Ecography

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Ridding, L. E., Newton, A. C., Keith, S. A., Walls, R. M., Diaz, A., Pywell, R. F. and Bullock, J. M. 2020. Inconsistent detection of extinction debts using different methods. – Ecography doi: 10.1111/ecog.05344

Supplementary material

Appendix 1

We tested for extinction debt using additional time periods (1950 and 1980) for the Past Habitat method. To determine the habitat patch area for heathland in 1950 rather than using the 1950 landscape map produced by Ridding et al. (2020b.), which remained largely unchanged since the 1930s, despite the fact that a considerable area of heathland was lost during this period (Ridding et al. 2020a), we manually digitised heathland areas from a historical maps series, OS Great Britain 1:25,000, 1937-1961 (Ordnance Survey 1961).

No extinction debt was evident for woodland in any of the time periods using the Past Habitat method, since the ΔAICc < 2 for each of the species groups (Table A1a). The same pattern was identified for the two specialist groups for heathland, however for all species the 1930 habitat area for heathland explained the contemporary species richness better than the habitat area in 1950, 1980 or 2015, with AICc increasing with time, which therefore suggests an extinction debt. For calcareous grassland, the 1930 habitat area remained the time period which explained contemporary species richness the best, thus an extinction debt is evident for this habitat. The support for the model did not necessarily increase with time for strict habitat specialists, whereas for habitat specialists and all species there was no difference between the models in 1950, 1980 and 2015.

It was also possible to analyse 1950 as another time point for the Stable Habitats method. We did this only for calcareous grassland, since dividing heathland and woodland into stable and unstable patches for 1950 produced greatly unbalanced sample sizes, which were unsuitable for analysis. Calcareous grassland was divided into 30 stable and 36 unstable sites, with an average of 46% and 11% retained respectively, between 1950 and 2015. Strict habitat specialists did not reveal an extinction debt, whilst the results for habitat specialists and all species was less clear (Table A1b). The past model (where the past habitat area is used as a predictor) indicated there was no evidence of an extinction debt, whilst the current model (based on contemporary area as a predictor) suggested there was. Helm et al. (2006) stated that the two models bracket the magnitude of the extinction debt, where the model based on past landscape structure probably gives an overestimate of extinction debt, whilst the model based on the contemporary landscape probably gives an underestimate.

References:

Helm, A. et al. 2006. Slow response of plant species richness to habitat loss and fragmentation. - Ecol. Lett. 9: 72–77

Ordnance Survey. 1961. Ordnance Survey Great Britain 1:25,000, 1937-1961. Using: National Library of Scotland <http://maps.nls.uk/index.html>, Downloaded October 2017.

Ridding, L.E. et al. 2020a. Ongoing, but slowing, habitat loss in a rural landscape over 85 years. *Landsc. Ecol*., 35, 257–273.

Ridding, L. E. et al. 2020b. Modelling historical landscape changes. - Landsc. Ecol.

Table A1a Extinction debt evaluated using the "Past Habitat" method for calcareous grassland, heathland and broadleaved woodland sites, for the three species groups (strict habitat specialist, habitat specialist and all species) between 1930 and 2015 in Dorset. The exponentiated coefficient and standard error along with the p-value for the patch variable, AICc and R^2 values are presented for each regression model.

	Species groups	Year	Coefficient	SE	P	AICc	R^2
Calcareous grassland	Strict habitat specialist	1930	1.29	1.07	<0.001	544.22	0.044
	Strict habitat specialist	1950	1.01	1.05	0.895	558.67	0.018
	Strict habitat specialist	1980	1.06	1.03	0.031	553.91	0.027
	Strict habitat specialist	2015	1.05	1.04	0.183	556.90	0.022
	Habitat specialist	1930	1.25	1.05	<0.001	661.87	0.047
	Habitat specialist	1950	1.02	1.03	0.548	682.45	0.017
	Habitat specialist	1980	1.03	1.02	0.185	681.04	0.019
	Habitat specialist	2015	1.01	1.03	0.662	682.62	0.017
	All species	1930	1.08	1.03	0.029	709.16	0.025
	All species	1950	0.98	1.02	0.335	713.10	0.019
	All species	1980	0.98	1.01	0.081	711.01	0.022
	All species	2015	0.98	1.02	0.312	713.00	0.019
Heathland	Strict habitat specialist	1930	1.34	1.26	0.204	183.31	0.120
	Strict habitat specialist	1950	1.35	1.22	0.135	182.64	0.123
	Strict habitat specialist	1980	1.29	1.16	0.081	181.78	0.127
	Strict habitat specialist	2015	1.28	1.15	0.080	181.77	0.127
	Habitat specialist	1930	1.29	1.16	0.081	259.29	0.153
	Habitat specialist	1950	1.30	1.14	0.043	258.08	0.157
	Habitat specialist	1980	1.23	1.10	0.025	257.12	0.160
	Habitat specialist	2015	1.23	1.09	0.025	257.13	0.160
	All species	1930	1.30	1.07	<0.001	561.23	0.036
	All species	1950	1.21	1.05	<0.001	565.75	0.029
	All species	1980	0.99	1.04	0.884	579.22	0.005
	All species	2015	1.00	1.03	0.927	579.24	0.005
Broadleaved woodland	Strict habitat specialist	1930	0.98	1.04	0.628	485.95	0.017
	Strict habitat specialist	1950	0.98	1.04	0.558	485.55	0.018
	Strict habitat specialist	1980	0.97	1.04	0.406	485.85	0.018
	Strict habitat specialist	2015	0.96	1.04	0.361	485.36	0.019
	Habitat specialist	1930	0.96	1.02	0.054	626.85	0.021
	Habitat specialist	1950	0.95	1.02	0.031	625.90	0.023
	Habitat specialist	1980	0.94	1.03	0.025	625.56	0.023
	Habitat specialist	2015	0.94	1.03	0.018	625.90	0.024
	All species	1930	0.94	1.01	0.001	780.09	0.102
	All species	1950	0.93	1.02	<0.001	777.49	0.105
	All species	1980	0.93	1.02	<0.001	777.28	0.106
	All species	2015	0.92	1.02	<0.001	777.28	0.107

Table A1b Extinction debt evaluated using the "Stable Habitats" method for calcareous grassland between 1950 and 2015, for the three species groups (strict habitat specialist, habitat specialist and all species) in Dorset. The exponentiated coefficient and standard error, and R^2 values are presented for each regression model. Extinction debt is calculated as the difference between the numbers of predicted and observed plant species, alongside the range and the p-value resulting from a Wilcoxon test comparing the two. Those in bold reveal where an extinction debt is suggested.

Species groups	Model	Coefficient	SE	R^2	Extinction debt		
Strict habitat specialist	Current	1.25	1.11	0.034	2.09	(-10.22 ~ 18.79)	0.074
Strict habitat specialist	Past	1.02	1.06	0.016	-1.48	(-13.72 ~ 13.78)	0.181
Habitat specialist	Current	**1.22**	**1.08**	**0.042**	**5.23**	**(-15.66 ~ 30.82)**	**0.006**
Habitat specialist	Past	1.03	1.04	0.020	0.66	(-19.21 ~ 24.38)	0.625
All species	Current	**1.06**	**1.05**	**0.044**	**5.81**	**(-32.21 ~ 40.94)**	**0.018**
All species	Past	0.98	1.03	0.040	0.90	(-35.83 ~ 32.31)	0.499

Appendix 2

The division of stable and unstable habitats using the "Stable Habitats" method produced very unbalanced sample sizes when employing a threshold of 20% for heathland and broadleaved woodland. For calcareous grassland this resulted in 30 stable habitats and 36 unstable habitats. Extinction debts were identified for all three species groups within calcareous grassland, whereby the observed plant species richness values were significantly higher than predicted (Table A2).

Table A2 Extinction debt evaluated using the "Stable Habitats" method with a 0.2 threshold for calcareous grassland for the three species groups (strict habitat specialist, habitat specialist and all species) between 1930 and 2015 in Dorset. Model indicates whether past or current patch area was used to predict contemporary species richness. The exponentiated coefficient and standard error, and R^2 values are presented for each regression model. Extinction debt is calculated as the difference between the numbers of predicted and observed plant species, alongside the range and the p-value resulting from a Wilcoxon test comparing the two. Those in bold reveal where an extinction debt is suggested.

Species groups	Model	Coefficient	SE	R^2	Extinction debt		
Strict habitat specialist	Current	**1.63**	**1.14**	**0.073**	**5.33**	**(-7.04 ~ 22.20)**	**<0.001**
Strict habitat specialist	Past	**1.69**	**1.12**	**0.114**	**7.87**	**(-4.23 ~ 23.90)**	**<0.001**
Habitat specialist	Current	**1.54**	**1.10**	**0.086**	**10.32**	**(-11.64 ~ 36.37)**	**<0.001**
Habitat specialist	Past	**1.61**	**1.09**	**0.144**	**14.96**	**(-6.47 ~ 39.74)**	**<0.001**
All species	Current	**1.21**	**1.06**	**0.062**	**13.37**	**(-26.94 ~ 52.30)**	**<0.001**
All species	Past	**1.24**	**1.05**	**0.094**	**20.20**	**(-19.92 ~ 58.24)**	**<0.001**