

1 **Supplementary material.**

2 **Niche-tracking migrants and niche-switching residents: Evolution of climatic niches in**
3 **New-World Warblers (Parulidae)**

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11 **Supplementary methods**

12 *Climatic variable preparation.*- We obtained spatial information on elevation, and
13 monthly means and extreme values of temperature and precipitation from WorldClim at a
14 1km² resolution [1]. Monthly data for June, July and August and for December, January
15 and February were averaged to construct climatic variables for the breeding period and
16 non-breeding period of migrants, and the same periods were compared for the resident
17 species. Slope and aspect were derived from the digital elevation model at a 1km²
18 resolution, temperature seasonality was estimated as the standard deviation*100 of
19 temperature for each three-month period, and precipitation seasonality was estimated as the
20 coefficient of variation of precipitation for each three-month period [1]. All spatial
21 calculations were carried out using packages ‘dismo’ and ‘raster’ in R [2–4].

22 *Niche modeling.*- To determine whether environmental variables appropriately
23 predicted the distributions of our study species during both the breeding and non-breeding

24 periods, we constructed species distribution models using the maximum entropy algorithm
25 (MaxEnt) implemented in package ‘dismo’ [2,5]. We calculated response curves for each
26 predictor variable and estimated the area under the receiver-operating-characteristic (ROC)
27 curve (AUC) as a measure of model fit [6]; 50% of presence records were used to train the
28 models and the remaining 50% to test them relative to 5,000 random samples from the
29 background [7,8]. We considered models to be adequate when they had AUC values greater
30 than 0.8 [9,10] and showed predicted distributions matching those in the literature [11,12].

31 Results of niche modelling confirmed that the climatic variables adequately
32 predicted the breeding and non-breeding distributions of the 103 species of warblers
33 fulfilling our data requirements (mean AUC breeding \pm SD = 0.89 ± 0.03 ; mean AUC non-
34 breeding \pm SD = 0.85 ± 0.06). This justified our use of these variables to estimate overlap
35 in climatic niches between breeding and non-breeding periods.

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37 *Stochastic mapping of migratory status.*- Evaluating models of evolution requires
38 estimates of character states along the tree [13–15]. Discrete character states (migrant or
39 resident) were assigned to each species as in [16] and then stochastically mapped 100 times
40 on the warbler phylogeny using package ‘phytools’ [17–19]. We assumed a single rate of
41 change between states and an equal probability of state changes (mk1 model; [16]). The
42 resulting 100 trees implied a mean of 11.3 changes from migrant to resident and 8.96 from
43 resident to migrant, consistent with results of an earlier study [16]. The models of evolution
44 were then fit to the 100 stochastic trait maps and the means of parameter estimates and
45 AICc weights were used for model comparison.

47 **Literature cited**

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95 **Supplementary Table.**

96 **Table S1.** Species of New-World Warblers (Parulidae) included in this study. The status
97 column indicates whether species are resident (R) or migratory (M). The list is ordered
98 from lower to higher values of seasonal niche overlap (D) obtained for temperature
99 variables. The last two columns are the number of spatially unique records used for climatic
100 analyses. Species marked with an asterisk (*) had 20 or less spatial records in one or both
101 periods. Status marked with an asterisk (*) indicate those species for which niche similarity
102 tests indicated that seasonal niches are more similar to each other than expected by chance
103 (niche trackers).

Scientific Name	Status	D (All Vars.)	D (Temp)	D (Temp + Topo)	D (Topo)	D (Prec)	No. records Jun-Aug	No. records Dec-Feb
<i>Geothlypis rostrata</i>	R	0.2	0.000	0.138	0.485	0.085	23	55
* <i>Geothlypis beldingi</i>	R	0.278	0.000	0.214	0.632	0.054	18	32
<i>Setophaga vitellina</i>	R	0.298	0.000	0.487	0.867	0.000	22	33
* <i>Setophaga angelae</i>	R	0.115	0.022	0.156	0.469	0.109	16	41
* <i>Myioborus pariae</i>	R	0.346	0.055	0.422	0.427	0.000	28	10
* <i>Myiothlypis leucophrys</i>	R	0.045	0.106	0.414	0.630	0.395	12	8
<i>Myiothlypis bivittatus</i>	R	0.157	0.129	0.158	0.689	0.227	56	24
<i>Myioborus flavivertex</i>	R	0.194	0.137	0.651	0.839	0.131	23	31
<i>Setophaga occidentalis</i>	M	0.277	0.145	0.336	0.395	0.183	3452	572
* <i>Geothlypis agilis</i>	M	0.503	0.149	0.57	0.748	0.168	661	7
* <i>Myiothlypis conspicillatus</i>	R	0.099	0.156	0.44	0.569	0.050	10	26
* <i>Setophaga kirtlandii</i>	M	0.253	0.163	0.623	0.401	0.114	265	20
<i>Setophaga adelaidae</i>	R	0.196	0.177	0.207	0.398	0.103	219	355
<i>Cardellina rubrifrons</i>	M	0.193	0.189	0.368	0.431	0.071	545	149
<i>Setophaga pityophila</i>	R	0.1	0.194	0.28	0.462	0.068	21	57
<i>Setophaga castanea</i>	M	0.284	0.195	0.382	0.706	0.085	166	94
<i>Vermivora bachmanii</i>	M	0.112	0.225	0.431	0.443	0.477	22	24
<i>Limnothlypis swainsonii</i>	M	0.165	0.227	0.591	0.414	0.260	1275	81
<i>Myioborus pictus</i>	M	0.155	0.254	0.28	0.460	0.091	712	343
<i>Oreothlypis virginiae</i>	M	0.564	0.254	0.626	0.752	0.559	206	63
<i>Myiothlypis chrysogaster</i>	R	0.344	0.266	0.472	0.665	0.197	46	26
<i>Setophaga tigrina</i>	M	0.227	0.278	0.794	0.478	0.366	167	52
<i>Vermivora chrysoptera</i>	*M	0.226	0.286	0.692	0.558	0.057	192	137
<i>Geothlypis nelsoni</i>	R	0.348	0.299	0.428	0.641	0.179	28	33
<i>Setophaga cerulea</i>	*M	0.265	0.300	0.584	0.669	0.121	162	74
* <i>Setophaga bishopi</i>	R	0.636	0.309	0.667	0.853	0.000	20	31
<i>Myioborus melanocephalus</i>	R	0.301	0.316	0.556	0.496	0.196	305	176
<i>Basileuterus tristriatus</i>	*R	0.359	0.320	0.548	0.615	0.364	339	360
<i>Protonotaria citrea</i>	*M	0.356	0.322	0.588	0.293	0.266	268	70
<i>Myiothlypis fulvicauda</i>	R	0.388	0.327	0.654	0.660	0.398	308	386
<i>Setophaga pinus</i>	M	0.165	0.327	0.488	0.531	0.578	199	137
<i>Basileuterus trifasciatus</i>	*R	0.3	0.334	0.534	0.558	0.334	29	858
<i>Myioborus ornatus</i>	*R	0.597	0.339	0.603	0.575	0.294	43	59
<i>Geothlypis philadelphia</i>	*M	0.429	0.342	0.857	0.610	0.088	271	102
<i>Oreothlypis superciliosa</i>	R	0.121	0.342	0.382	0.683	0.208	143	243
<i>Myioborus torquatus</i>	R	0.153	0.342	0.492	0.580	0.000	114	202
<i>Setophaga petechia</i>	M	0.617	0.345	0.714	0.682	0.452	165	73
<i>Myiothlypis coronatus_1</i>	*R	0.337	0.346	0.509	0.696	0.336	206	169
<i>Myiothlypis coronatus_2</i>	*R	0.337	0.346	0.509	0.696	0.331	206	169
<i>Setophaga discolor</i>	*M	0.469	0.351	0.75	0.522	0.684	249	75

<i>Geothlypis poliocephala</i>	*R	0.317	0.355	0.552	0.637	0.231	366	588
<i>Cardellina canadensis</i>	*M	0.382	0.359	0.757	0.454	0.051	270	110
<i>Geothlypis semiflava</i>	*R	0.412	0.374	0.759	0.623	0.364	78	125
<i>Setophaga pitayumi</i>	*R	0.501	0.374	0.485	0.707	0.591	689	871
<i>Myiothlypis fraseri</i>	*R	0.485	0.378	0.502	0.534	0.220	25	30
<i>Myiothlypis leucoblepharus</i>	*R	0.364	0.381	0.369	0.675	0.313	56	62
<i>Setophaga striata</i>	M	0.378	0.383	0.646	0.786	0.465	195	58
* <i>Geothlypis flavovelata</i>	R	0.169	0.389	0.207	0.741	0.345	20	23
<i>Setophaga fusca</i>	*M	0.382	0.390	0.735	0.749	0.039	247	149
<i>Setophaga magnolia</i>	*M	0.16	0.390	0.732	0.811	0.084	221	106
* <i>Setophaga delicata</i>	*R	0.466	0.392	0.587	0.665	0.325	14	29
<i>Basileuterus lachrymosa</i>	*R	0.348	0.393	0.466	0.396	0.260	47	115
<i>Myioborus miniatus</i>	*R	0.386	0.402	0.532	0.699	0.377	760	972
<i>Setophaga caeruleascens</i>	*M	0.449	0.402	0.823	0.685	0.215	197	75
<i>Setophaga townsendi</i>	*M	0.49	0.409	0.572	0.679	0.296	196	165
<i>Myiothlypis luteoviridis</i>	*R	0.555	0.410	0.681	0.783	0.451	117	126
<i>Basileuterus rufifrons</i>	R	0.267	0.411	0.581	0.650	0.188	574	858
<i>Geothlypis tolmiei</i>	*M	0.583	0.415	0.682	0.744	0.631	303	137
<i>Basileuterus belli</i>	*R	0.449	0.429	0.523	0.572	0.163	139	209
<i>Myiothlypis flaveolus</i>	*R	0.506	0.429	0.63	0.635	0.583	42	41
<i>Oreothlypis crissalis</i>	*M	0.3	0.429	0.595	0.608	0.164	23	31
* <i>Setophaga pharetra</i>	*R	0.692	0.436	0.78	0.768	0.373	13	62
<i>Myiothlypis nigrocristatus</i>	*R	0.556	0.437	0.678	0.772	0.493	117	120
<i>Setophaga americana</i>	*M	0.425	0.439	0.827	0.712	0.287	325	82
* <i>Setophaga plumbea</i>	*R	0.35	0.440	0.578	0.881	0.551	19	30
<i>Oreothlypis gutturalis</i>	R	0.206	0.443	0.647	0.721	0.049	71	127
<i>Setophaga pennsylvanica</i>	*M	0.387	0.444	0.702	0.738	0.126	232	121
<i>Basileuterus melanogenys</i>	R	0.213	0.446	0.623	0.733	0.080	73	113
* <i>Geothlypis speciosa</i>	*R	0.336	0.457	0.744	0.701	0.189	24	19
<i>Oreothlypis luciae</i>	*M	0.422	0.460	0.774	0.807	0.347	143	53
<i>Basileuterus culicivorus</i>	*R	0.506	0.461	0.589	0.753	0.463	458	594
<i>Setophaga graciae</i>	*M	0.709	0.465	0.8	0.754	0.540	152	97
<i>Oreothlypis peregrina</i>	*M	0.379	0.470	0.642	0.691	0.129	274	154
<i>Oreothlypis celata</i>	*M	0.478	0.471	0.447	0.402	0.434	11134	242
<i>Setophaga palmarum</i>	*M	0.506	0.483	0.658	0.798	0.502	236	119
* <i>Myioborus albifacies</i>	R	0.313	0.486	0.847	0.882	0.603	17	25
* <i>Myioborus albifrons</i>	*R	0.411	0.514	0.825	0.872	0.557	19	26
<i>Geothlypis aequinoctialis</i>	*R	0.562	0.516	0.651	0.572	0.451	149	177
<i>Setophaga ruticilla</i>	*M	0.466	0.519	0.735	0.545	0.200	314	98
<i>Myiothlypis rivularis</i>	R	0.382	0.522	0.345	0.654	0.516	47	37
* <i>Myioborus castaneocapilla</i>	R	0.099	0.537	0.544	0.705	0.025	10	16
<i>Helmitheros vermivorus</i>	*M	0.373	0.538	0.852	0.770	0.165	193	88
<i>Cardellina pusilla</i>	*M	0.659	0.543	0.762	0.701	0.483	429	165

<i>Oreothlypis ruficapilla</i>	*M	0.723	0.545	0.835	0.648	0.691	297	140
<i>Setophaga chrysoparia</i>	*M	0.273	0.546	0.511	0.531	0.312	30	31
<i>Setophaga nigrescens</i>	*M	0.645	0.559	0.694	0.785	0.536	220	166
<i>Geothlypis formosus</i>	*M	0.388	0.563	0.833	0.465	0.132	208	93
* <i>Vermivora pinus</i>	*M	0.346	0.569	0.387	0.560	0.459	101	17
* <i>Myiothlypis signatus</i>	*R	0.495	0.574	0.615	0.559	0.595	10	22
<i>Geothlypis trichas</i>	*M	0.775	0.578	0.832	0.822	0.517	397	100
<i>Myioborus bruniceps</i>	R	0.338	0.578	0.655	0.800	0.165	43	23
<i>Setophaga dominica</i>	*M	0.446	0.587	0.554	0.584	0.398	256	91
<i>Parkesia noveboracensis</i>	*M	0.485	0.611	0.818	0.795	0.167	302	129
<i>Setophaga virens</i>	*M	0.442	0.615	0.753	0.768	0.111	231	142
* <i>Myiothlypis roraimae</i>	*R	0.528	0.616	0.658	1.000	0.509	12	10
<i>Cardellina ruber</i>	*R	0.292	0.621	0.676	0.806	0.200	77	160
<i>Seiurus aurocapilla</i>	*M	0.371	0.627	0.853	0.776	0.136	319	108
<i>Mniotilta varia</i>	*M	0.446	0.663	0.675	0.584	0.233	278	180
<i>Parkesia motacilla</i>	*M	0.402	0.687	0.783	0.515	0.162	229	123
<i>Setophaga citrina</i>	*M	0.463	0.721	0.797	0.520	0.250	241	82
<i>Setophaga coronata</i>	*M	0.625	0.740	0.785	0.612	0.390	376	234
<i>Cardellina versicolor</i>	*R	0.548	0.748	0.867	0.838	0.387	38	46
* <i>Myiothlypis cinereicollis</i>	*R	0.735	0.866	0.885	0.804	0.618	16	17

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