Supplementary Material

Table S1. Logistic regression equations relating butterfly species occupancy to elevation.

a) 1967-1973

Species	N_P	N_A	-2LL	R^2	Chi^2	B_0	B_1	B_2	Optimum elevation (m)
Argynnis adippe	18	25	39.09	0.49	19.38***	-11.18	12.35	-2.79	2213
Argynnis aglaja	14	29	40.94	0.37	13.33**	-27.51	41.72	-15.39	1355
Argynnis paphia	9	33	27.55	0.49	16.10***	-70.83	118.36	-48.98	1208
Coenonympha arcania	9	31	25.23	0.54	17.43***	-51.45	70.70	-23.84	1483
Erebia meolans	7	34	27.12	0.37	10.36**	-6.70	3.08	0.51	>2400
Erebia triaria	12	26	38.17	0.30	9.23*	-17.02	22.54	-7.26	1552
Hesperia comma	13	26	35.63	0.42	14.02**	-29.01	43.03	-15.48	1390
Hipparchia alcyone	8	34	29.53	0.38	11.37**	-54.46	89.10	-36.29	1228
Hipparchia statilinus[§]	20	20	45.39	0.30	10.06**	-11.64	16.18	-5.04	1605
Hyponephele lycaon	6	34	13.38	0.70	20.44***	-190.38	310.91	-125.9	1235
Kanetisa circe[§]	17	27	40.63	0.46	18.07***	-21.11	40.36	-18.58	1086
Lycaena alciphron	18	22	42.39	0.36	12.66**	-15.76	21.15	-6.55	1615
Lycaena virgaureae	14	30	41.31	0.38	13.73**	-24.84	34.08	-11.32	1505
Maniola jurtina[§]	20	23	43.09	0.42	16.31***	2.62	9.29	-5.77	805
Melanargia lachesis[§]	26	16	48.63	0.21	7.19*	-5.91	12.41	-5.41	1147
Melanargia russiae	12	32	25.74	0.64	25.83***	-63.16	84.83	-27.69	1532
Melitaea cinxia	16	21	43.68	0.23	6.94*	-7.84	14.43	-6.23	1158
Melitaea phoebe[§]	16	26	43.50	0.35	12.32**	-11.37	22.46	-10.66	1053
Parnassius apollo	20	24	26.74	0.72	33.90***	-14.51	13.97	-1.73	>2400
Pyronia bathseba[§]	12	31	41.90	0.27	9.01*	-0.87	3.84	-3.30	582
Pyronia cecilia[§]	20	23	35.01	0.58	24.39***	-11.98	29.12	-15.69	928
Pyronia tithonus	11	27	29.96	0.49	15.77***	-23.48	47.56	-23.57	1009
Satyrus actaea	18	26	38.96	0.50	20.57***	-25.30	34.20	-10.86	1575

b) 2004

Species	N_P	N_A	-2LL	R^2	Chi^2	B_0	B_1	B_2	Optimum elevation (m)
Argynnis adippe	29	61	88.23	0.34	24.91***	-20.52	24.63	-7.24	1701
Argynnis aglaja	27	61	91.54	0.25	16.97***	-15.81	19.65	-6.04	1627
Argynnis paphia	22	63	83.45	0.22	13.77**	-16.07	20.98	-6.90	1520
Coenonympha arcania	19	76	74.58	0.31	20.50***	-25.58	35.44	-12.34	1436
Erebia meolans	14	79	52.39	0.43	26.41***	-41.16	42.12	-10.78	1954
Erebia triaria	34	61	81.98	0.49	41.94***	-27.48	31.27	-8.58	1822
Hesperia comma	49	39	69.02	0.60	51.83***	-23.89	30.08	-8.66	1737
Hipparchia alcyone	45	42	56.92	0.69	63.59***	-39.81	52.07	-16.00	1627
Hipparchia statilinus§	42	46	71.79	0.58	50.03***	-11.61	23.31	-10.11	1153
Hyponephele lycaon	62	31	58.74	0.66	59.65***	-25.48	33.12	-9.58	1729
Kanetisa circe§	60	34	63.41	0.64	59.62***	-12.26	25.05	-10.40	1204
Lycaena alciphron	32	44	62.07	0.57	41.38***	-32.10	39.71	-11.72	1694
Lycaena virgaureae	43	49	63.88	0.66	63.27***	-40.58	51.14	-15.25	1677
Maniola jurtina§	60	22	59.84	0.51	35.54***	12.41	-10.08	1.72	<600
Melanargia lachesis§	74	18	37.64	0.70	53.31***	-19.02	36.49	-13.49	1352
Melanargia russiae	12	85	54.63	0.32	17.97***	-48.52	58.12	-17.60	1651
Melitaea cinxia	11	82	49.54	0.34	18.07***	-27.51	45.71	-19.31	1184
Melitaea phoebe§	15	75	56.51	0.40	24.59***	-11.53	22.47	-11.06	1016
Parnassius apollo	9	85	47.51	0.25	11.83**	-40.09	46.12	-13.61	1694
Pyronia bathseba§	19	75	64.39	0.43	30.24***	2.95	-1.88	-1.13	<600
Pyronia cecilia§	19	77	31.57	0.77	63.95***	-23.03	59.42	-35.45	838
Pyronia tithonus	50	42	54.49	0.73	72.35***	-23.43	42.49	-17.16	1238
Satyrus actaea	21	68	48.55	0.63	48.70***	-61.69	66.12	-17.12	1931

$N_{P/A}$ = N present / absent; -2LL = -2 log likelihood ratio of model. Logit (Probability of occupancy) = $B_0 + B_1$ X elevation (km) + B_2 X elevation^2. Significance:*** $P < 0.001$;** $P < 0.01$;* $P < 0.05$. § denotes species observed below 800 m. Optimum elevation is the elevation with the highest probability of occupancy. Nomenclature follows García-Barros *et al.* (2004).

Table S2. Huisman-Olff-Fresco (HOF) models relating butterfly species occupancy to elevation.

a) 1967-1973

Species	Model	Deviance change	df	F	a	b	c	d	Optimum elevation (m)
Argynnis adippe	II	18.96	42	18.72***	3.40	-6.97			>2400
Argynnis aglaja	IV	15.25	41	16.43***	-9.39	15.31	5.30	b	1301
Argynnis paphia	IV	15.63	40	21.38***	-11.18	22.78	7.69	b	1208
Coenonympha arcania	IV	11.46	38	16.00***	-11.68	13.99	7.72	b	1480
Erebia meolans	II	10.35	40	14.12***	4.87	-5.61			>2400
Erebia triaria	II	6.46	37	5.81*	2.50	-3.31			>2400
Hesperia comma	IV	12.94	37	13.24***	-9.15	13.78	5.14	b	1356
Hipparchia alcyone	V	2.99	39	4.36*	-460.62	829.01	5.99	15.53	1398
Hipparchia statilinus§	II	7.34	39	5.87*	1.57	-3.97			>2400
Hyponephele lycaon	V	2.44	37	9.62**	272.57	516.52	12.98	34.57	1349
Kanetisa circe§	IV	11.50	42	11.37**	-5.43	11.72	2.22	b	1083
Lycaena alciphron	II	9.29	39	8.21**	2.09	-4.44			>2400
Lycaena virgaureae	IV	9.11	42	9.07**	-9.49	11.97	5.28	b	1496
Maniola jurtina§	III	6.07	41	6.07*	-540.39	971.39	-0.75		<600-1399
Melanargia lachesis§	IV	5.73	40	4.81*	-4.47	6.94	0.15	b	1093
Melanargia russiae	IV	15.79	42	25.44***	-16.32	20.16	9.57	b	1532
Melitaea cinxia	V	6.22	34	5.47*	-2.35	4.95	18.20	202.61	787
Melitaea phoebe§	III	9.14	40	8.90**	-491.58	882.88	-0.22		<600-1398
Parnassius apollo	II	33.87	43	50.63***	5.93	-13.81			>2400
Pyronia bathseba§	II	8.62	41	8.01**	-0.89	4.96			<600
Pyronia cecilia§	IV	6.78	41	7.49**	-5.27	12.91	-0.04	b	908
Pyronia tithonus	IV	8.53	36	10.23**	-4.62	13.34	1.78	b	976
Satyrus actaea	IV	6.87	42	7.67**	-11.03	12.63	5.12	b	1528

b) 2004

Species	Model	Deviance change	df	F	a	b	c	d	Optimum elevation (m)
Argynnis adippe	IV	13.44	88	12.95***	-7.38	9.07	4.58	b	1721
Argynnis aglaja	III	16.36	86	15.75***	567.33	-2166.5	0.34		1075->2400
Argynnis paphia	IV	13.99	83	14.38***	-5.97	9.76	4.07	b	1484
Coenonympha arcania	IV	21.62	93	27.57***	-7.80	13.55	5.78	b	1462
Erebia meolans	III	9.32	91	16.62***	703.04	-1333.2	0.54		1513->2400
Erebia triaria	IV	12.87	93	14.19***	-9.91	10.64	5.79	b	1846
Hesperia comma	IV	20.63	86	25.80***	-12.19	12.85	4.92	b	1732
Hipparchia alcyone	IV	48.91	85	69.03***	-14.55	17.29	6.57	b	1642
Hipparchia statilinus§	IV	16.47	86	18.84***	-6.17	11.35	0.46	b	1119
Hyponephele lycaon	IV	24.83	91	40.11***	-16.13	16.14	5.39	b	1733
Kanetisa circe§	IV	24.89	92	36.51***	-9.20	14.48	0.31	b	1179
Lycaena alciphron	V	7.67	73	9.74**	-4.47	5.32	33.63	84.53	1388
Lycaena virgaureae	V	3.67	89	4.89*	-5.14	5.90	18.90	50.45	1404
Maniola jurtina§	II	35.12	81	45.47***	-5.14	7.33			<600
Melanargia lachesis§	IV	30.95	90	70.65***	-16.19	21.25	0.77	b	1302
Melanargia russiae	V	6.64	94	13.13***	-4.02	7.71	2808.7	5716.1	1448
Melitaea cinxia	IV	12.38	91	22.04***	-5.78	15.74	4.52	b	1177
Melitaea phoebe§	V	2.54	87	4.06*	-2.40	9.58	10.00	75.17	927
Parnassius apollo	V	4.83	91	10.02**	-1.81	4.89	2394.4	4883.5	1447
Pyronia bathseba§	II	30.11	93	42.47***	-1.58	7.61			<600
Pyronia cecilia§	IV	5.16	94	14.40***	-5.87	23.92	-0.55	b	822
Pyronia tithonus	IV	40.52	90	64.55***	-10.84	18.27	2.11	b	1221
Satyrus actaea	V	2.85	86	5.20*	-164.16	185.95	9.02	13.75	2040

Model: V – Skewed; IV – Symmetrical; III – Plateau; II – Monotone (curvilinear). Model formula: Probability of occupancy = 1 / (1 + exp (a + bx)) (1 / (1 + exp (c – dx))). x variable is elevation (m), scaled between 0 (for lowest elevation datapoint) and 1 (for highest elevation datapoint). Significance of deviance change:*** $P < 0.001$;** $P < 0.01$;* $P < 0.05$. § denotes species observed below 800 m.

Table S3. Phylogenetic GLS regressions of change in minimum and maximum elevations, and modelled habitable area, against occupancy change. a) 16 species not found below 800 m; b) 15 species not found below 800 m, excluding one outlier (*H. lycaon*); c) 7 species found below 800 m.

Dependent variable	Alpha[†]	R	Ln Likelihood	B_0 (±SE)	B_1 (±SE)
a) 16 species, >800 m					
Δ minimum elevation (m)	5.71	-0.63**	-89.86	212.2 (±60.1)**	-159.3 (±52.9)**
Δ maximum elevation (m)	9.53	0.89***	-86.12	61.1 (±38.5)^{NS}	299.1 (±41.7)***
Δ LR modelled area ≥10%	4.13	0.81***	13.39	-0.32 (±0.12)*	0.33 (±0.07)***
Δ HOF modelled area ≥10%	4.47	0.85***	13.02	-0.37 (±0.11)**	0.41 (±0.07)***
Δ LR modelled area ≥20%	4.51	0.87***	17.12	-0.34 (±0.09)**	0.35 (±0.05)***
Δ HOF modelled area ≥20%	6.93	0.88***	15.68	-0.32 (±0.08)**	0.41 (±0.06)***
Δ LR modelled area ≥50%	15.50	0.85***	8.10	-0.50 (±0.10)***	0.57 (±0.10)***
Δ HOF modelled area ≥50%	15.50	0.84***	8.85	-0.46 (±0.10)***	0.53 (±0.09)***
b) 15 species, >800 m					
Δ minimum elevation (m)	5.03	-0.62*	-84.41	205.3 (±68.2)*	-197.2 (±69.4)*
Δ maximum elevation (m)	12.10	0.84***	-80.87	71.0 (±39.1)^{NS}	331.6 (±59.4)***
Δ LR modelled area ≥10%	4.39	0.63*	12.16	-0.32 (±0.12)*	0.30 (±0.10)*
Δ HOF modelled area ≥10%	4.83	0.69**	11.92	-0.37 (±0.11)**	0.40 (±0.10)**
Δ LR modelled area ≥20%	4.35	0.78***	15.55	-0.35 (±0.10)**	0.37 (±0.08)***
Δ HOF modelled area ≥20%	7.18	0.76***	14.19	-0.32 (±0.08)**	0.40 (±0.10)**
Δ LR modelled area ≥50%	15.50	0.89***	11.24	-0.48 (±0.08)***	0.87 (±0.12)***
Δ HOF modelled area ≥50%	15.50	0.84***	9.96	-0.44 (±0.09)***	0.75 (±0.13)***

Dependent variable	Alpha[†]	R	Ln Likelihood	B_0 (±SE)	B_1 (±SE)
c) 7 species, <800 m					
Δ minimum elevation (m)	4.22	-0.57^{NS}	-37.45	$27.2\ (\pm 67.3)^{NS}$	$-174.3\ (\pm 113.4)^{NS}$
Δ maximum elevation (m)	15.50	0.72^{NS}	-39.93	$-65.0\ (\pm 91.6)^{NS}$	$376.5\ (\pm 162.8)^{NS}$
Δ LR modelled area ≥10%	3.95	0.67^{NS}	11.73	$0.06\ (\pm 0.05)^{NS}$	$0.21\ (\pm 0.10)^{NS}$
Δ HOF modelled area ≥10%	1.87	0.93^{**}	16.08	$-0.03\ (\pm 0.04)^{NS}$	0.30 (±0.05)**
Δ LR modelled area ≥20%	3.64	0.70^{NS}	8.98	$0.09\ (\pm 0.08)^{NS}$	$0.33\ (\pm 0.15)^{NS}$
Δ HOF modelled area ≥20%	4.30	0.86^{*}	10.98	$0.01\ (\pm 0.06)^{NS}$	0.44 (±0.12)*
Δ LR modelled area ≥50%	7.50	0.55^{NS}	1.07	$0.17\ (\pm 0.23)^{NS}$	$0.70\ (\pm 0.48)^{NS}$
Δ HOF modelled area ≥50%	6.50	0.38^{NS}	-0.90	$0.35\ (\pm 0.31)^{NS}$	$0.59\ (\pm 0.63)^{NS}$

Δ = change in variable, regressed against proportion change in occupancy. [†]Maximum likelihood estimate of alpha – higher values show lower phylogenetic constraint. Area models: LR – logistic regression (Table S1); HOF – Huisman-Olff-Fresco (Table S2). Significance tested using N-2 degrees of freedom: $^{***}P < 0.001$; $^{**}P < 0.01$; $^{*}P < 0.05$; $^{NS}P \geq 0.05$.

Table S4. Tests of models using temperature associations in 1967-1973 to predict high-elevation species distributions in 2004, and vice versa.

a) Predictions of 2004 distributions using 1967-1973 temperature associations

Species	N_P	N_A	-2LL	R^2	Chi^2
Argynnis adippe	29	61	101.33	0.17	11.81**
Argynnis aglaja	27	61	100.33	0.13	8.18**
Argynnis paphia	22	63	88.77	0.14	8.44**
Coenonympha arcania	19	76	92.52	0.04	2.56^{NS}
Erebia meolans	14	79	65.26	0.24	13.54***
Erebia triaria	34	61	84.86	0.46	39.06***
Hesperia comma	49	39	75.59	0.54	45.26***
Hipparchia alcyone	45	42	101.01	0.27	19.49***
Hyponephele lycaon	62	31	107.76	0.15	10.64**
Lycaena alciphron	32	44	73.31	0.44	30.15***
Lycaena virgaureae	43	49	79.92	0.54	47.23***
Melanargia russiae	12	85	63.68	0.17	8.93**
Melitaea cinxia	11	82	61.76	0.12	5.85*
Parnassius apollo	9	85	53.84	0.12	5.5*
Pyronia tithonus	50	42	71.30	0.61	55.55***
Satyrus actaea	21	68	51.95	0.60	45.30***

Models used to predict distributions from Table S1a, elevation converted to mean annual temperature (ºC). $N_{P\,/\,A}$ = N present / absent in 2004; -2LL is -2 log likelihood ratio of logistic regression model for presence / absence in 2004, using temperature associations in 1967-1973. Significance:*** $P < 0.001$;** $P < 0.01$;* $P < 0.05$; ^{NS} $P > 0.05$.

B) Predictions of 1967-1973 distributions using 2004 temperature associations.

Species	N_P	N_A	-2LL	R^2	Chi^2
Argynnis adippe	18	25	52.16	0.18	6.31*
Argynnis aglaja	14	29	41.44	0.36	12.83***
Argynnis paphia	9	33	28.52	0.47	15.13***
Coenonympha arcania	9	31	41.21	0.05	1.24^{NS}
Erebia meolans	7	34	26.65	0.39	10.83**
Erebia triaria	12	26	39.10	0.28	8.3**
Hesperia comma	13	26	38.90	0.33	10.74**
Hipparchia alcyone	8	34	34.43	0.23	6.47*
Hyponephele lycaon	6	34	27.90	0.24	5.92*
Lycaena alciphron	18	22	44.77	0.30	10.28**
Lycaena virgaureae	14	30	44.93	0.29	10.12**
Melanargia russiae	12	32	35.51	0.44	16.05***
Melitaea cinxia	16	21	44.62	0.20	5.99*
Parnassius apollo	20	24	49.59	0.30	11.05**
Pyronia tithonus	11	27	29.45	0.50	16.28***
Satyrus actaea	18	26	50.09	0.26	9.45**

Models used to predict distributions from Table S1b, elevation converted to mean annual temperature (ºC). $N_{P/A}$ = N present / absent in 1967-1973; -2LL is -2 log likelihood ratio of logistic regression model for presence / absence in 1967-1973, using temperature associations in 2004. Significance:*** $P < 0.001$;** $P < 0.01$;* $P < 0.05$; ^{NS} $P > 0.05$.