarpa</i>	-109.7424	43.148

<i>Carex pelocarpa</i>	-109.7222	43.1586
<i>Carex pelocarpa</i>	-109.6073	43.1741
<i>Carex pelocarpa</i>	-109.5988	43.195
<i>Carex pelocarpa</i>	-109.8208	43.2028
<i>Carex pelocarpa</i>	-109.603	43.2054
<i>Carex pelocarpa</i>	-109.5094	43.2097
<i>Carex pelocarpa</i>	-109.7006	43.2317
<i>Carex pelocarpa</i>	-109.7006	43.2317
<i>Carex pelocarpa</i>	-109.8786	43.2558
<i>Carex pelocarpa</i>	-109.7594	43.2608
<i>Carex pelocarpa</i>	-109.5259	43.2622
<i>Carex pelocarpa</i>	-109.9169	43.2692
<i>Carex pelocarpa</i>	-109.8819	43.2772
<i>Carex pelocarpa</i>	-109.7594	43.29
<i>Carex pelocarpa</i>	-109.7433	43.3194
<i>Carex pelocarpa</i>	-109.5928	43.3382
<i>Carex pelocarpa</i>	-109.5928	43.3382
<i>Carex pelocarpa</i>	-109.5857	43.3627
<i>Carex pelocarpa</i>	-109.7307	43.3683
<i>Carex pelocarpa</i>	-110.3748	43.3708
<i>Carex pelocarpa</i>	-109.7088	43.3743
<i>Carex pelocarpa</i>	-109.8387	43.4754
<i>Carex pelocarpa</i>	-110.8553	43.706
<i>Carex pelocarpa</i>	-110.7756	43.7636
<i>Carex pelocarpa</i>	-109.30333	43.8514
<i>Carex pelocarpa</i>	-109.3639	43.8655
<i>Carex pelocarpa</i>	-109.32389	43.89528
<i>Carex pelocarpa</i>	-109.9217	44.1268
<i>Carex pelocarpa</i>	-107.0325	44.1728
<i>Carex pelocarpa</i>	-107.1331	44.2583
<i>Carex pelocarpa</i>	-109.9053	44.2733
<i>Carex pelocarpa</i>	-107.1332	44.2764
<i>Carex pelocarpa</i>	-107.1734	44.3503
<i>Carex pelocarpa</i>	-107.13361	44.4178
<i>Carex pelocarpa</i>	-107.2786	44.45
<i>Carex pelocarpa</i>	-107.3269	44.5333
<i>Carex pelocarpa</i>	-107.3848	44.5851
<i>Carex pelocarpa</i>	-109.7763	44.5862
<i>Carex pelocarpa</i>	-109.7592	44.6309

<i>Carex pelocarpa</i>	-109.7965	44.6441
<i>Carex pelocarpa</i>	-109.79611	44.6447
<i>Carex pelocarpa</i>	-109.6947	44.6883
<i>Carex pelocarpa</i>	-109.7967	44.84861
<i>Carex pelocarpa</i>	-109.5551	45.1465
<i>Carex pelocarpa</i>	-109.6794	45.1465
<i>Carex pelocarpa</i>	-114.597017	39.336294
<i>Carex pelocarpa</i>	-114.308459	38.909056
<i>Carex pelocarpa</i>	-117.22913	39.095056
<i>Carex pelocarpa</i>	-114.300833	38.945759
<i>Carex pelocarpa</i>	-115.098333	41.025278
<i>Carex pelocarpa</i>	-112.621695	40.46529

Supporting Information Table S4. For each of the four species, normalized Levin’s *B*, a measure of niche breadth, was calculated using the ‘*raster.breadth*’ function in the R package ENMTools (Warren et al. 2019). Levin’s *B* was calculated using niche models generated with bioclim layers from the present and hindcast into the mid-Holocene (labeled as ‘past’).

Species	Range size	<i>B</i> present	<i>B</i> past
<i>Carex bella</i>	small	0.065	0.037
<i>Carex chalciolepis</i>	small	0.020	0.012
<i>Carex epapillosa</i>	large	0.092	0.084
<i>Carex pelocarpa</i>	large	0.026	0.019