

Ecography

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Supplementary material

Appendix 1

Fig. A1: Map of survey locations showing site numbers.

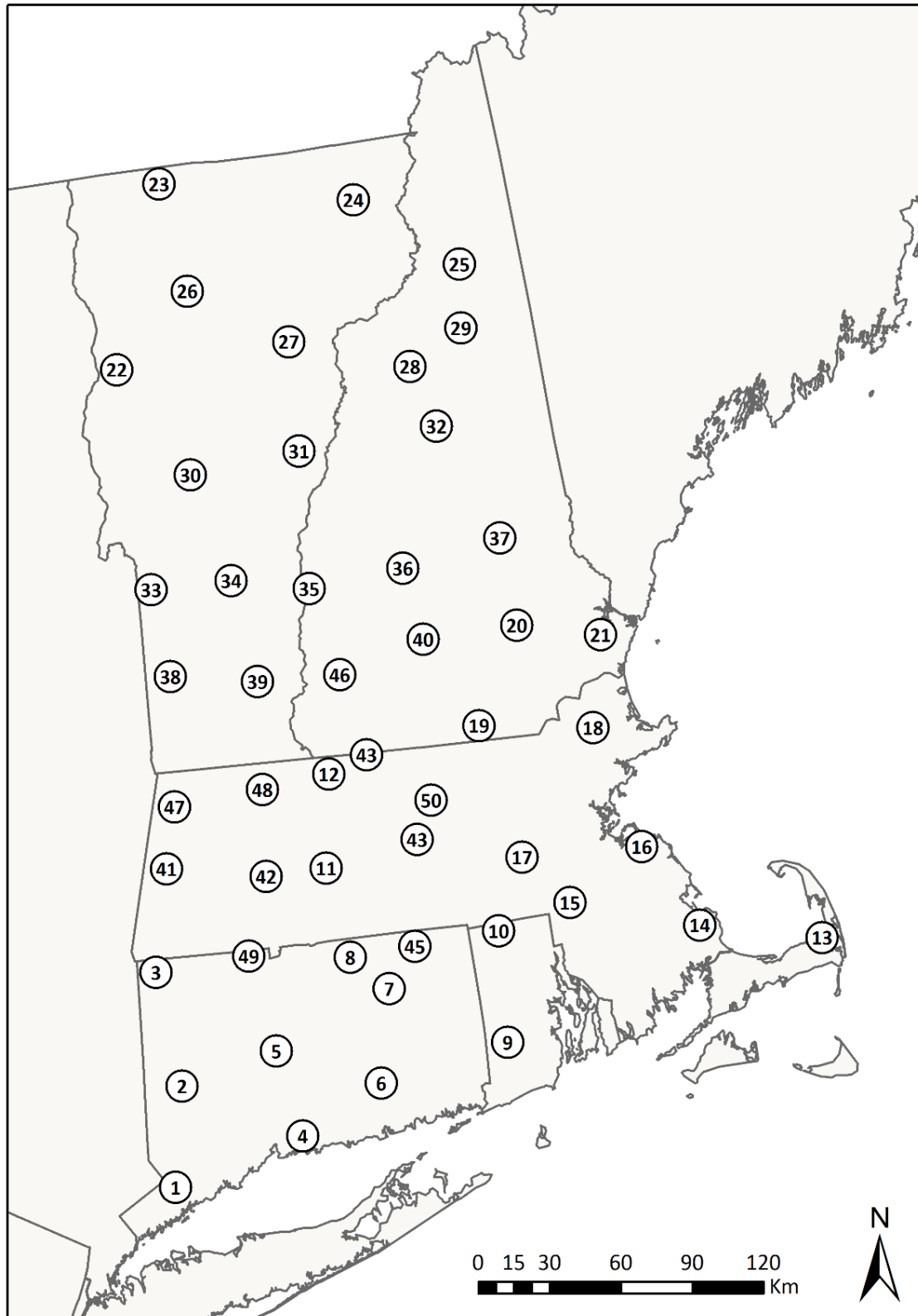


Table A1: *Plethodon cinereus* color morph count data from the 1970s (Lotter and Scott 1977) and 2015 surveys.

Site #	1970s Surveys				2015 Surveys			
	Striped	Unstriped	Erythristic	Amelanistic	Striped	Unstriped	Erythristic	Amelanistic
1	81	19	0	0	72	29	0	0
2	69	31	0	0	81	20	0	0
3	67	33	0	0	64	37	0	0
4	67	33	0	0	74	26	0	0
5	84	16	0	0	65	35	0	0
6	87	13	0	0	87	13	0	0
7	76	33	0	0	81	19	0	0
8	71	29	0	0	81	20	0	0
9	82	18	0	0	98	2	0	0
10	89	11	0	0	85	15	0	0
11	76	24	0	0	72	29	0	0
12	88	12	0	0	101	2	0	0
13	86	14	0	0	92	9	0	0
14	87	13	0	0	81	19	0	0
15	88	9	2	1	91	7	2	0
16	80	18	2	0	86	15	0	0
17	82	18	0	0	75	25	0	0
18	67	33	0	0	58	42	0	0
19	93	7	0	0	87	12	0	1
20	94	6	0	0	99	3	0	0
21	91	9	0	0	94	5	1	0
22	95	5	0	0	97	3	0	0
23	99	1	0	0	100	0	0	0
24	99	1	0	0	98	2	0	0
25	100	0	0	0	100	0	0	0
26	100	0	0	0	127	3	0	0
27	97	0	3	0	100	0	0	0
28	100	0	0	0	100	0	0	0
29	98	0	2	0	101	0	0	0
30	100	0	0	0	100	0	0	0
31	100	0	0	0	101	0	0	0
32	100	0	0	0	101	0	0	0
33	98	2	0	0	99	3	0	0
34	100	0	0	0	100	0	0	0
35	100	0	0	0	99	1	0	0
36	99	1	0	0	106	0	0	0
37	100	0	0	0	100	0	0	0
38	99	0	1	0	98	2	0	0
39	100	0	0	0	102	0	0	0
40	100	0	0	0	98	3	0	0
41	100	0	0	0	95	3	2	0
42	99	1	0	0	106	0	0	0
43	100	0	0	0	100	0	0	0

Site #	1970s Surveys				2015 Surveys			
	Striped	Unstriped	Erythristic	Amelanistic	Striped	Unstriped	Erythristic	Amelanistic
44	100	0	0	0	100	0	0	0
45	96	4	0	0	102	7	0	0
46	87	0	13	0	94	0	10	0
47	112	0	10	0	101	0	0	0
48	111	1	25	0	98	0	7	0
49	92	0	8	0	89	0	11	0
50*	362	2	52	0	102	0	0	0
Totals	4848	417	118	1	4638	411	33	1
%	90.0%	7.7%	2.2%	0.02%	91.2%	8.1%	0.6%	0.02%

* In the 1970s survey, site 50 counts were derived from museum specimens rather than a field survey as in 2015.

Table A2: *Plethodon cinereus* survey locations (2015) and survey dates for 1970s and 2015.

Site #	2015 Site Name	Township	State	Latitude	Longitude	2015 Survey Date	1970 Survey Date
1	Leonard Bradley Park	Wilton	CT	41.1827	-73.4311	9 Oct 2015	Oct 1971
2	Mine Hill Preserve	Roxbury	CT	41.5596	-73.3375	9 Oct 2015	Oct 1971
3	Edith Scoville Memorial Park	Salisbury	CT	42.0006	-73.3980	8 Oct 2015	Oct 1971
4	North Farms Park	North Branford	CT	41.3152	-72.7656	14 May 2015	Apr 1973
5	Sunset Rock	Plainville	CT	41.6470	-72.8424	10 Oct 2015	Oct 1971
6	Devil's Hopyard State Park	East Haddam	CT	41.4743	-72.3400	14-15 May 2015	Apr 1973
7	Univ. Conn. Forest; Fenton River	Mansfield	CT	41.8238	-72.2356	12-13 June 2015; 30 June 2015	Jun 1973
8	Shenipset State Forest	Somers	CT	41.9616	-72.4085	10 Oct 2015	Oct 1971
9	Browning Mill Pond	Exeter	RI	41.5608	-71.6832	15 May 2015	May 1973
10	Black Hut State Management Area	Burrillville	RI	41.9820	-71.6454	16 May 2015	May 1973
11	Mt Holyoke State Park	Amherst	MA	42.3075	-72.4709	16 Sep 2015	Sep 1971
12	Northfield State Forest	Northfield	MA	42.6586	-72.3930	18 May 2015	May 1973
	Northfield Town Forest	Northfield	MA	42.6596	-72.4190		
13	Nickerson State Park	Brewster	MA	41.7690	-70.0311	9-10 June 2015	Jun 1972
14	Myles Standish - Middle	South Carver	MA	41.8897	-70.6321	9-10 June 2015; 6 Aug 2015; 20 Sept 2015	Jun 1972
	Myles Standish - Cranberry Rd	South Carver	MA	41.8395	-70.6907		
	Rocky Gutter WMA	South Carver	MA	41.8527	-70.8428		
15	Norton - Great Woods	Norton	MA	42.0102	-71.2192	6 Aug 2015; 19 Sept 2015	Jul 1973
	Norton - Gilbert Hills	Norton	MA	42.0491	-71.2667		
16	Whitney & Thayer Woods	Cohasset	MA	42.2340	-70.8240	16-17 May 2015	May 1973
	Wompatuck State Park	Hingham	MA	42.2169	-70.8619		
	Scituate Town Forest	Scituate	MA	42.2077	-70.7814		

Site #	2015 Site Name	Township	State	Latitude	Longitude	2015 Survey Date	1970 Survey Date
17	Ashland State Park	Ashland	MA	42.2455	-71.4690	11 Oct 2015	Oct 1971
18	Boxford Wildlife Sanctuary	Boxford	MA	42.6402	-70.9911	5 Aug 2015	Jul 1971
	Wildcat Conservation Area	Boxford	MA	42.6895	-71.0166		
19	Silver Lake State Park	Hollis	NH	42.7600	-71.5996	4-5 Aug 2015	Aug 1971
	Big Dickerman Town Forest	Hollis	NH	42.7829	-71.6061		
20	Bear Brook State Park	Allenstown	NH	43.1149	-71.3255	2 Aug 2015	Aug 1971
21	Stratham Hill Park	Stratham	NH	43.0408	-70.8919	3 Aug 2015	Aug 1973
	Stratham Hill - Elementary	Stratham	NH	43.0286	-70.8815		
22	Mt Philo	Charlotte	VT	44.2779	-73.2138	28-29 Jul 2015	Jul 1971
23	Lake Carmi State Park	Franklin	VT	44.9528	-72.8682	29-30 Jul 2015	Jul 1971
24	Brighton State Park	Brighton	VT	44.7941	-71.8504	30 Jul 2015	Jul 1971
25	White Mt. National Forest	Milan	NH	44.5075	-71.3364	31 Jul 2015	Sep 1971
	Mill Brook Trail - York Pond Rd	Milan	NH	44.4979	-71.3429		
26	Smugglers' Notch	Cambridge	VT	44.5382	-72.7909	11 Jun 2015	Jun 1973
27	Groton State Forest, Nature Trail	Groton	VT	44.2857	-72.2646	28 Jul 2015	Jul 1971
	Groton State Forest, Owls Head	Peacham	VT	44.2980	-72.2952		
28	Franconia Notch	Lincoln	NH	44.1421	-71.6812	11 Jun 2015	Jun 1973
29	Jefferson Notch 1 (Jeff. Notch Rd)	Randolph	NH	44.2579	-71.3824	31 Jul 2015; 1 Aug 2015	Aug 1971
	Jefferson Notch 2 (Mt. Clinton Rd)	Jefferson	NH	44.2300	-71.4065		
30	Green Mt. National Forest	Rutland	VT	43.8483	-72.9003	27 Jul 2015	Aug 1971
31	Podunk Wildlife Mngt Area	Strafford	VT	43.8886	-72.3313	11 Jun 2015	Jun 1973
32	White Mt. National Forest	Gorham	NH	43.9060	-71.5890	1 Aug 2015	Jul 1971
33	Pond Mountain B&B, backyard	Wells	VT	43.4369	-73.1788	25-26 Jul 2015	Aug 1971
34	Okemo State Park	Ludlow	VT	43.4314	-72.7611	27 Jul 2015	Aug 1971

Site #	2015 Site Name	Township	State	Latitude	Longitude	2015 Survey Date	1970 Survey Date
35	Moody Park	Claremont	NH	43.3577	-72.3662	17 Sep 2015	Sep 1971
36	Winslow State Park	Wilmot	NH	43.3897	-71.8660	17 Sep 2015	Sep 1971
37	Thompson Town Forest	Thompson	NH	43.4549	-71.3439	1 Aug 2015	Aug 1971
38	Arlington State Forest	Arlington	VT	43.0209	-73.1851	25 Jul 2015	Aug 1971
	Fisher-Scott Pines Park	Arlington	VT	43.1027	-73.1367		
39	Townshend State Park	Townshend	VT	43.0416	-72.6925	26 Jul 2015	Aug 1971
40	Vincent State Forest	Deering	NH	43.1157	-71.8082	2 Aug 2015	Aug 1971
41	Kennedy Park	Lenox	MA	42.3830	-73.2787	24 Jul 2015	Jul 1971
42	Tob Hill Rd Town parcel	Westhampton	MA	42.3064	-72.7802	16-17 Sept 2015	Sep 1971
43	Lawrence Brook WMA	Royalston	MA	42.7118	-72.1865	18 Sep 2015	Sep 1971
44	Rutland State Park	Rutland	MA	42.3690	-71.9880	19 Sep 2015	Sep 1971
45	Black Pond YMCA	Woodstock	CT	41.9719	-72.0737	13 Jun 2015	Jun 1972
46	Bear Den Geological Park	Gilsum	NH	43.0253	-72.2680	18 May 2015	May 1971
47	Mt. Greylock - Bellows Pipe	Adams	MA	42.6734	-73.1391	19 May 2015	Jul 1971
	Mt. Greylock - Slopes	Adams	MA	42.6121	-73.2001		
	Mt. Greylock - Visitor Center	Adams	MA	42.5536	-73.2122		
48	Catamount State Forest	Colrain	MA	42.6348	-72.7406	19 May 2015	Sep 1971
49	Tunxis State Forest	Hartland	CT	42.0162	-72.9201	12 Jun 2015	Jun 1971
50	Wachusset Mountain	Princeton	MA	42.5079	-71.8926	18 Sep 2015	NA (Museum collection)

Table A3: Polymorphic 2015 sites that had more than one survey location. Striped+Other column includes counts of striped, erythristic, and amelanistic morphs. Includes a test of subsite morph differences (Chi-squared with simulated p-value). Two sites include a Chi-squared test at the same subsite, but in different sampling months. Four other sites with more than one survey location were monomorphic for striped morphs so not included in the analysis (Sites 25, 27, 29 and 47).

Site #	Site Name	Unstriped	Striped+Other	Chi-squared	Simulated p-value
12	Northfield State Forest	0	53	2.162	0.247
	Northfield Town Forest	2	48		
14	Myles Standish - Cranberry Rd	19	71	2.606	0.352
	Myles Standish - Middle	0	6		
	Rocky Gutter WMA	0	4		
15	Norton - Great Woods	2	84	20.618	0.001
	Norton - Gilbert Hills	5	9		
16	Whitney & Thayer Woods	8	46	0.866	0.657
	Wompatuck State Park	2	19		
	Scituate Town Forest	5	21		
19	Silver Lake State Park	10	54	2.212	0.206
	Big Dickerman Town Forest	2	34		
38	Arlington 1	1	42	0.041	1.000
	Arlington 2	1	56		
SITES SAMPLED ACROSS TWO MONTHS:					
14	Myles Standish - Cranberry Rd, June	1	17	3.269	0.112
	Myles Standish - Cranberry Rd, September	18	54		
15	Norton - Great Woods, August	1	9	2.934	0.217
	Norton - Great Woods, September	1	75		

Table A4: Predictor variables averaged over 1962–1971 for Lotter and Scotts 1970s survey and 2005–2014 for our 2015 resurvey.

Predictor	Description	Months Included
Actual evapotranspiration (AET)	The supply component of the climatic water balance; accounts for the concurrent availability of water and energy.	April- November*
Water deficit (DEF)	The unmet demand component of the climatic water balance; accounts for the concurrent availability of water and energy.	April- November*
Mean monthly mean temperature (Tmean0411)	Average monthly mean temperature; calculated from daily mean temperatures.	April- November
Mean monthly maximum temperature (Tmax0411)	Average monthly maximum temperature; calculated from daily maximum temperatures.	April- November
Mean monthly minimum temperature (Tmin0411)	Average monthly minimum temperature; calculated from daily minimum temperatures.	April- November
Growing degree days, 0°C base (GDD)	Average annual sum of degrees above 0°C; calculated from daily mean temperatures.	January- December
Freezing degree days (FDD)	Average annual sum of degrees below 0°C; calculated from daily minimum temperatures.	January- December
Frost free days (FrFD)	Number of days between the last 0°C day in the spring and the first 0°C day in the fall; calculated from daily minimum temperatures.	January- December
Number of days above critical thermal max (CTmax)	Number of days where maximum temperature is above <i>Plethodon cinereus</i> critical thermal max ($> 32^{\circ}\text{C}$)†.	January- December

* Current water balance data are a six-year average of 2005–2010.

† Spotila JR (1972) Role of temperature and water in the ecology of lungless salamanders. *Ecological Monographs*, **42**, 95-125.

Table A5: Candidate model sets ordered by log-likelihood values (lnL, best models at top) for 1970 and 2015. Grey shading indicates candidate models that included variables correlated above |0.7|. These were included to allow all models to be compared between time periods. See Supplementary materials Appendix 1, Table A4 for the full name of each abbreviated climate variable.

Model	1970 lnL	Model	2015 lnL
AET + CTmax + FDD	-240.25	Tmax0411	-236.69
AET + FDD	-252.07	CTmax + Tmean0411	-237.40
AET + Tmean0411	-253.29	Tmean0411	-238.62
AET + GDD	-257.45	CTmax + Tmax0411	-246.36
AET + CTmax + Tmean0411	-261.71	CTmax + GDD	-246.44
AET + CTmax + GDD	-263.15	AET + CTmax + Tmean0411	-253.58
Tmean0411	-266.92	AET + Tmean0411	-254.32
Tmax0411	-268.47	GDD	-254.70
CTmax + Tmean0411	-272.49	CTmax + FDD	-261.83
CTmax + Tmax0411	-272.69	AET + CTmax + GDD	-262.05
AET + DEF	-278.05	AET + CTmax + FDD	-265.99
GDD	-279.49	AET + CTmax + DEF	-266.53
CTmax + GDD	-282.57	AET + GDD	-267.59
AET + CTmax + Tmin0411	-284.25	CTmax + Tmin0411	-271.77
AET + CTmax + DEF	-285.97	AET + DEF	-276.18
AET + CTmax + FrFD	-292.77	CTmax + DEF	-276.64
CTmax + FDD	-303.61	AET + CTmax + Tmin0411	-279.09
AET + Tmin0411	-305.72	AET + CTmax + FrFD	-285.36
AET + FrFD	-320.16	AET + FDD	-288.03
FDD	-325.99	CTmax + FrFD	-301.88
CTmax + Tmin0411	-363.72	AET + Tmin0411	-308.48
AET	-389.87	FDD	-308.68
AET + CTmax	-391.75	AET + FrFD	-316.54
DEF	-395.62	DEF	-320.47
CTmax + FrFD	-404.23	AET + CTmax	-332.65
Tmin0411	-407.08	Tmin0411	-333.50
CTmax + DEF	-413.25	AET	-363.00
FrFD	-462.68	CTmax	-366.83
CTmax	-485.72	FrFD	-415.48

Table A6: Candidate change models ordered by change in DIC values. See Supplementary materials Appendix 1, Table A4 for the full name of each abbreviated climate variable.

Model	DIC	delta DIC	weight
null model	-288.2	0.0	0.3
CTmax	-285.4	2.8	0.1
Tmean0411	-285.2	3.0	0.1
GDD	-285.2	3.0	0.1
AET	-285.1	3.2	0.1
Tmax0411	-284.9	3.3	0.1
Tmin0411	-284.9	3.3	0.1
DEF	-284.7	3.5	0.1
FDD	-284.5	3.7	0.0
FrFD	-283.7	4.5	0.0
DEF + CTmax	-282.3	6.0	0.0
CTmax + Tmax0411	-282.0	6.2	0.0
AET + Tmean0411	-281.9	6.3	0.0
AET + Tmax0411	-281.8	6.4	0.0
DEF + GDD	-281.7	6.5	0.0
AET + Tmin0411	-281.7	6.6	0.0
DEF + Tmean0411	-281.6	6.6	0.0
Tmax0411 + Tmin0411	-281.6	6.6	0.0
FDD + Tmean0411	-281.6	6.7	0.0
CTmax + FDD	-281.4	6.8	0.0
DEF + Tmin0411	-281.4	6.9	0.0
DEF + FDD	-281.3	6.9	0.0
FDD + Tmax0411	-281.2	7.0	0.0
FDD + Tmin0411	-281.1	7.1	0.0
FrFD + GDD	-280.7	7.6	0.0
CTmax + rFFD	-280.6	7.6	0.0
FrFD + Tmean0411	-280.5	7.7	0.0
AET + FrFD	-280.4	7.9	0.0
FrFD + Tmin0411	-280.3	8.0	0.0
FDD + FrFD	-279.9	8.3	0.0
DEF + CTmax + FDD	-278.6	9.6	0.0
AET + Tmax0411 + Tmin0411	-278.3	9.9	0.0
DEF + FDD + Tmin0411	-278.1	10.1	0.0
DEF + FDD + Tmean0411	-278.0	10.3	0.0
CTmax + FDD + Tmax0411	-277.9	10.3	0.0
AET + FrFD + Tmean0411	-277.1	11.1	0.0
AET + FrFD + Tmin0411	-276.9	11.3	0.0
FDD + FrFD + Tmean0411	-276.9	11.4	0.0
CTmax + FDD + FrFD	-276.5	11.7	0.0
FDD + FrFD + Tmin0411	-276.3	11.9	0.0
global model	-109.2	179.1	0.0

Table A7: Observed and predicted unstriped morph frequencies (unstriped morph percent with 95% credible intervals) for the 1970s survey.

Site	Observed: 1970	Predicted: 1970 model predicting 1970 data	Predicted: 2015 model predicting 1970 data
1	19	36 (22--48)	17 (10-25)
2	31	28 (17-40)	13 (8-19)
3	33	15 (6-25)	6 (4-10)
4	33	27 (16-40)	12 (7-17)
5	16	23 (13-34)	9 (6-14)
6	13	26 (14-39)	7 (4-10)
7	30	15 (9-22)	8 (5-12)
8	29	8 (4-13)	4 (2-6)
9	18	26 (13-41)	4 (2-7)
10	11	16 (11-23)	8 (5-12)
11	24	10 (5-16)	8 (5-12)
12	12	3 (1-5)	2 (1-3)
13	14	22 (4-44)	1 (0-2)
14	13	11 (3-22)	4 (2-7)
15	9	21 (13-29)	10 (6-14)
16	18	30 (17-44)	7 (5-11)
17	18	27 (14-41)	12 (7-17)
18	33	16 (6-29)	7 (4-10)
19	7	11 (3-21)	9 (5-13)
20	6	7 (4-11)	3 (2-6)
21	9	12 (4-22)	5 (3-7)
22	5	2 (0-3)	1 (0-3)
23	1	0 (0-0)	0 (0-1)
24	1	0 (0-0)	0 (0-0)
25	0	0 (0-0)	0 (0-0)
26	0	0 (0-0)	0 (0-0)
27	0	0 (0-0)	0 (0-0)
28	0	0 (0-0)	0 (0-0)
29	0	0 (0-0)	0 (0-0)
30	0	0 (0-1)	0 (0-1)
31	0	0 (0-0)	0 (0-0)
32	0	0 (0-1)	0 (0-1)
33	2	2 (0-3)	1 (0-2)
34	0	0 (0-1)	0 (0-1)
35	0	2 (1-3)	3 (2-5)
36	1	1 (0-2)	0 (0-0)
37	0	2 (1-4)	2 (1-3)
38	0	4 (2-8)	4 (2-7)
39	0	9 (2-17)	7 (4-10)
40	0	1 (0-3)	1 (0-2)

Site	Observed: 1970	Predicted: 1970 model predicting 1970 data	Predicted: 2015 model predicting 1970 data
41	0	2 (1-4)	2 (1-3)
42	1	4 (2-7)	3 (1-5)
43	0	2 (1-3)	2 (1-4)
44	0	6 (3-8)	3 (2-5)
45	4	11 (6-18)	3 (2-6)
46	0	1 (0-2)	1 (0-2)
47	0	0 (0-1)	0 (0-1)
48	1	5 (2-8)	5 (3-8)
49	0	6 (2-10)	2 (1-3)
50	0	3 (1-5)	3 (1-5)

Table A8: Observed and predicted unstriped morph frequencies (unstriped morph percent with 95% credible intervals) for the 2015 survey.

Site	Observed: 2015	Predicted: 2015 model predicting 2015 data	Predicted: 1970 model predicting 2015 data
1	29	34 (20–48)	88 (70–99)
2	20	29 (17–41)	82 (58–99)
3	37	14 (9–21)	62 (32–88)
4	26	26 (15–36)	78 (59–95)
5	35	21 (12–30)	66 (43–88)
6	13	15 (9–22)	70 (45–92)
7	19	16 (10–23)	54 (33–76)
8	20	8 (5–12)	41 (20–62)
9	2	12 (7–17)	70 (45–92)
10	15	17 (10–25)	65 (42–88)
11	29	16 (10–23)	56 (29–83)
12	2	3 (2–5)	24 (8–42)
13	9	4 (2–6)	58 (34–82)
14	19	12 (7–17)	57 (37–75)
15	7	23 (14–33)	78 (55–98)
16	15	17 (10–24)	85 (66–99)
17	25	24 (14–34)	82 (55–100)
18	42	14 (9–20)	71 (46–94)
19	12	16 (10–22)	56 (24–87)
20	3	7 (4–10)	41 (19–62)
21	5	9 (5–13)	61 (33–87)
22	3	4 (2–7)	19 (5–36)
23	0	2 (1–3)	3 (1–6)
24	2	0 (0–1)	0 (0–1)
25	0	0 (0–1)	0 (0–0)
26	2	0 (0–0)	0 (0–1)
27	0	0 (0–1)	1 (0–1)
28	0	0 (0–0)	1 (0–1)
29	0	0 (0–0)	0 (0–0)
30	0	1 (0–2)	3 (1–5)
31	0	0 (0–1)	1 (0–2)
32	0	1 (0–2)	3 (1–6)
33	3	2 (1–3)	18 (2–39)
34	0	1 (0–2)	3 (1–7)
35	1	7 (4–10)	21 (7–38)
36	0	0 (0–1)	3 (1–6)
37	0	3 (1–5)	18 (8–30)
38	2	9 (5–13)	25 (10–42)
39	0	12 (7–17)	43 (16–73)
40	3	2 (1–4)	8 (4–11)

Site	Observed: 2015	Predicted: 2015 model predicting 2015 data	Predicted: 1970 model predicting 2015 data
41	3	4 (2-6)	16 (7-27)
42	0	7 (4-11)	38 (16-59)
43	0	4 (2-7)	19 (8-29)
44	0	6 (4-10)	36 (19-56)
45	6	7 (4-11)	43 (22-65)
46	0	2 (1-4)	7 (3-11)
47	0	1 (0-2)	3 (1-4)
48	0	11 (7-15)	44 (19-68)
49	0	5 (3-7)	37 (14-60)
50	0	5 (3-8)	25 (14-37)