The following supplement accompanies the article

Assessing the vulnerability of the marine bird community in the western North Sea to climate change and other anthropogenic impacts

Sarah J. Burthe[1,*], Sarah Wanless[1], Mark A. Newell[1], Adam Butler[2], Francis Daunt[1]

[1]Centre for Ecology & Hydrology, Bush Estate, Penicuik, Midlothian EH26 0QB, UK
[2]Biomathematics and Statistics Scotland, The Kings Buildings, Edinburgh EH9 3JZ, UK

*Corresponding author: sburthe@ceh.ac.uk

Marine Ecology Progress Series 507: 277–295 (2014)

Supplement. Additional tables providing information on the bird community (Table S1), quantitative analyses (Tables S2–S4), trend models (Tables S5–S7) and vulnerability assessments (Tables S8–S10)

Table S1. Species comprising the marine bird community of the study area with their status in the Birds Directive. Seven species (marked with an asterisk) were not or only rarely present in the Forth Tay study region, had insufficient data for analysis and are not discussed in the main paper. Due to there being insufficient data for the one species representing the Scolopacidae family, analysis in the main paper focused on 11 of the 12 families utilising the study area.

Species	Species group	Status
Red-throated diver *Gavia stellata*	Diver	Annex I
Black-throated diver *Gavia arctica*	Diver	Annex I
Great northern diver *Gavia immer*	Diver	Annex I
Great crested grebe *Podiceps cristatus*	Grebe	Migratory
Red-necked grebe *Podiceps grisegena*	Grebe	Migratory
Slavonian grebe *Podiceps auritus*	Grebe	Annex I
Black-necked grebe *Podiceps nigricollis*	Grebe	Migratory
Northern fulmar *Fulmarus glacialis*	Fulmar	Migratory
Cory's shearwater *Calonectris diomede**	Shearwater	Annex I
Great shearwater *Puffinus gravis**	Shearwater	Migratory
Sooty shearwater *Puffinus griseus*	Shearwater	Migratory
Manx shearwater *Puffinus puffinus*	Shearwater	Migratory
Balearic shearwater *Puffinus mauretanicus**	Shearwater	Annex I
European storm-petrel *Hydrobates pelagicus*	Storm-petrel	Annex I
Leach's storm-petrel *Oceanodroma leucorhoa*	Storm-petrel	Annex I
Northern gannet *Morus bassanus*	Gannet	Migratory
Great cormorant *Phalacrocorax carbo*	Cormorant	Migratory
European shag *Phalacrocorax aristotelis*	Cormorant	Migratory
Greater scaup *Aythya marila*	Sea duck	Migratory
Common eider *Somateria mollissima*	Sea duck	Migratory
Long-tailed duck *Clangula hyemalis*	Sea duck	Migratory
Black scoter *Melanitta nigra*	Sea duck	Migratory
Surf scoter *Melanitta perspicillata*	Sea duck	Migratory
Velvet scoter *Melanitta fusca*	Sea duck	Migratory
Common goldeneye *Bucephala clangula*	Sea duck	Migratory
Red-breasted merganser *Mergus serrator*	Sea duck	Migratory
Goosander *Mergus merganser*	Sea duck	Migratory
Red-necked phalarope *Phalaropus lobatus**	Phalarope	Annex I
Pomarine skua *Stercorarius pomarinus*	Skua	Migratory
Arctic skua *Stercorarius parasiticus*	Skua	Migratory
Long-tailed skua *Stercorarius longicaudus*	Skua	Migratory
Great skua *Stercorarius skua*	Skua	Migratory
Mediterranean gull *Ichthyaetus melanocephalus*	Gull	Annex I
Little gull *Hydrocoloeus minutus*	Gull	Migratory
Sabine's gull *Xema sabini**	Gull	Migratory

Black-headed gull *Chroicocephalus ridibundus*	Gull	Migratory
Common gull *Larus canus*	Gull	Migratory
Lesser black-backed gull *Larus fuscus*	Gull	Migratory
Herring gull *Larus argentatus*	Gull	Migratory
Iceland gull *Larus glaucoides**	Gull	Migratory
Glaucous gull *Larus hyperboreus**	Gull	Migratory
Great black-backed gull *Larus marinus*	Gull	Migratory
Black-legged kittiwake *Rissa tridactyla*	Gull	Migratory
Sandwich tern *Sterna sandvicensis*	Tern	Annex I
Roseate tern *Sterna dougallii*	Tern	Annex I
Common tern *Sterna hirundo*	Tern	Annex I
Arctic tern *Sterna paradisaea*	Tern	Annex I
Little tern *Sternula albifrons*	Tern	Annex I
Common guillemot *Uria aalge*	Auk	Migratory
Razorbill *Alca torda*	Auk	Migratory
Little auk *Alle alle*	Auk	Migratory
Atlantic puffin *Fratercula arctica*	Auk	Migratory

SUMMARY TABLES FROM QUANTITATIVE ANALYSIS

Table S2. Relationships between bird count estimates (data from European Seabirds at Sea [ESAS], Seabird Monitoring Programme [SMP] and Wetlands Bird Survey [WeBS]) and sea surface temperature (SST). All models were fitted with temporal autocorrelation accounted for

Data source	Species	Climate term	Climate est	Climate SE	DF	*t*	p
SMP	Arctic tern	annual SST	0.029	0.077	91	0.373	0.710
SMP	Arctic tern	winter SST	0.042	0.050	91	0.837	0.405
SMP	Arctic tern	spring SST	0.073	0.045	91	1.613	0.110
SMP	Arctic tern	summer SST	0.010	0.038	91	0.262	0.794
SMP	Arctic tern	autumn SST	–0.138	0.053	91	–2.593	0.011
SMP	Arctic tern	annual SST lag 1	–0.072	0.082	93	–0.883	0.380
SMP	Arctic tern	winter SST lag 1	–0.108	0.058	93	–1.871	0.065
SMP	Arctic tern	spring SST lag 1	–0.116	0.051	93	–2.257	0.026
SMP	Arctic tern	summer SST lag 1	0.030	0.041	93	0.726	0.470
SMP	Arctic tern	autumn SST lag 1	0.054	0.056	93	0.960	0.340
SMP	Arctic tern	annual SST lag 2	–0.036	0.081	93	–0.448	0.656
SMP	Arctic tern	winter SST lag 2	0.060	0.053	93	1.130	0.262
SMP	Arctic tern	spring SST lag 2	0.030	0.047	93	0.640	0.524
SMP	Arctic tern	summer SST lag 2	–0.040	0.041	93	–0.976	0.332
SMP	Arctic tern	autumn SST lag 2	–0.029	0.058	93	–0.503	0.616
WeBS	Arctic tern summer	annual SST	0.484	0.512	24	0.946	0.354
WeBS	Arctic tern summer	winter SST	0.251	0.475	24	0.529	0.602
WeBS	Arctic tern summer	spring SST	0.300	0.354	24	0.849	0.404
WeBS	Arctic tern summer	summer SST	0.143	0.327	24	0.439	0.665
WeBS	Arctic tern summer	autumn SST	0.253	0.381	24	0.664	0.513
WeBS	Arctic tern summer	annual SST lag 1	–0.176	0.494	25	–0.357	0.724
WeBS	Arctic tern summer	winter SST lag 1	–0.033	0.410	25	–0.080	0.937
WeBS	Arctic tern summer	spring SST lag 1	–0.223	0.299	25	–0.746	0.463
WeBS	Arctic tern summer	summer SST lag 1	–0.235	0.342	25	–0.688	0.498
WeBS	Arctic tern summer	autumn SST lag 1	0.270	0.399	25	0.676	0.506
WeBS	Arctic tern summer	annual SST lag 2	–0.362	0.410	25	–0.883	0.386
WeBS	Arctic tern summer	winter SST lag 2	–0.076	0.366	25	–0.207	0.838
WeBS	Arctic tern summer	spring SST lag 2	–0.082	0.295	25	–0.278	0.783
WeBS	Arctic tern summer	summer SST lag 2	–0.214	0.307	25	–0.698	0.491
WeBS	Arctic tern summer	autumn SST lag 2	–0.527	0.338	25	–1.562	0.131
SMP	Atlantic puffin	annual SST	0.275	0.172	51	1.597	0.116
SMP	Atlantic puffin	winter SST	0.077	0.141	51	0.543	0.589
SMP	Atlantic puffin	spring SST	0.108	0.114	51	0.946	0.349
SMP	Atlantic puffin	summer SST	0.202	0.105	51	1.913	0.061
SMP	Atlantic puffin	autumn SST	0.068	0.121	51	0.556	0.580
SMP	Atlantic puffin	annual SST lag 1	0.238	0.174	54	1.366	0.178
SMP	Atlantic puffin	winter SST lag 1	0.000	0.140	54	0.002	0.999

SMP	Atlantic puffin	spring SST lag 1	0.102	0.093	54	1.093	0.279
SMP	Atlantic puffin	summer SST lag 1	0.118	0.116	54	1.017	0.314
SMP	Atlantic puffin	autumn SST lag 1	0.120	0.125	54	0.957	0.343
SMP	Atlantic puffin	annual SST lag 2	–0.003	0.202	55	–0.014	0.989
SMP	Atlantic puffin	winter SST lag 2	–0.251	0.149	55	–1.686	0.097
SMP	Atlantic puffin	spring SST lag 2	0.064	0.109	55	0.592	0.556
SMP	Atlantic puffin	summer SST lag 2	0.066	0.126	55	0.520	0.606
SMP	Atlantic puffin	autumn SST lag 2	–0.025	0.130	55	–0.190	0.850
WeBS	Black scoter winter	annual SST	–0.190	0.232	26	–0.819	0.420
WeBS	Black scoter winter	winter SST	–0.021	0.268	26	–0.078	0.939
WeBS	Black scoter winter	spring SST	–0.348	0.157	26	–2.220	0.035
WeBS	Black scoter winter	summer SST	–0.126	0.184	26	–0.683	0.501
WeBS	Black scoter winter	autumn SST	–0.064	0.204	26	–0.313	0.757
WeBS	Black scoter winter	annual SST lag 1	–0.449	0.243	26	–1.844	0.077
WeBS	Black scoter winter	winter SST lag 1	–0.633	0.193	26	–3.275	0.003
WeBS	Black scoter winter	spring SST lag 1	–0.421	0.151	26	–2.783	0.010
WeBS	Black scoter winter	summer SST lag 1	–0.148	0.225	26	–0.661	0.515
WeBS	Black scoter winter	autumn SST lag 1	–0.112	0.236	26	–0.474	0.639
WeBS	Black scoter winter	annual SST lag 2	–0.790	0.226	27	–3.487	0.002
WeBS	Black scoter winter	winter SST lag 2	–0.471	0.209	27	–2.255	0.032
WeBS	Black scoter winter	spring SST lag 2	–0.271	0.197	27	–1.378	0.179
WeBS	Black scoter winter	summer SST lag 2	–0.750	0.195	27	–3.851	0.001
WeBS	Black scoter winter	autumn SST lag 2	–0.721	0.172	27	–4.201	0.000
SMP	Black-headed gull	annual SST	0.356	0.245	22	1.453	0.160
SMP	Black-headed gull	winter SST	0.101	0.166	22	0.611	0.548
SMP	Black-headed gull	spring SST	0.053	0.142	22	0.372	0.714
SMP	Black-headed gull	summer SST	0.178	0.129	22	1.380	0.181
SMP	Black-headed gull	autumn SST	0.144	0.174	22	0.826	0.418
SMP	Black-headed gull	annual SST lag 1	0.623	0.216	23	2.882	0.008
SMP	Black-headed gull	winter SST lag 1	0.295	0.144	23	2.055	0.051
SMP	Black-headed gull	spring SST lag 1	0.288	0.126	23	2.294	0.031
SMP	Black-headed gull	summer SST lag 1	0.127	0.124	23	1.031	0.313
SMP	Black-headed gull	autumn SST lag 1	0.175	0.162	23	1.078	0.292
SMP	Black-headed gull	annual SST lag 2	0.259	0.221	24	1.176	0.251
SMP	Black-headed gull	winter SST lag 2	–0.066	0.134	24	–0.492	0.627
SMP	Black-headed gull	spring SST lag 2	–0.070	0.108	24	–0.645	0.525
SMP	Black-headed gull	summer SST lag 2	0.153	0.111	24	1.377	0.181
SMP	Black-headed gull	autumn SST lag 2	0.268	0.144	24	1.860	0.075
SMP	Black-legged kittiwake	annual SST	0.109	0.048	186	2.268	0.025
SMP	Black-legged kittiwake	winter SST	0.062	0.050	186	1.245	0.215
SMP	Black-legged kittiwake	spring SST	0.083	0.042	186	1.974	0.050
SMP	Black-legged kittiwake	summer SST	0.030	0.025	186	1.216	0.226
SMP	Black-legged kittiwake	autumn SST	–0.002	0.051	186	–0.047	0.963
SMP	Black-legged kittiwake	annual SST lag 1	–0.016	0.069	195	–0.231	0.818
SMP	Black-legged kittiwake	winter SST lag 1	–0.028	0.046	195	–0.604	0.546
SMP	Black-legged kittiwake	spring SST lag 1	–0.091	0.023	195	–3.923	0.000
SMP	Black-legged kittiwake	summer SST lag 1	0.018	0.036	195	0.503	0.615
SMP	Black-legged kittiwake	autumn SST lag 1	0.082	0.030	195	2.732	0.007
SMP	Black-legged kittiwake	annual SST lag 2	–0.071	0.069	204	–1.019	0.309
SMP	Black-legged kittiwake	winter SST lag 2	0.023	0.029	204	0.801	0.424
SMP	Black-legged kittiwake	spring SST lag 2	–0.001	0.038	204	–0.016	0.988
SMP	Black-legged kittiwake	summer SST lag 2	–0.055	0.036	204	–1.526	0.128
SMP	Black-legged kittiwake	autumn SST lag 2	–0.038	0.030	204	–1.274	0.204
ESAS	Black-legged kittiwake summer	annual SST	0.391	0.229	25	1.708	0.100
ESAS	Black-legged kittiwake summer	winter SST	–0.078	0.204	25	–0.381	0.707
ESAS	Black-legged kittiwake summer	spring SST	–0.017	0.208	25	–0.082	0.936
ESAS	Black-legged kittiwake summer	summer SST	0.321	0.140	25	2.293	0.031
ESAS	Black-legged kittiwake summer	autumn SST	0.357	0.194	25	1.839	0.078
ESAS	Black-legged kittiwake summer	annual SST lag 1	0.030	0.252	25	0.119	0.906
ESAS	Black-legged kittiwake summer	winter SST lag 1	–0.307	0.234	25	–1.311	0.202
ESAS	Black-legged kittiwake summer	spring SST lag 1	–0.049	0.188	25	–0.258	0.798
ESAS	Black-legged kittiwake summer	summer SST lag 1	0.143	0.156	25	0.918	0.368
ESAS	Black-legged kittiwake summer	autumn SST lag 1	0.108	0.210	25	0.516	0.611
ESAS	Black-legged kittiwake summer	annual SST lag 2	0.164	0.311	24	0.529	0.602

ESAS	Black-legged kittiwake summer	winter SST lag 2	0.132	0.235	24	0.562	0.580
ESAS	Black-legged kittiwake summer	spring SST lag 2	0.208	0.247	24	0.843	0.407
ESAS	Black-legged kittiwake summer	summer SST lag 2	0.203	0.197	24	1.032	0.312
ESAS	Black-legged kittiwake summer	autumn SST lag 2	–0.122	0.246	24	–0.496	0.625
ESAS	Black-legged kittiwake winter	annual SST	–0.469	0.349	19	–1.342	0.195
ESAS	Black-legged kittiwake winter	winter SST	–0.291	0.260	19	–1.119	0.277
ESAS	Black-legged kittiwake winter	spring SST	–0.255	0.230	19	–1.109	0.281
ESAS	Black-legged kittiwake winter	summer SST	–0.218	0.265	19	–0.824	0.420
ESAS	Black-legged kittiwake winter	autumn SST	–0.408	0.358	19	–1.142	0.268
ESAS	Black-legged kittiwake winter	annual SST lag 1	–1.099	0.348	19	–3.154	0.005
ESAS	Black-legged kittiwake winter	winter SST lag 1	–0.882	0.245	19	–3.596	0.002
ESAS	Black-legged kittiwake winter	spring SST lag 1	–0.559	0.261	19	–2.144	0.045
ESAS	Black-legged kittiwake winter	summer SST lag 1	–0.459	0.260	19	–1.764	0.094
ESAS	Black-legged kittiwake winter	autumn SST lag 1	–1.080	0.344	19	–3.136	0.005
ESAS	Black-legged kittiwake winter	annual SST lag 2	–0.721	0.432	19	–1.668	0.112
ESAS	Black-legged kittiwake winter	winter SST lag 2	–0.848	0.318	19	–2.670	0.015
ESAS	Black-legged kittiwake winter	spring SST lag 2	–0.467	0.350	19	–1.333	0.198
ESAS	Black-legged kittiwake winter	summer SST lag 2	0.162	0.376	19	0.431	0.671
ESAS	Black-legged kittiwake winter	autumn SST lag 2	–0.512	0.326	19	–1.570	0.133
SMP	Common guillemot	annual SST	0.030	0.047	148	0.646	0.520
SMP	Common guillemot	winter SST	0.017	0.032	148	0.518	0.605
SMP	Common guillemot	spring SST	–0.012	0.027	148	–0.442	0.659
SMP	Common guillemot	summer SST	0.022	0.025	148	0.884	0.378
SMP	Common guillemot	autumn SST	–0.001	0.033	148	–0.018	0.986
SMP	Common guillemot	annual SST lag 1	0.016	0.046	155	0.343	0.732
SMP	Common guillemot	winter SST lag 1	–0.029	0.023	155	–1.217	0.225
SMP	Common guillemot	spring SST lag 1	–0.014	0.019	155	–0.723	0.471
SMP	Common guillemot	summer SST lag 1	0.019	0.025	155	0.788	0.432
SMP	Common guillemot	autumn SST lag 1	0.041	0.024	155	1.684	0.094
SMP	Common guillemot	annual SST lag 2	–0.042	0.046	162	–0.907	0.366
SMP	Common guillemot	winter SST lag 2	0.009	0.029	162	0.312	0.755
SMP	Common guillemot	spring SST lag 2	–0.020	0.026	162	–0.769	0.443
SMP	Common guillemot	summer SST lag 2	–0.019	0.023	162	–0.828	0.409
SMP	Common guillemot	autumn SST lag 2	–0.005	0.030	162	–0.159	0.874
ESAS	Common guillemot summer	annual SST	0.403	0.149	25	2.712	0.012
ESAS	Common guillemot summer	winter SST	0.186	0.151	25	1.235	0.229
ESAS	Common guillemot summer	spring SST	0.205	0.152	25	1.355	0.188
ESAS	Common guillemot summer	summer SST	0.303	0.108	25	2.811	0.010
ESAS	Common guillemot summer	autumn SST	0.349	0.130	25	2.680	0.013
ESAS	Common guillemot summer	annual SST lag 1	0.219	0.192	25	1.140	0.265
ESAS	Common guillemot summer	winter SST lag 1	0.021	0.181	25	0.119	0.906
ESAS	Common guillemot summer	spring SST lag 1	0.009	0.152	25	0.058	0.955
ESAS	Common guillemot summer	summer SST lag 1	0.171	0.122	25	1.401	0.174
ESAS	Common guillemot summer	autumn SST lag 1	0.262	0.155	25	1.689	0.104
ESAS	Common guillemot summer	annual SST lag 2	0.316	0.247	24	1.279	0.213
ESAS	Common guillemot summer	winter SST lag 2	0.270	0.193	24	1.401	0.174
ESAS	Common guillemot summer	spring SST lag 2	0.154	0.208	24	0.741	0.466
ESAS	Common guillemot summer	summer SST lag 2	0.099	0.160	24	0.620	0.541
ESAS	Common guillemot summer	autumn SST lag 2	0.215	0.165	24	1.306	0.204
ESAS	Common guillemot winter	annual SST	–0.347	0.302	19	–1.146	0.266
ESAS	Common guillemot winter	winter SST	0.037	0.207	19	0.180	0.859
ESAS	Common guillemot winter	spring SST	–0.083	0.193	19	–0.431	0.671
ESAS	Common guillemot winter	summer SST	–0.472	0.193	19	–2.440	0.025
ESAS	Common guillemot winter	autumn SST	–0.366	0.283	19	–1.291	0.212
ESAS	Common guillemot winter	annual SST lag 1	–0.252	0.323	19	–0.780	0.445
ESAS	Common guillemot winter	winter SST lag 1	0.053	0.227	19	0.235	0.817
ESAS	Common guillemot winter	spring SST lag 1	–0.023	0.204	19	–0.110	0.913
ESAS	Common guillemot winter	summer SST lag 1	–0.287	0.235	19	–1.220	0.237
ESAS	Common guillemot winter	autumn SST lag 1	–0.505	0.336	19	–1.504	0.149
ESAS	Common guillemot winter	annual SST lag 2	–0.242	0.333	19	–0.727	0.476
ESAS	Common guillemot winter	winter SST lag 2	–0.127	0.250	19	–0.506	0.619
ESAS	Common guillemot winter	spring SST lag 2	–0.485	0.259	19	–1.870	0.077
ESAS	Common guillemot winter	summer SST lag 2	0.060	0.282	19	0.214	0.833
ESAS	Common guillemot winter	autumn SST lag 2	0.026	0.251	19	0.103	0.919

ESAS	Common guillemot winter	annual SST	–0.347	0.302	19	–1.146	0.266
ESAS	Common guillemot winter	winter SST	0.037	0.207	19	0.180	0.859
ESAS	Common guillemot winter	spring SST	–0.083	0.193	19	–0.431	0.671
ESAS	Common guillemot winter	summer SST	–0.472	0.193	19	–2.440	0.025
ESAS	Common guillemot winter	autumn SST	–0.366	0.283	19	–1.291	0.212
ESAS	Common guillemot winter	annual SST lag 1	–0.252	0.323	19	–0.780	0.445
ESAS	Common guillemot winter	winter SST lag 1	0.053	0.227	19	0.235	0.817
ESAS	Common guillemot winter	spring SST lag 1	–0.023	0.204	19	–0.110	0.913
ESAS	Common guillemot winter	summer SST lag 1	–0.287	0.235	19	–1.220	0.237
ESAS	Common guillemot winter	autumn SST lag 1	–0.505	0.336	19	–1.504	0.149
ESAS	Common guillemot winter	annual SST lag 2	–0.242	0.333	19	–0.727	0.476
ESAS	Common guillemot winter	winter SST lag 2	–0.127	0.250	19	–0.506	0.619
ESAS	Common guillemot winter	spring SST lag 2	–0.485	0.259	19	–1.870	0.077
ESAS	Common guillemot winter	summer SST lag 2	0.060	0.282	19	0.214	0.833
ESAS	Common guillemot winter	autumn SST lag 2	0.026	0.251	19	0.103	0.919
SMP	Common tern	annual SST	–0.092	0.106	151	–0.861	0.391
SMP	Common tern	winter SST	–0.130	0.073	151	–1.797	0.074
SMP	Common tern	spring SST	0.022	0.063	151	0.356	0.722
SMP	Common tern	summer SST	–0.047	0.053	151	–0.878	0.382
SMP	Common tern	autumn SST	–0.042	0.078	151	–0.535	0.594
SMP	Common tern	annual SST lag 1	0.069	0.114	153	0.604	0.547
SMP	Common tern	winter SST lag 1	0.090	0.070	153	1.279	0.203
SMP	Common tern	spring SST lag 1	0.016	0.066	153	0.245	0.807
SMP	Common tern	summer SST lag 1	0.013	0.055	153	0.230	0.819
SMP	Common tern	autumn SST lag 1	0.045	0.078	153	0.583	0.560
SMP	Common tern	annual SST lag 2	0.043	0.110	150	0.391	0.697
SMP	Common tern	winter SST lag 2	0.123	0.074	150	1.653	0.100
SMP	Common tern	spring SST lag 2	0.023	0.067	150	0.344	0.732
SMP	Common tern	summer SST lag 2	0.012	0.056	150	0.209	0.835
SMP	Common tern	autumn SST lag 2	–0.042	0.079	150	–0.530	0.597
WeBS	Common tern summer	annual SST	–1.695	1.272	9	–1.333	0.215
WeBS	Common tern summer	winter SST	–2.935	0.985	9	–2.982	0.015
WeBS	Common tern summer	spring SST	0.300	1.405	9	0.213	0.836
WeBS	Common tern summer	summer SST	–0.779	0.609	9	–1.279	0.233
WeBS	Common tern summer	autumn SST	–0.909	0.767	9	–1.185	0.266
WeBS	Common tern summer	annual SST lag 1	–0.358	1.253	9	–0.286	0.782
WeBS	Common tern summer	winter SST lag 1	–0.157	0.950	9	–0.165	0.873
WeBS	Common tern summer	spring SST lag 1	0.817	1.170	9	0.698	0.503
WeBS	Common tern summer	summer SST lag 1	–1.088	0.784	9	–1.388	0.199
WeBS	Common tern summer	autumn SST lag 1	–0.289	1.035	9	–0.279	0.786
WeBS	Common tern summer	annual SST lag 2	–0.073	0.953	9	–0.076	0.941
WeBS	Common tern summer	winter SST lag 2	1.628	1.033	9	1.576	0.150
WeBS	Common tern summer	spring SST lag 2	1.220	0.865	9	1.411	0.192
WeBS	Common tern summer	summer SST lag 2	–0.652	0.609	9	–1.072	0.312
WeBS	Common tern summer	autumn SST lag 2	–0.442	0.673	9	–0.657	0.528
SMP	Cormorant	annual SST	0.080	0.092	130	0.870	0.386
SMP	Cormorant	winter SST	0.004	0.066	130	0.061	0.952
SMP	Cormorant	spring SST	0.000	0.054	130	0.007	0.994
SMP	Cormorant	summer SST	0.065	0.050	130	1.294	0.198
SMP	Cormorant	autumn SST	0.026	0.067	130	0.386	0.700
SMP	Cormorant	annual SST lag 1	–0.096	0.089	135	–1.076	0.284
SMP	Cormorant	winter SST lag 1	–0.112	0.063	135	–1.775	0.078
SMP	Cormorant	spring SST lag 1	–0.102	0.053	135	–1.944	0.054
SMP	Cormorant	summer SST lag 1	–0.012	0.051	135	–0.239	0.811
SMP	Cormorant	autumn SST lag 1	0.061	0.065	135	0.936	0.351
SMP	Cormorant	annual SST lag 2	–0.025	0.088	140	–0.283	0.777
SMP	Cormorant	winter SST lag 2	0.082	0.062	140	1.326	0.187
SMP	Cormorant	spring SST lag 2	0.072	0.052	140	1.393	0.166
SMP	Cormorant	summer SST lag 2	–0.050	0.048	140	–1.028	0.306
SMP	Cormorant	autumn SST lag 2	–0.079	0.063	140	–1.249	0.214
WeBS	Cormorant winter	annual SST	0.765	0.182	22	4.198	0.000
WeBS	Cormorant winter	winter SST	0.752	0.166	22	4.537	0.000
WeBS	Cormorant winter	spring SST	0.501	0.175	22	2.863	0.009
WeBS	Cormorant winter	summer SST	0.418	0.163	22	2.554	0.018

WeBS	Cormorant winter	autumn SST	0.622	0.158	22	3.941	0.001
WeBS	Cormorant winter	annual SST lag 1	0.540	0.168	22	3.213	0.004
WeBS	Cormorant winter	winter SST lag 1	0.548	0.160	22	3.423	0.002
WeBS	Cormorant winter	spring SST lag 1	0.242	0.164	22	1.474	0.155
WeBS	Cormorant winter	summer SST lag 1	0.338	0.149	22	2.273	0.033
WeBS	Cormorant winter	autumn SST lag 1	0.541	0.124	22	4.370	0.000
WeBS	Cormorant winter	annual SST lag 2	0.404	0.189	21	2.136	0.045
WeBS	Cormorant winter	winter SST lag 2	0.435	0.191	21	2.277	0.033
WeBS	Cormorant winter	spring SST lag 2	0.239	0.160	21	1.491	0.151
WeBS	Cormorant winter	summer SST lag 2	0.060	0.175	21	0.344	0.734
WeBS	Cormorant winter	autumn SST lag 2	0.337	0.152	21	2.222	0.037
SMP	Eider	annual SST	0.221	0.103	18	2.137	0.047
SMP	Eider	winter SST	0.050	0.088	18	0.573	0.574
SMP	Eider	spring SST	0.052	0.073	18	0.707	0.489
SMP	Eider	summer SST	0.173	0.058	18	2.966	0.008
SMP	Eider	autumn SST	0.123	0.074	18	1.664	0.114
SMP	Eider	annual SST lag 1	0.027	0.105	19	0.255	0.801
SMP	Eider	winter SST lag 1	0.076	0.086	19	0.881	0.389
SMP	Eider	spring SST lag 1	–0.019	0.072	19	–0.260	0.798
SMP	Eider	summer SST lag 1	–0.057	0.069	19	–0.826	0.419
SMP	Eider	autumn SST lag 1	0.075	0.075	19	1.004	0.328
SMP	Eider	annual SST lag 2	0.065	0.108	19	0.607	0.551
SMP	Eider	winter SST lag 2	–0.007	0.089	19	–0.082	0.936
SMP	Eider	spring SST lag 2	–0.010	0.072	19	–0.138	0.892
SMP	Eider	summer SST lag 2	0.076	0.068	19	1.119	0.277
SMP	Eider	autumn SST lag 2	0.040	0.077	19	0.526	0.605
WeBS	Eider winter	annual SST	0.091	0.322	24	0.284	0.779
WeBS	Eider winter	winter SST	0.226	0.306	24	0.739	0.467
WeBS	Eider winter	spring SST	0.073	0.260	24	0.282	0.781
WeBS	Eider winter	summer SST	0.049	0.253	24	0.193	0.848
WeBS	Eider winter	autumn SST	0.053	0.278	24	0.192	0.849
WeBS	Eider winter	annual SST lag 1	0.190	0.286	24	0.665	0.512
WeBS	Eider winter	winter SST lag 1	0.067	0.272	24	0.246	0.808
WeBS	Eider winter	spring SST lag 1	–0.027	0.218	24	–0.121	0.904
WeBS	Eider winter	summer SST lag 1	0.266	0.216	24	1.233	0.229
WeBS	Eider winter	autumn SST lag 1	0.265	0.259	24	1.024	0.316
WeBS	Eider winter	annual SST lag 2	0.079	0.262	24	0.302	0.766
WeBS	Eider winter	winter SST lag 2	–0.085	0.243	24	–0.348	0.731
WeBS	Eider winter	spring SST lag 2	0.019	0.204	24	0.095	0.925
WeBS	Eider winter	summer SST lag 2	0.132	0.215	24	0.613	0.546
WeBS	Eider winter	autumn SST lag 2	0.126	0.229	24	0.550	0.587
SMP	European shag	annual SST	0.103	0.063	250	1.644	0.101
SMP	European shag	winter SST	0.141	0.043	250	3.264	0.001
SMP	European shag	spring SST	0.112	0.036	250	3.137	0.002
SMP	European shag	summer SST	0.024	0.034	250	0.706	0.481
SMP	European shag	autumn SST	–0.103	0.045	250	–2.274	0.024
SMP	European shag	annual SST lag 1	0.176	0.063	261	2.798	0.006
SMP	European shag	winter SST lag 1	–0.117	0.041	261	–2.873	0.004
SMP	European shag	spring SST lag 1	–0.080	0.034	261	–2.384	0.018
SMP	European shag	summer SST lag 1	0.170	0.032	261	5.304	0.000
SMP	European shag	autumn SST lag 1	0.261	0.040	261	6.438	0.000
SMP	European shag	annual SST lag 2	–0.155	0.058	272	–2.681	0.008
SMP	European shag	winter SST lag 2	0.038	0.040	272	0.957	0.339
SMP	European shag	spring SST lag 2	–0.003	0.034	272	–0.085	0.932
SMP	European shag	summer SST lag 2	–0.158	0.030	272	–5.223	0.000
SMP	European shag	autumn SST lag 2	–0.009	0.042	272	–0.207	0.837
ESAS	Gannet summer	annual SST	1.182	0.157	25	7.510	0.000
ESAS	Gannet summer	winter SST	0.507	0.223	25	2.276	0.032
ESAS	Gannet summer	spring SST	0.609	0.212	25	2.869	0.008
ESAS	Gannet summer	summer SST	0.594	0.139	25	4.285	0.000
ESAS	Gannet summer	autumn SST	1.112	0.135	25	8.231	0.000
ESAS	Gannet summer	annual SST lag 1	0.581	0.247	25	2.352	0.027
ESAS	Gannet summer	winter SST lag 1	0.542	0.215	25	2.524	0.018
ESAS	Gannet summer	spring SST lag 1	0.288	0.203	25	1.418	0.168

ESAS	Gannet summer	summer SST lag 1	0.151	0.165	25	0.912	0.370
ESAS	Gannet summer	autumn SST lag 1	0.599	0.188	25	3.184	0.004
ESAS	Gannet summer	annual SST lag 2	0.115	0.397	24	0.289	0.775
ESAS	Gannet summer	winter SST lag 2	0.456	0.296	24	1.542	0.136
ESAS	Gannet summer	spring SST lag 2	–0.151	0.286	24	–0.529	0.602
ESAS	Gannet summer	summer SST lag 2	–0.037	0.223	24	–0.168	0.868
ESAS	Gannet summer	autumn SST lag 2	0.085	0.273	24	0.310	0.759
ESAS	Gannet winter	annual SST	–0.223	0.427	19	–0.522	0.608
ESAS	Gannet winter	winter SST	–0.101	0.286	19	–0.354	0.728
ESAS	Gannet winter	spring SST	0.121	0.266	19	0.456	0.654
ESAS	Gannet winter	summer SST	–0.127	0.260	19	–0.489	0.631
ESAS	Gannet winter	autumn SST	–0.578	0.388	19	–1.490	0.153
ESAS	Gannet winter	annual SST lag 1	0.264	0.474	19	0.556	0.585
ESAS	Gannet winter	winter SST lag 1	0.194	0.306	19	0.632	0.535
ESAS	Gannet winter	spring SST lag 1	0.386	0.260	19	1.482	0.155
ESAS	Gannet winter	summer SST lag 1	0.308	0.346	19	0.892	0.384
ESAS	Gannet winter	autumn SST lag 1	–0.703	0.386	19	–1.823	0.084
ESAS	Gannet winter	annual SST lag 2	0.432	0.462	19	0.936	0.361
ESAS	Gannet winter	winter SST lag 2	–0.307	0.359	19	–0.854	0.404
ESAS	Gannet winter	spring SST lag 2	0.158	0.340	19	0.464	0.648
ESAS	Gannet winter	summer SST lag 2	0.598	0.339	19	1.764	0.094
ESAS	Gannet winter	autumn SST lag 2	0.382	0.333	19	1.146	0.266
ESAS	Gannet winter	annual SST	–0.223	0.427	19	–0.522	0.608
ESAS	Gannet winter	winter SST	–0.101	0.286	19	–0.354	0.728
ESAS	Gannet winter	spring SST	0.121	0.266	19	0.456	0.654
ESAS	Gannet winter	summer SST	–0.127	0.260	19	–0.489	0.631
ESAS	Gannet winter	autumn SST	–0.578	0.388	19	–1.490	0.153
ESAS	Gannet winter	annual SST lag 1	0.264	0.474	19	0.556	0.585
ESAS	Gannet winter	winter SST lag 1	0.194	0.306	19	0.632	0.535
ESAS	Gannet winter	spring SST lag 1	0.386	0.260	19	1.482	0.155
ESAS	Gannet winter	summer SST lag 1	0.308	0.346	19	0.892	0.384
ESAS	Gannet winter	autumn SST lag 1	–0.703	0.386	19	–1.823	0.084
ESAS	Gannet winter	annual SST lag 2	0.432	0.462	19	0.936	0.361
ESAS	Gannet winter	winter SST lag 2	–0.307	0.359	19	–0.854	0.404
ESAS	Gannet winter	spring SST lag 2	0.158	0.340	19	0.464	0.648
ESAS	Gannet winter	summer SST lag 2	0.598	0.339	19	1.764	0.094
ESAS	Gannet winter	autumn SST lag 2	0.382	0.333	19	1.146	0.266
WeBS	Goldeneye winter	annual SST	–0.145	0.218	42	–0.665	0.510
WeBS	Goldeneye winter	winter SST	–0.093	0.196	42	–0.476	0.637
WeBS	Goldeneye winter	spring SST	–0.132	0.169	42	–0.781	0.439
WeBS	Goldeneye winter	summer SST	–0.106	0.159	42	–0.664	0.511
WeBS	Goldeneye winter	autumn SST	–0.031	0.186	42	–0.169	0.867
WeBS	Goldeneye winter	annual SST lag 1	–0.066	0.216	42	–0.304	0.763
WeBS	Goldeneye winter	winter SST lag 1	0.001	0.193	42	0.003	0.998
WeBS	Goldeneye winter	spring SST lag 1	–0.098	0.159	42	–0.617	0.540
WeBS	Goldeneye winter	summer SST lag 1	–0.008	0.160	42	–0.048	0.962
WeBS	Goldeneye winter	autumn SST lag 1	–0.018	0.197	42	–0.090	0.929
WeBS	Goldeneye winter	annual SST lag 2	–0.164	0.198	43	–0.827	0.413
WeBS	Goldeneye winter	winter SST lag 2	–0.058	0.182	43	–0.316	0.754
WeBS	Goldeneye winter	spring SST lag 2	–0.146	0.152	43	–0.958	0.343
WeBS	Goldeneye winter	summer SST lag 2	–0.077	0.155	43	–0.500	0.620
WeBS	Goldeneye winter	autumn SST lag 2	–0.159	0.171	43	–0.929	0.358
WeBS	Goosander summer	annual SST	0.270	0.176	40	1.535	0.133
WeBS	Goosander summer	winter SST	–0.054	0.124	40	–0.433	0.667
WeBS	Goosander summer	spring SST	–0.155	0.103	40	–1.509	0.139
WeBS	Goosander summer	summer SST	0.151	0.102	40	1.481	0.146
WeBS	Goosander summer	autumn SST	0.359	0.107	40	3.352	0.002
WeBS	Goosander summer	annual SST lag 1	–0.037	0.171	42	–0.213	0.832
WeBS	Goosander summer	winter SST lag 1	0.097	0.121	42	0.802	0.427
WeBS	Goosander summer	spring SST lag 1	0.061	0.106	42	0.574	0.569
WeBS	Goosander summer	summer SST lag 1	–0.018	0.093	42	–0.193	0.848
WeBS	Goosander summer	autumn SST lag 1	–0.157	0.121	42	–1.293	0.203
WeBS	Goosander summer	annual SST lag 2	0.081	0.175	41	0.465	0.645
WeBS	Goosander summer	winter SST lag 2	0.105	0.124	41	0.847	0.402

WeBS	Goosander summer	spring SST lag 2	0.069	0.105	41	0.654	0.517
WeBS	Goosander summer	summer SST lag 2	–0.032	0.096	41	–0.328	0.745
WeBS	Goosander summer	autumn SST lag 2	0.017	0.122	41	0.141	0.888
WeBS	Great black-backed gull summer	annual SST	0.275	0.384	12	0.716	0.488
WeBS	Great black-backed gull summer	winter SST	0.341	0.281	12	1.216	0.248
WeBS	Great black-backed gull summer	spring SST	0.259	0.259	12	1.001	0.337
WeBS	Great black-backed gull summer	summer SST	0.107	0.214	12	0.502	0.624
WeBS	Great black-backed gull summer	autumn SST	–0.138	0.274	12	–0.503	0.624
WeBS	Great black-backed gull summer	annual SST lag 1	–0.047	0.325	13	–0.144	0.888
WeBS	Great black-backed gull summer	winter SST lag 1	–0.128	0.270	13	–0.475	0.643
WeBS	Great black-backed gull summer	spring SST lag 1	–0.355	0.187	13	–1.904	0.079
WeBS	Great black-backed gull summer	summer SST lag 1	0.061	0.199	13	0.307	0.764
WeBS	Great black-backed gull summer	autumn SST lag 1	0.235	0.273	13	0.861	0.405
WeBS	Great black-backed gull summer	annual SST lag 2	–0.342	0.289	13	–1.183	0.258
WeBS	Great black-backed gull summer	winter SST lag 2	–0.256	0.242	13	–1.059	0.309
WeBS	Great black-backed gull summer	spring SST lag 2	–0.469	0.110	13	–4.278	0.001
WeBS	Great black-backed gull summer	summer SST lag 2	–0.125	0.202	13	–0.619	0.547
WeBS	Great black-backed gull summer	autumn SST lag 2	0.129	0.264	13	0.487	0.634
SMP	Great black-backed gull	annual SST	0.086	0.133	129	0.650	0.517
SMP	Great black-backed gull	winter SST	–0.073	0.101	129	–0.720	0.473
SMP	Great black-backed gull	spring SST	0.032	0.078	129	0.411	0.682
SMP	Great black-backed gull	summer SST	0.040	0.065	129	0.613	0.541
SMP	Great black-backed gull	autumn SST	0.040	0.091	129	0.436	0.664
SMP	Great black-backed gull	annual SST lag 1	–0.045	0.132	134	–0.338	0.736
SMP	Great black-backed gull	winter SST lag 1	0.164	0.092	134	1.776	0.078
SMP	Great black-backed gull	spring SST lag 1	0.034	0.076	134	0.451	0.652
SMP	Great black-backed gull	summer SST lag 1	–0.088	0.070	134	–1.253	0.212
SMP	Great black-backed gull	autumn SST lag 1	–0.048	0.089	134	–0.542	0.589
SMP	Great black-backed gull	annual SST lag 2	0.107	0.122	142	0.876	0.383
SMP	Great black-backed gull	winter SST lag 2	–0.106	0.083	142	–1.278	0.203
SMP	Great black-backed gull	spring SST lag 2	0.016	0.066	142	0.247	0.805
SMP	Great black-backed gull	summer SST lag 2	0.094	0.063	142	1.484	0.140
SMP	Great black-backed gull	autumn SST lag 2	0.009	0.076	142	0.114	0.910
ESAS	Great black-backed gull winter	annual SST	0.173	0.625	19	0.277	0.785
ESAS	Great black-backed gull winter	winter SST	0.375	0.409	19	0.916	0.371
ESAS	Great black-backed gull winter	spring SST	0.185	0.388	19	0.476	0.640
ESAS	Great black-backed gull winter	summer SST	–0.144	0.352	19	–0.408	0.688
ESAS	Great black-backed gull winter	autumn SST	0.225	0.537	19	0.418	0.681
ESAS	Great black-backed gull winter	annual SST lag 1	–0.205	1.304	19	–0.157	0.877
ESAS	Great black-backed gull winter	winter SST lag 1	–1.184	0.318	19	–3.721	0.001
ESAS	Great black-backed gull winter	spring SST lag 1	–0.826	0.321	19	–2.575	0.019
ESAS	Great black-backed gull winter	summer SST lag 1	–0.550	1.270	19	–0.433	0.670
ESAS	Great black-backed gull winter	autumn SST lag 1	0.616	1.321	19	0.466	0.646
ESAS	Great black-backed gull winter	annual SST lag 2	–0.944	0.603	19	–1.565	0.134
ESAS	Great black-backed gull winter	winter SST lag 2	–1.321	0.281	19	–4.702	0.000
ESAS	Great black-backed gull winter	spring SST lag 2	–0.294	0.442	19	–0.665	0.514
ESAS	Great black-backed gull winter	summer SST lag 2	0.051	0.370	19	0.137	0.892
ESAS	Great black-backed gull winter	autumn SST lag 2	–0.886	0.420	19	–2.112	0.048
ESAS	Great black-backed gull winter	annual SST	0.173	0.625	19	0.277	0.785
ESAS	Great black-backed gull winter	winter SST	0.375	0.409	19	0.916	0.371
ESAS	Great black-backed gull winter	spring SST	0.185	0.388	19	0.476	0.640
ESAS	Great black-backed gull winter	summer SST	–0.144	0.352	19	–0.408	0.688
ESAS	Great black-backed gull winter	autumn SST	0.225	0.537	19	0.418	0.681
ESAS	Great black-backed gull winter	annual SST lag 1	–0.205	1.304	19	–0.157	0.877
ESAS	Great black-backed gull winter	winter SST lag 1	–1.184	0.318	19	–3.721	0.001
ESAS	Great black-backed gull winter	spring SST lag 1	–0.826	0.321	19	–2.575	0.019
ESAS	Great black-backed gull winter	summer SST lag 1	–0.550	1.270	19	–0.433	0.670
ESAS	Great black-backed gull winter	autumn SST lag 1	0.616	1.321	19	0.466	0.646
ESAS	Great black-backed gull winter	annual SST lag 2	–0.944	0.603	19	–1.565	0.134
ESAS	Great black-backed gull winter	winter SST lag 2	–1.321	0.281	19	–4.702	0.000
ESAS	Great black-backed gull winter	spring SST lag 2	–0.294	0.442	19	–0.665	0.514
ESAS	Great black-backed gull winter	summer SST lag 2	0.051	0.370	19	0.137	0.892
ESAS	Great black-backed gull winter	autumn SST lag 2	–0.886	0.420	19	–2.112	0.048
WeBS	Great crested grebe winter	annual SST	–0.531	0.200	75	–2.655	0.010

WeBS	Great crested grebe winter	winter SST	–0.286	0.209	75	–1.365	0.176
WeBS	Great crested grebe winter	spring SST	–0.300	0.162	75	–1.852	0.068
WeBS	Great crested grebe winter	summer SST	–0.373	0.162	75	–2.298	0.024
WeBS	Great crested grebe winter	autumn SST	–0.500	0.179	75	–2.789	0.007
WeBS	Great crested grebe winter	annual SST lag 1	–0.728	0.203	76	–3.589	0.001
WeBS	Great crested grebe winter	winter SST lag 1	–0.484	0.199	76	–2.428	0.018
WeBS	Great crested grebe winter	spring SST lag 1	–0.565	0.146	76	–3.861	0.000
WeBS	Great crested grebe winter	summer SST lag 1	–0.429	0.168	76	–2.562	0.012
WeBS	Great crested grebe winter	autumn SST lag 1	–0.495	0.195	76	–2.537	0.013
WeBS	Great crested grebe winter	annual SST lag 2	–0.647	0.204	77	–3.174	0.002
WeBS	Great crested grebe winter	winter SST lag 2	–0.466	0.180	77	–2.584	0.012
WeBS	Great crested grebe winter	spring SST lag 2	–0.330	0.159	77	–2.072	0.042
WeBS	Great crested grebe winter	summer SST lag 2	–0.407	0.161	77	–2.531	0.013
WeBS	Great crested grebe winter	autumn SST lag 2	–0.542	0.186	77	–2.922	0.005
SMP	Herring gull	annual SST	–0.014	0.054	169	–0.255	0.799
SMP	Herring gull	winter SST	–0.002	0.039	169	–0.063	0.950
SMP	Herring gull	spring SST	0.002	0.032	169	0.048	0.962
SMP	Herring gull	summer SST	–0.030	0.030	169	–1.014	0.312
SMP	Herring gull	autumn SST	0.021	0.039	169	0.533	0.594
SMP	Herring gull	annual SST lag 1	0.073	0.052	174	1.409	0.161
SMP	Herring gull	winter SST lag 1	0.015	0.037	174	0.423	0.673
SMP	Herring gull	spring SST lag 1	0.010	0.031	174	0.338	0.736
SMP	Herring gull	summer SST lag 1	0.039	0.028	174	1.385	0.168
SMP	Herring gull	autumn SST lag 1	0.051	0.037	174	1.376	0.171
SMP	Herring gull	annual SST lag 2	–0.061	0.053	178	–1.160	0.248
SMP	Herring gull	winter SST lag 2	0.015	0.037	178	0.416	0.678
SMP	Herring gull	spring SST lag 2	0.004	0.032	178	0.138	0.891
SMP	Herring gull	summer SST lag 2	–0.045	0.028	178	–1.615	0.108
SMP	Herring gull	autumn SST lag 2	–0.047	0.038	178	–1.247	0.214
ESAS	Herring gull winter	annual SST	0.470	0.564	19	0.833	0.415
ESAS	Herring gull winter	winter SST	0.475	0.339	19	1.398	0.178
ESAS	Herring gull winter	spring SST	0.277	0.336	19	0.824	0.420
ESAS	Herring gull winter	summer SST	–0.049	0.320	19	–0.152	0.881
ESAS	Herring gull winter	autumn SST	0.368	0.477	19	0.772	0.449
ESAS	Herring gull winter	annual SST lag 1	–0.794	0.488	19	–1.627	0.120
ESAS	Herring gull winter	winter SST lag 1	–1.257	0.314	19	–4.000	0.001
ESAS	Herring gull winter	spring SST lag 1	–0.641	0.286	19	–2.237	0.037
ESAS	Herring gull winter	summer SST lag 1	0.087	0.318	19	0.272	0.788
ESAS	Herring gull winter	autumn SST lag 1	–0.143	0.473	19	–0.302	0.766
ESAS	Herring gull winter	annual SST lag 2	–1.134	0.633	19	–1.792	0.089
ESAS	Herring gull winter	winter SST lag 2	–1.123	0.410	19	–2.742	0.013
ESAS	Herring gull winter	spring SST lag 2	–0.831	0.482	19	–1.727	0.101
ESAS	Herring gull winter	summer SST lag 2	–0.048	0.442	19	–0.109	0.914
ESAS	Herring gull winter	autumn SST lag 2	–0.733	0.455	19	–1.613	0.123
ESAS	Herring gull winter	annual SST	0.470	0.564	19	0.833	0.415
ESAS	Herring gull winter	winter SST	0.475	0.339	19	1.398	0.178
ESAS	Herring gull winter	spring SST	0.277	0.336	19	0.824	0.420
ESAS	Herring gull winter	summer SST	–0.049	0.320	19	–0.152	0.881
ESAS	Herring gull winter	autumn SST	0.368	0.477	19	0.772	0.449
ESAS	Herring gull winter	annual SST lag 1	–0.794	0.488	19	–1.627	0.120
ESAS	Herring gull winter	winter SST lag 1	–1.257	0.314	19	–4.000	0.001
ESAS	Herring gull winter	spring SST lag 1	–0.641	0.286	19	–2.237	0.037
ESAS	Herring gull winter	summer SST lag 1	0.087	0.318	19	0.272	0.788
ESAS	Herring gull winter	autumn SST lag 1	–0.143	0.473	19	–0.302	0.766
ESAS	Herring gull winter	annual SST lag 2	–1.134	0.633	19	–1.792	0.089
ESAS	Herring gull winter	winter SST lag 2	–1.123	0.410	19	–2.742	0.013
ESAS	Herring gull winter	spring SST lag 2	–0.831	0.482	19	–1.727	0.101
ESAS	Herring gull winter	summer SST lag 2	–0.048	0.442	19	–0.109	0.914
ESAS	Herring gull winter	autumn SST lag 2	–0.733	0.455	19	–1.613	0.123
SMP	Lesser black-backed gull	annual SST	0.086	0.084	108	1.025	0.308
SMP	Lesser black-backed gull	winter SST	–0.052	0.091	108	–0.568	0.571
SMP	Lesser black-backed gull	spring SST	–0.013	0.050	108	–0.254	0.800
SMP	Lesser black-backed gull	summer SST	0.027	0.045	108	0.604	0.547
SMP	Lesser black-backed gull	autumn SST	0.135	0.096	108	1.404	0.163

SMP	Lesser black-backed gull	annual SST lag 1	0.095	0.112	112	0.848	0.398
SMP	Lesser black-backed gull	winter SST lag 1	0.081	0.080	112	1.006	0.317
SMP	Lesser black-backed gull	spring SST lag 1	0.089	0.072	112	1.242	0.217
SMP	Lesser black-backed gull	summer SST lag 1	0.039	0.043	112	0.921	0.359
SMP	Lesser black-backed gull	autumn SST lag 1	–0.032	0.079	112	–0.403	0.688
SMP	Lesser black-backed gull	annual SST lag 2	–0.090	0.078	115	–1.155	0.251
SMP	Lesser black-backed gull	winter SST lag 2	–0.063	0.076	115	–0.822	0.413
SMP	Lesser black-backed gull	spring SST lag 2	–0.058	0.066	115	–0.880	0.381
SMP	Lesser black-backed gull	summer SST lag 2	–0.017	0.041	115	–0.421	0.674
SMP	Lesser black-backed gull	autumn SST lag 2	–0.084	0.082	115	–1.026	0.307
WeBS	Little tern summer	annual SST	–1.650	1.254	11	–1.316	0.215
WeBS	Little tern summer	winter SST	–0.936	0.908	11	–1.031	0.325
WeBS	Little tern summer	spring SST	–1.181	0.541	11	–2.182	0.052
WeBS	Little tern summer	summer SST	–0.204	0.610	11	–0.334	0.744
WeBS	Little tern summer	autumn SST	0.029	0.798	11	0.036	0.972
WeBS	Little tern summer	annual SST lag 1	0.894	1.059	11	0.845	0.416
WeBS	Little tern summer	winter SST lag 1	0.444	0.635	11	0.700	0.499
WeBS	Little tern summer	spring SST lag 1	–0.616	0.573	11	–1.074	0.306
WeBS	Little tern summer	summer SST lag 1	0.549	0.571	11	0.962	0.357
WeBS	Little tern summer	autumn SST lag 1	0.857	0.620	11	1.383	0.194
WeBS	Little tern summer	annual SST lag 2	–0.790	0.758	11	–1.041	0.320
WeBS	Little tern summer	winter SST lag 2	–1.606	0.643	11	–2.499	0.030
WeBS	Little tern summer	spring SST lag 2	–1.020	0.468	11	–2.177	0.052
WeBS	Little tern summer	summer SST lag 2	0.281	0.466	11	0.603	0.558
WeBS	Little tern summer	autumn SST lag 2	0.014	0.649	11	0.022	0.983
WeBS	Long-tailed duck winter	annual SST	0.279	0.261	42	1.070	0.291
WeBS	Long-tailed duck winter	winter SST	0.308	0.278	42	1.105	0.276
WeBS	Long-tailed duck winter	spring SST	0.033	0.243	42	0.135	0.894
WeBS	Long-tailed duck winter	summer SST	0.225	0.193	42	1.163	0.252
WeBS	Long-tailed duck winter	autumn SST	0.286	0.216	42	1.325	0.192
WeBS	Long-tailed duck winter	annual SST lag 1	0.592	0.260	42	2.282	0.028
WeBS	Long-tailed duck winter	winter SST lag 1	0.706	0.289	42	2.445	0.019
WeBS	Long-tailed duck winter	spring SST lag 1	0.447	0.235	42	1.900	0.064
WeBS	Long-tailed duck winter	summer SST lag 1	0.354	0.190	42	1.858	0.070
WeBS	Long-tailed duck winter	autumn SST lag 1	0.533	0.236	42	2.256	0.029
WeBS	Long-tailed duck winter	annual SST lag 2	0.343	0.249	43	1.379	0.175
WeBS	Long-tailed duck winter	winter SST lag 2	0.216	0.262	43	0.824	0.414
WeBS	Long-tailed duck winter	spring SST lag 2	0.118	0.232	43	0.510	0.613
WeBS	Long-tailed duck winter	summer SST lag 2	0.348	0.187	43	1.858	0.070
WeBS	Long-tailed duck winter	autumn SST lag 2	0.280	0.230	43	1.216	0.231
WeBS	Merganser summer	annual SST	0.381	0.333	35	1.142	0.261
WeBS	Merganser summer	winter SST	–0.121	0.301	35	–0.402	0.691
WeBS	Merganser summer	spring SST	–0.112	0.236	35	–0.476	0.637
WeBS	Merganser summer	summer SST	0.214	0.216	35	0.992	0.328
WeBS	Merganser summer	autumn SST	0.440	0.262	35	1.679	0.102
WeBS	Merganser summer	annual SST lag 1	0.299	0.314	37	0.954	0.346
WeBS	Merganser summer	winter SST lag 1	0.266	0.279	37	0.954	0.346
WeBS	Merganser summer	spring SST lag 1	0.191	0.236	37	0.807	0.425
WeBS	Merganser summer	summer SST lag 1	0.199	0.217	37	0.916	0.366
WeBS	Merganser summer	autumn SST lag 1	0.070	0.260	37	0.270	0.789
WeBS	Merganser summer	annual SST lag 2	0.468	0.290	36	1.613	0.116
WeBS	Merganser summer	winter SST lag 2	0.537	0.274	36	1.960	0.058
WeBS	Merganser summer	spring SST lag 2	0.378	0.218	36	1.734	0.091
WeBS	Merganser summer	summer SST lag 2	0.246	0.202	36	1.219	0.231
WeBS	Merganser summer	autumn SST lag 2	0.225	0.252	36	0.892	0.378
WeBS	Merganser winter	annual SST	–0.152	0.344	42	–0.442	0.661
WeBS	Merganser winter	winter SST	–0.004	0.312	42	–0.012	0.991
WeBS	Merganser winter	spring SST	–0.378	0.241	42	–1.569	0.124
WeBS	Merganser winter	summer SST	–0.076	0.249	42	–0.306	0.761
WeBS	Merganser winter	autumn SST	0.164	0.285	42	0.576	0.568
WeBS	Merganser winter	annual SST lag 1	–0.368	0.324	42	–1.136	0.262
WeBS	Merganser winter	winter SST lag 1	–0.639	0.255	42	–2.507	0.016
WeBS	Merganser winter	spring SST lag 1	–0.416	0.213	42	–1.949	0.058
WeBS	Merganser winter	summer SST lag 1	0.013	0.242	42	0.056	0.956

WeBS	Merganser winter	autumn SST lag 1	–0.201	0.304	42	–0.659	0.513
WeBS	Merganser winter	annual SST lag 2	–0.304	0.315	43	–0.966	0.340
WeBS	Merganser winter	winter SST lag 2	–0.127	0.280	43	–0.453	0.653
WeBS	Merganser winter	spring SST lag 2	0.033	0.253	43	0.132	0.896
WeBS	Merganser winter	summer SST lag 2	–0.184	0.227	43	–0.810	0.422
WeBS	Merganser winter	autumn SST lag 2	–0.586	0.268	43	–2.185	0.034
SMP	Northern fulmar	annual SST	0.070	0.039	230	1.820	0.070
SMP	Northern fulmar	winter SST	–0.031	0.028	230	–1.118	0.265
SMP	Northern fulmar	spring SST	–0.026	0.023	230	–1.160	0.247
SMP	Northern fulmar	summer SST	0.049	0.021	230	2.359	0.019
SMP	Northern fulmar	autumn SST	0.085	0.025	230	3.362	0.001
SMP	Northern fulmar	annual SST lag 1	–0.078	0.038	241	–2.031	0.043
SMP	Northern fulmar	winter SST lag 1	–0.065	0.027	241	–2.434	0.016
SMP	Northern fulmar	spring SST lag 1	–0.078	0.022	241	–3.632	0.000
SMP	Northern fulmar	summer SST lag 1	–0.002	0.021	241	–0.103	0.918
SMP	Northern fulmar	autumn SST lag 1	0.038	0.027	241	1.434	0.153
SMP	Northern fulmar	annual SST lag 2	–0.068	0.038	252	–1.778	0.077
SMP	Northern fulmar	winter SST lag 2	0.048	0.024	252	2.026	0.044
SMP	Northern fulmar	spring SST lag 2	0.027	0.022	252	1.215	0.225
SMP	Northern fulmar	summer SST lag 2	–0.055	0.020	252	–2.747	0.007
SMP	Northern fulmar	autumn SST lag 2	–0.088	0.027	252	–3.304	0.001
ESAS	Northern fulmar summer	annual SST	–0.049	0.322	25	–0.151	0.881
ESAS	Northern fulmar summer	winter SST	0.042	0.264	25	0.159	0.875
ESAS	Northern fulmar summer	spring SST	0.008	0.267	25	0.031	0.976
ESAS	Northern fulmar summer	summer SST	–0.144	0.204	25	–0.707	0.486
ESAS	Northern fulmar summer	autumn SST	0.010	0.270	25	0.038	0.970
ESAS	Northern fulmar summer	annual SST lag 1	–0.472	0.336	25	–1.407	0.172
ESAS	Northern fulmar summer	winter SST lag 1	–0.383	0.296	25	–1.295	0.207
ESAS	Northern fulmar summer	spring SST lag 1	–0.326	0.239	25	–1.364	0.185
ESAS	Northern fulmar summer	summer SST lag 1	–0.208	0.226	25	–0.922	0.365
ESAS	Northern fulmar summer	autumn SST lag 1	–0.393	0.292	25	–1.349	0.189
ESAS	Northern fulmar summer	annual SST lag 2	–0.481	0.401	24	–1.198	0.243
ESAS	Northern fulmar summer	winter SST lag 2	–0.066	0.311	24	–0.211	0.835
ESAS	Northern fulmar summer	spring SST lag 2	–0.207	0.325	24	–0.636	0.531
ESAS	Northern fulmar summer	summer SST lag 2	–0.329	0.270	24	–1.219	0.235
ESAS	Northern fulmar summer	autumn SST lag 2	–0.417	0.328	24	–1.273	0.215
ESAS	Northern fulmar winter	annual SST	–0.203	0.203	19	–1.001	0.330
ESAS	Northern fulmar winter	winter SST	–0.014	0.137	19	–0.102	0.920
ESAS	Northern fulmar winter	spring SST	–0.137	0.125	19	–1.093	0.288
ESAS	Northern fulmar winter	summer SST	–0.055	0.133	19	–0.416	0.682
ESAS	Northern fulmar winter	autumn SST	–0.213	0.200	19	–1.068	0.299
ESAS	Northern fulmar winter	annual SST lag 1	–0.394	0.221	19	–1.784	0.090
ESAS	Northern fulmar winter	winter SST lag 1	–0.470	0.142	19	–3.301	0.004
ESAS	Northern fulmar winter	spring SST lag 1	–0.413	0.136	19	–3.051	0.007
ESAS	Northern fulmar winter	summer SST lag 1	0.142	0.164	19	0.868	0.397
ESAS	Northern fulmar winter	autumn SST lag 1	–0.133	0.233	19	–0.571	0.575
ESAS	Northern fulmar winter	annual SST lag 2	–0.860	0.227	19	–3.792	0.001
ESAS	Northern fulmar winter	winter SST lag 2	–0.743	0.116	19	–6.414	0.000
ESAS	Northern fulmar winter	spring SST lag 2	–0.297	0.194	19	–1.531	0.142
ESAS	Northern fulmar winter	summer SST lag 2	–0.367	0.149	19	–2.455	0.024
ESAS	Northern fulmar winter	autumn SST lag 2	–0.576	0.162	19	–3.549	0.002
SMP	Razorbill	annual SST	0.068	0.047	155	1.443	0.151
SMP	Razorbill	winter SST	0.145	0.031	155	4.718	0.000
SMP	Razorbill	spring SST	0.058	0.027	155	2.176	0.031
SMP	Razorbill	summer SST	–0.018	0.026	155	–0.697	0.487
SMP	Razorbill	autumn SST	–0.048	0.034	155	–1.400	0.163
SMP	Razorbill	annual SST lag 1	0.081	0.046	163	1.768	0.079
SMP	Razorbill	winter SST lag 1	–0.026	0.031	163	–0.846	0.399
SMP	Razorbill	spring SST lag 1	0.000	0.026	163	–0.012	0.991
SMP	Razorbill	summer SST lag 1	0.039	0.024	163	1.625	0.106
SMP	Razorbill	autumn SST lag 1	0.026	0.032	163	0.802	0.424
SMP	Razorbill	annual SST lag 2	–0.063	0.044	171	–1.429	0.155
SMP	Razorbill	winter SST lag 2	–0.051	0.030	171	–1.692	0.092
SMP	Razorbill	spring SST lag 2	–0.024	0.026	171	–0.932	0.353

SMP	Razorbill	summer SST lag 2	–0.019	0.023	171	–0.816	0.415
SMP	Razorbill	autumn SST lag 2	0.022	0.031	171	0.699	0.486
ESAS	Razorbill summer	annual SST	0.184	0.246	25	0.750	0.460
ESAS	Razorbill summer	winter SST	0.265	0.233	25	1.138	0.266
ESAS	Razorbill summer	spring SST	0.276	0.207	25	1.332	0.195
ESAS	Razorbill summer	summer SST	–0.004	0.200	25	–0.020	0.984
ESAS	Razorbill summer	autumn SST	0.114	0.221	25	0.517	0.610
ESAS	Razorbill summer	annual SST lag 1	0.255	0.259	25	0.987	0.333
ESAS	Razorbill summer	winter SST lag 1	0.085	0.248	25	0.343	0.734
ESAS	Razorbill summer	spring SST lag 1	0.209	0.209	25	1.003	0.325
ESAS	Razorbill summer	summer SST lag 1	0.203	0.205	25	0.989	0.332
ESAS	Razorbill summer	autumn SST lag 1	0.156	0.230	25	0.680	0.503
ESAS	Razorbill summer	annual SST lag 2	0.670	0.269	24	2.493	0.020
ESAS	Razorbill summer	winter SST lag 2	0.500	0.243	24	2.054	0.051
ESAS	Razorbill summer	spring SST lag 2	0.188	0.288	24	0.653	0.520
ESAS	Razorbill summer	summer SST lag 2	0.277	0.255	24	1.089	0.287
ESAS	Razorbill summer	autumn SST lag 2	0.634	0.158	24	4.017	0.001
SMP	Sandwich tern	annual SST	–0.027	0.084	76	–0.320	0.750
SMP	Sandwich tern	winter SST	–0.041	0.059	76	–0.705	0.483
SMP	Sandwich tern	spring SST	–0.009	0.048	76	–0.190	0.850
SMP	Sandwich tern	summer SST	0.019	0.034	76	0.546	0.586
SMP	Sandwich tern	autumn SST	–0.074	0.052	76	–1.428	0.157
SMP	Sandwich tern	annual SST lag 1	–0.031	0.098	76	–0.319	0.750
SMP	Sandwich tern	winter SST lag 1	0.046	0.050	76	0.913	0.364
SMP	Sandwich tern	spring SST lag 1	–0.009	0.058	76	–0.160	0.873
SMP	Sandwich tern	summer SST lag 1	–0.020	0.047	76	–0.436	0.664
SMP	Sandwich tern	autumn SST lag 1	–0.014	0.070	76	–0.199	0.843
SMP	Sandwich tern	annual SST lag 2	0.086	0.123	74	0.698	0.488
SMP	Sandwich tern	winter SST lag 2	–0.024	0.080	74	–0.305	0.761
SMP	Sandwich tern	spring SST lag 2	–0.032	0.071	74	–0.457	0.649
SMP	Sandwich tern	summer SST lag 2	0.048	0.060	74	0.797	0.428
SMP	Sandwich tern	autumn SST lag 2	0.109	0.068	74	1.610	0.112
WeBS	Sandwich tern summer	annual SST	–0.162	0.695	20	–0.233	0.818
WeBS	Sandwich tern summer	winter SST	0.417	0.656	20	0.635	0.533
WeBS	Sandwich tern summer	spring SST	–0.223	0.437	20	–0.511	0.615
WeBS	Sandwich tern summer	summer SST	–0.493	0.421	20	–1.170	0.256
WeBS	Sandwich tern summer	autumn SST	0.466	0.517	20	0.902	0.378
WeBS	Sandwich tern summer	annual SST lag 1	0.058	0.670	20	0.087	0.932
WeBS	Sandwich tern summer	winter SST lag 1	–0.004	0.549	20	–0.007	0.994
WeBS	Sandwich tern summer	spring SST lag 1	–0.329	0.404	20	–0.815	0.425
WeBS	Sandwich tern summer	summer SST lag 1	0.157	0.384	20	0.409	0.687
WeBS	Sandwich tern summer	autumn SST lag 1	0.478	0.489	20	0.977	0.340
WeBS	Sandwich tern summer	annual SST lag 2	0.061	0.560	20	0.109	0.914
WeBS	Sandwich tern summer	winter SST lag 2	0.476	0.473	20	1.006	0.326
WeBS	Sandwich tern summer	spring SST lag 2	0.051	0.394	20	0.129	0.899
WeBS	Sandwich tern summer	summer SST lag 2	–0.065	0.369	20	–0.176	0.862
WeBS	Sandwich tern summer	autumn SST lag 2	–0.082	0.451	20	–0.181	0.858
WeBS	Scaup winter	annual SST	–1.423	0.366	45	–3.888	0.000
WeBS	Scaup winter	winter SST	–1.165	0.390	45	–2.986	0.005
WeBS	Scaup winter	spring SST	–0.772	0.324	45	–2.384	0.021
WeBS	Scaup winter	summer SST	–1.167	0.360	45	–3.240	0.002
WeBS	Scaup winter	autumn SST	–1.282	0.380	45	–3.375	0.002
WeBS	Scaup winter	annual SST lag 1	–0.931	0.467	46	–1.996	0.052
WeBS	Scaup winter	winter SST lag 1	–1.253	0.355	46	–3.524	0.001
WeBS	Scaup winter	spring SST lag 1	–0.712	0.322	46	–2.209	0.032
WeBS	Scaup winter	summer SST lag 1	0.189	0.400	46	0.472	0.639
WeBS	Scaup winter	autumn SST lag 1	–0.731	0.476	46	–1.536	0.131
WeBS	Scaup winter	annual SST lag 2	–1.309	0.378	47	–3.465	0.001
WeBS	Scaup winter	winter SST lag 2	–1.548	0.299	47	–5.184	0.000
WeBS	Scaup winter	spring SST lag 2	–0.860	0.328	47	–2.621	0.012
WeBS	Scaup winter	summer SST lag 2	–0.655	0.338	47	–1.935	0.059
WeBS	Scaup winter	autumn SST lag 2	–1.066	0.349	47	–3.058	0.004
WeBS	Velvet scoter winter	annual SST	0.052	0.370	17	0.142	0.889
WeBS	Velvet scoter winter	winter SST	0.218	0.407	17	0.535	0.600

WeBS	Velvet scoter winter	spring SST	0.261	0.326	17	0.800	0.435
WeBS	Velvet scoter winter	summer SST	–0.105	0.294	17	–0.358	0.725
WeBS	Velvet scoter winter	autumn SST	–0.048	0.318	17	–0.151	0.882
WeBS	Velvet scoter winter	annual SST lag 1	–0.153	0.384	17	–0.397	0.696
WeBS	Velvet scoter winter	winter SST lag 1	0.142	0.420	17	0.339	0.739
WeBS	Velvet scoter winter	spring SST lag 1	0.063	0.330	17	0.192	0.850
WeBS	Velvet scoter winter	summer SST lag 1	–0.382	0.296	17	–1.292	0.214
WeBS	Velvet scoter winter	autumn SST lag 1	–0.228	0.348	17	–0.654	0.522
WeBS	Velvet scoter winter	annual SST lag 2	–0.244	0.382	18	–0.638	0.532
WeBS	Velvet scoter winter	winter SST lag 2	–0.036	0.400	18	–0.090	0.929
WeBS	Velvet scoter winter	spring SST lag 2	–0.182	0.343	18	–0.531	0.602
WeBS	Velvet scoter winter	summer SST lag 2	–0.326	0.291	18	–1.118	0.278
WeBS	Velvet scoter winter	autumn SST lag 2	–0.218	0.344	18	–0.632	0.535

Table S3. Relationships between productivity estimates (data from the Seabird Monitoring Programme) and sea surface temperature (SST). All models were fitted with temporal autocorrelation accounted for

Species	Climate term	Climate est	Climate SE	DF	*t*	p
Arctic tern	annual SST	–0.288	0.308	42	–0.936	0.355
Arctic tern	winter SST	–0.754	0.266	42	–2.835	0.007
Arctic tern	spring SST	–0.447	0.222	42	–2.018	0.050
Arctic tern	summer SST	0.183	0.218	42	0.840	0.406
Arctic tern	autumn SST	–0.132	0.244	42	–0.542	0.591
Arctic tern	annual SST lag 1	–0.557	0.277	45	–2.010	0.051
Arctic tern	winter SST lag 1	–0.603	0.247	45	–2.446	0.018
Arctic tern	spring SST lag 1	–0.513	0.193	45	–2.659	0.011
Arctic tern	summer SST lag 1	–0.167	0.209	45	–0.799	0.429
Arctic tern	autumn SST lag 1	–0.087	0.241	45	–0.363	0.719
Arctic tern	annual SST lag 2	–0.084	0.261	46	–0.321	0.749
Arctic tern	winter SST lag 2	0.278	0.279	46	0.996	0.325
Arctic tern	spring SST lag 2	0.155	0.203	46	0.760	0.451
Arctic tern	summer SST lag 2	–0.118	0.190	46	–0.623	0.537
Arctic tern	autumn SST lag 2	–0.343	0.221	46	–1.549	0.128
Common tern	annual SST	–0.043	0.311	41	–0.137	0.892
Common tern	winter SST	–0.282	0.287	41	–0.983	0.331
Common tern	spring SST	–0.330	0.216	41	–1.529	0.134
Common tern	summer SST	0.205	0.242	41	0.849	0.401
Common tern	autumn SST	0.082	0.247	41	0.332	0.741
Common tern	annual SST lag 1	–0.661	0.319	43	–2.069	0.045
Common tern	winter SST lag 1	–0.663	0.275	43	–2.411	0.020
Common tern	spring SST lag 1	–0.445	0.226	43	–1.967	0.056
Common tern	summer SST lag 1	–0.410	0.269	43	–1.525	0.135
Common tern	autumn SST lag 1	–0.308	0.255	43	–1.212	0.232
Common tern	annual SST lag 2	–0.538	0.309	43	–1.738	0.089
Common tern	winter SST lag 2	–0.132	0.291	43	–0.452	0.653
Common tern	spring SST lag 2	–0.040	0.235	43	–0.171	0.865
Common tern	summer SST lag 2	–0.378	0.236	43	–1.602	0.116
Common tern	autumn SST lag 2	–0.743	0.258	43	–2.884	0.006
Northern fulmar	annual SST	–0.598	0.170	80	–3.524	0.001
Northern fulmar	winter SST	–0.607	0.138	80	–4.385	0.000
Northern fulmar	spring SST	–0.374	0.116	80	–3.219	0.002
Northern fulmar	summer SST	–0.024	0.120	80	–0.203	0.840
Northern fulmar	autumn SST	–0.320	0.142	80	–2.250	0.027
Northern fulmar	annual SST lag 1	–0.638	0.161	83	–3.960	0.000
Northern fulmar	winter SST lag 1	–0.267	0.143	83	–1.865	0.066
Northern fulmar	spring SST lag 1	–0.320	0.113	83	–2.832	0.006
Northern fulmar	summer SST lag 1	–0.330	0.114	83	–2.891	0.005
Northern fulmar	autumn SST lag 1	–0.336	0.135	83	–2.498	0.015
Northern fulmar	annual SST lag 2	–0.228	0.176	86	–1.293	0.200
Northern fulmar	winter SST lag 2	–0.194	0.144	86	–1.344	0.183
Northern fulmar	spring SST lag 2	0.175	0.123	86	1.430	0.156
Northern fulmar	summer SST lag 2	–0.033	0.114	86	–0.287	0.775

Northern fulmar	autumn SST lag 2	–0.377	0.133	86	–2.830	0.006
Common guillemot	annual SST	–0.173	0.278	29	–0.621	0.539
Common guillemot	winter SST	–0.355	0.203	29	–1.749	0.091
Common guillemot	spring SST	–0.218	0.167	29	–1.304	0.203
Common guillemot	summer SST	0.217	0.185	29	1.172	0.251
Common guillemot	autumn SST	0.017	0.224	29	0.075	0.941
Common guillemot	annual SST lag 1	–0.136	0.287	31	–0.473	0.640
Common guillemot	winter SST lag 1	–0.075	0.224	31	–0.333	0.741
Common guillemot	spring SST lag 1	0.211	0.167	31	1.258	0.218
Common guillemot	summer SST lag 1	–0.091	0.181	31	–0.499	0.621
Common guillemot	autumn SST lag 1	–0.346	0.201	31	–1.718	0.096
Common guillemot	annual SST lag 2	–0.126	0.280	33	–0.450	0.656
Common guillemot	winter SST lag 2	–0.050	0.210	33	–0.239	0.813
Common guillemot	spring SST lag 2	–0.008	0.166	33	–0.051	0.960
Common guillemot	summer SST lag 2	–0.140	0.171	33	–0.818	0.420
Common guillemot	autumn SST lag 2	–0.095	0.209	33	–0.452	0.654
Herring gull	annual SST	–0.124	0.275	17	–0.452	0.657
Herring gull	winter SST	0.024	0.206	17	0.118	0.907
Herring gull	spring SST	–0.224	0.163	17	–1.374	0.187
Herring gull	summer SST	0.056	0.156	17	0.362	0.722
Herring gull	autumn SST	–0.025	0.191	17	–0.132	0.897
Herring gull	annual SST lag 1	–0.050	0.277	17	–0.180	0.859
Herring gull	winter SST lag 1	–0.358	0.199	17	–1.801	0.090
Herring gull	spring SST lag 1	–0.199	0.186	17	–1.071	0.299
Herring gull	summer SST lag 1	0.132	0.148	17	0.886	0.388
Herring gull	autumn SST lag 1	0.167	0.192	17	0.868	0.397
Herring gull	annual SST lag 2	–0.242	0.248	17	–0.977	0.343
Herring gull	winter SST lag 2	–0.128	0.197	17	–0.648	0.526
Herring gull	spring SST lag 2	–0.013	0.183	17	–0.071	0.944
Herring gull	summer SST lag 2	–0.123	0.147	17	–0.841	0.412
Herring gull	autumn SST lag 2	–0.211	0.195	17	–1.084	0.293
Black-legged kittiwake	annual SST	–0.171	0.157	87	–1.091	0.278
Black-legged kittiwake	winter SST	–0.317	0.134	87	–2.365	0.020
Black-legged kittiwake	spring SST	–0.246	0.108	87	–2.268	0.026
Black-legged kittiwake	summer SST	0.199	0.106	87	1.877	0.064
Black-legged kittiwake	autumn SST	–0.063	0.130	87	–0.485	0.629
Black-legged kittiwake	annual SST lag 1	–0.398	0.137	91	–2.905	0.005
Black-legged kittiwake	winter SST lag 1	–0.238	0.129	91	–1.847	0.068
Black-legged kittiwake	spring SST lag 1	–0.312	0.099	91	–3.140	0.002
Black-legged kittiwake	summer SST lag 1	–0.240	0.103	91	–2.330	0.022
Black-legged kittiwake	autumn SST lag 1	–0.066	0.123	91	–0.535	0.594
Black-legged kittiwake	annual SST lag 2	–0.292	0.137	95	–2.133	0.036
Black-legged kittiwake	winter SST lag 2	–0.217	0.125	95	–1.732	0.086
Black-legged kittiwake	spring SST lag 2	0.099	0.106	95	0.931	0.354
Black-legged kittiwake	summer SST lag 2	–0.184	0.101	95	–1.825	0.071
Black-legged kittiwake	autumn SST lag 2	–0.413	0.115	95	–3.590	0.001
Lesser black-backed gull	annual SST	–0.156	0.264	17	–0.590	0.563
Lesser black-backed gull	winter SST	–0.066	0.228	17	–0.288	0.777
Lesser black-backed gull	spring SST	–0.193	0.184	17	–1.054	0.307
Lesser black-backed gull	summer SST	–0.039	0.197	17	–0.199	0.845
Lesser black-backed gull	autumn SST	–0.048	0.199	17	–0.243	0.811
Lesser black-backed gull	annual SST lag 1	–0.196	0.271	17	–0.722	0.480
Lesser black-backed gull	winter SST lag 1	–0.044	0.245	17	–0.180	0.859
Lesser black-backed gull	spring SST lag 1	–0.081	0.211	17	–0.382	0.708
Lesser black-backed gull	summer SST lag 1	–0.157	0.191	17	–0.824	0.421
Lesser black-backed gull	autumn SST lag 1	–0.139	0.194	17	–0.717	0.483
Lesser black-backed gull	annual SST lag 2	0.245	0.234	17	1.044	0.311
Lesser black-backed gull	winter SST lag 2	0.028	0.236	17	0.117	0.908
Lesser black-backed gull	spring SST lag 2	0.284	0.180	17	1.578	0.133
Lesser black-backed gull	summer SST lag 2	0.147	0.170	17	0.863	0.400
Lesser black-backed gull	autumn SST lag 2	0.116	0.198	17	0.584	0.567
Atlantic puffin	annual SST	–0.410	0.270	37	–1.520	0.137
Atlantic puffin	winter SST	–0.750	0.227	37	–3.301	0.002
Atlantic puffin	spring SST	–0.761	0.163	37	–4.682	0.000

Atlantic puffin	summer SST	0.259	0.201	37	1.283	0.207
Atlantic puffin	autumn SST	0.179	0.241	37	0.743	0.462
Atlantic puffin	annual SST lag 1	–0.576	0.259	39	–2.226	0.032
Atlantic puffin	winter SST lag 1	–0.488	0.230	39	–2.120	0.041
Atlantic puffin	spring SST lag 1	–0.301	0.190	39	–1.582	0.122
Atlantic puffin	summer SST lag 1	–0.278	0.184	39	–1.507	0.140
Atlantic puffin	autumn SST lag 1	–0.348	0.210	39	–1.655	0.106
Atlantic puffin	annual SST lag 2	–0.187	0.270	41	–0.691	0.493
Atlantic puffin	winter SST lag 2	–0.211	0.238	41	–0.888	0.380
Atlantic puffin	spring SST lag 2	0.183	0.194	41	0.943	0.351
Atlantic puffin	summer SST lag 2	–0.104	0.189	41	–0.553	0.584
Atlantic puffin	autumn SST lag 2	–0.438	0.200	41	–2.187	0.035
Razorbill	annual SST	–0.252	0.146	35	–1.725	0.093
Razorbill	winter SST	–0.265	0.139	35	–1.904	0.065
Razorbill	spring SST	–0.197	0.110	35	–1.790	0.082
Razorbill	summer SST	–0.032	0.112	35	–0.284	0.778
Razorbill	autumn SST	–0.190	0.123	35	–1.545	0.131
Razorbill	annual SST lag 1	–0.127	0.142	37	–0.895	0.377
Razorbill	winter SST lag 1	–0.080	0.140	37	–0.576	0.568
Razorbill	spring SST lag 1	–0.021	0.108	37	–0.192	0.849
Razorbill	summer SST lag 1	–0.084	0.105	37	–0.802	0.428
Razorbill	autumn SST lag 1	–0.138	0.118	37	–1.167	0.251
Razorbill	annual SST lag 2	–0.003	0.139	39	–0.024	0.981
Razorbill	winter SST lag 2	–0.023	0.130	39	–0.178	0.860
Razorbill	spring SST lag 2	0.006	0.101	39	0.063	0.950
Razorbill	summer SST lag 2	0.002	0.106	39	0.023	0.982
Razorbill	autumn SST lag 2	–0.004	0.119	39	–0.038	0.970
European shag	annual SST	0.024	0.209	63	0.114	0.910
European shag	winter SST	–0.180	0.173	63	–1.041	0.302
European shag	spring SST	–0.090	0.143	63	–0.629	0.532
European shag	summer SST	0.135	0.136	63	0.993	0.325
European shag	autumn SST	0.091	0.163	63	0.561	0.577
European shag	annual SST lag 1	–0.114	0.204	66	–0.558	0.579
European shag	winter SST lag 1	–0.121	0.170	66	–0.708	0.481
European shag	spring SST lag 1	–0.040	0.138	66	–0.293	0.770
European shag	summer SST lag 1	–0.096	0.134	66	–0.716	0.476
European shag	autumn SST lag 1	0.050	0.160	66	0.313	0.755
European shag	annual SST lag 2	–0.046	0.200	69	–0.229	0.820
European shag	winter SST lag 2	0.127	0.166	69	0.767	0.446
European shag	spring SST lag 2	0.200	0.133	69	1.501	0.138
European shag	summer SST lag 2	–0.217	0.129	69	–1.680	0.097
European shag	autumn SST lag 2	–0.181	0.157	69	–1.150	0.254

Table S4. Relationships between logit transformed adult survival estimates (data from the Isle of May Long-term Study) and sea surface temperature (SST). All models were fitted with temporal autocorrelation accounted for

Species	Climate term	Climate est	Climate SE	DF	*t*	p
Black-legged kittiwake	annual SST	–0.554	0.240	20	–2.307	0.032
Black-legged kittiwake	winter SST	–0.434	0.220	20	–1.974	0.062
Black-legged kittiwake	spring SST	–0.372	0.179	20	–2.081	0.051
Black-legged kittiwake	summer SST	–0.249	0.185	20	–1.342	0.195
Black-legged kittiwake	autumn SST	–0.321	0.207	20	–1.549	0.137
Black-legged kittiwake	annual SST lag 1	–0.468	0.223	20	–2.101	0.049
Black-legged kittiwake	winter SST lag 1	–0.357	0.235	20	–1.523	0.144
Black-legged kittiwake	spring SST lag 1	–0.202	0.210	20	–0.958	0.349
Black-legged kittiwake	summer SST lag 1	–0.263	0.173	20	–1.518	0.145
Black-legged kittiwake	autumn SST lag 1	–0.367	0.180	20	–2.040	0.055
Black-legged kittiwake	annual SST lag 2	–0.575	0.214	20	–2.691	0.014
Black-legged kittiwake	winter SST lag 2	–0.588	0.207	20	–2.843	0.010
Black-legged kittiwake	spring SST lag 2	–0.342	0.201	20	–1.700	0.105

Black-legged kittiwake	summer SST lag 2	–0.347	0.156	20	–2.223	0.038
Black-legged kittiwake	autumn SST lag 2	–0.484	0.186	20	–2.600	0.017
European shag	annual SST	–0.306	0.691	20	–0.443	0.662
European shag	winter SST	–0.763	0.712	20	–1.072	0.297
European shag	spring SST	–0.533	0.529	20	–1.008	0.325
European shag	summer SST	0.991	0.601	20	1.651	0.114
European shag	autumn SST	0.230	0.582	20	0.395	0.697
European shag	annual SST lag 1	–1.700	0.782	20	–2.174	0.042
European shag	winter SST lag 1	–0.790	0.671	20	–1.177	0.253
European shag	spring SST lag 1	–1.153	0.584	20	–1.974	0.062
European shag	summer SST lag 1	–1.499	0.446	20	–3.357	0.003
European shag	autumn SST lag 1	–0.689	0.566	20	–1.218	0.237
European shag	annual SST lag 2	–1.284	0.619	20	–2.074	0.051
European shag	winter SST lag 2	–0.692	0.673	20	–1.028	0.316
European shag	spring SST lag 2	–0.478	0.536	20	–0.892	0.383
European shag	summer SST lag 2	–1.029	0.400	20	–2.570	0.018
European shag	autumn SST lag 2	–1.473	0.526	20	–2.799	0.011
Atlantic puffin	annual SST	–0.648	0.400	20	–1.620	0.121
Atlantic puffin	winter SST	–0.524	0.336	20	–1.562	0.134
Atlantic puffin	spring SST	–0.469	0.273	20	–1.717	0.101
Atlantic puffin	summer SST	–0.114	0.270	20	–0.421	0.678
Atlantic puffin	autumn SST	–0.407	0.317	20	–1.285	0.213
Atlantic puffin	annual SST lag 1	–0.155	0.419	20	–0.370	0.715
Atlantic puffin	winter SST lag 1	–0.573	0.364	20	–1.575	0.131
Atlantic puffin	spring SST lag 1	0.322	0.276	20	1.167	0.257
Atlantic puffin	summer SST lag 1	0.050	0.271	20	0.186	0.855
Atlantic puffin	autumn SST lag 1	–0.390	0.295	20	–1.322	0.201
Atlantic puffin	annual SST lag 2	–0.504	0.404	20	–1.247	0.227
Atlantic puffin	winter SST lag 2	–0.743	0.335	20	–2.221	0.038
Atlantic puffin	spring SST lag 2	–0.409	0.304	20	–1.343	0.194
Atlantic puffin	summer SST lag 2	–0.017	0.266	20	–0.065	0.949
Atlantic puffin	autumn SST lag 2	–0.278	0.346	20	–0.804	0.431
Razorbill	annual SST	–0.561	0.358	20	–1.567	0.133
Razorbill	winter SST	–0.448	0.320	20	–1.398	0.178
Razorbill	spring SST	–0.240	0.275	20	–0.871	0.394
Razorbill	summer SST	–0.266	0.273	20	–0.974	0.342
Razorbill	autumn SST	–0.594	0.282	20	–2.105	0.048
Razorbill	annual SST lag 1	–0.189	0.345	20	–0.549	0.589
Razorbill	winter SST lag 1	–0.359	0.364	20	–0.987	0.336
Razorbill	spring SST lag 1	0.092	0.288	20	0.320	0.753
Razorbill	summer SST lag 1	–0.060	0.268	20	–0.225	0.824
Razorbill	autumn SST lag 1	–0.257	0.272	20	–0.946	0.356
Razorbill	annual SST lag 2	–0.095	0.360	20	–0.263	0.795
Razorbill	winter SST lag 2	–0.168	0.360	20	–0.467	0.645
Razorbill	spring SST lag 2	–0.206	0.299	20	–0.688	0.499
Razorbill	summer SST lag 2	–0.033	0.273	20	–0.121	0.905
Razorbill	autumn SST lag 2	0.126	0.323	20	0.389	0.701
Common guillemot	annual SST	–0.777	0.328	20	–2.369	0.028
Common guillemot	winter SST	–0.944	0.252	20	–3.749	0.001
Common guillemot	spring SST	–0.325	0.213	20	–1.523	0.144
Common guillemot	summer SST	0.122	0.173	20	0.704	0.489
Common guillemot	autumn SST	–0.187	0.221	20	–0.847	0.407
Common guillemot	annual SST lag 1	–0.782	0.322	20	–2.429	0.025
Common guillemot	winter SST lag 1	0.390	0.199	20	1.954	0.065
Common guillemot	spring SST lag 1	0.227	0.187	20	1.213	0.239
Common guillemot	summer SST lag 1	–0.329	0.168	20	–1.959	0.064
Common guillemot	autumn SST lag 1	–0.787	0.198	20	–3.975	0.001
Common guillemot	annual SST lag 2	0.304	0.288	20	1.057	0.303
Common guillemot	winter SST lag 2	–0.562	0.236	20	–2.379	0.027
Common guillemot	spring SST lag 2	–0.125	0.202	20	–0.618	0.543
Common guillemot	summer SST lag 2	0.313	0.139	20	2.244	0.036
Common guillemot	autumn SST lag 2	0.211	0.229	20	0.921	0.368

TREND MODELS

Table S5. Relationships with time for count estimates based on Seabird Monitoring Programme (SMP), Wetlands Bird Survey (WeBS) and European Seabirds at Sea (ESAS) data. SMP data are all based on counts from breeding colonies (summer). Seasons of WeBS and ESAS data counts are indicated next to the species concerned. All models were fitted with temporal autocorrelation accounted for

Species	Data set	Est	SE	DF	*t*	p
Arctic tern summer	WeBS	–0.021	0.044	25	–0.466	0.645
Black scoter winter	WeBS	–0.022	0.018	28	–1.253	0.221
Common tern summer	WeBS	–0.012	0.115	9	–0.102	0.921
Cormorant winter	WeBS	0.053	0.015	24	3.565	0.002
Eider winter	WeBS	0.009	0.016	27	0.570	0.573
Goldeneye winter	WeBS	–0.004	0.012	47	–0.292	0.772
Goosander summer	WeBS	0.021	0.017	42	1.211	0.233
Great black-backed gull summer	WeBS	–0.030	0.029	13	–1.025	0.324
Great crested grebe winter	WeBS	–0.046	0.013	83	–3.553	0.001
Little tern summer	WeBS	–0.161	0.097	11	–1.654	0.126
Long-tailed duck winter	WeBS	0.025	0.017	47	1.425	0.161
Merganser summer	WeBS	0.034	0.020	37	1.703	0.097
Merganser winter	WeBS	0.009	0.019	47	0.473	0.638
Sandwich tern summer	WeBS	0.033	0.065	20	0.509	0.617
Scaup winter	WeBS	–0.112	0.022	51	–5.087	0.000
Velvet scoter winter	WeBS	–0.008	0.027	19	–0.289	0.776
Arctic tern	SMP	–0.018	0.010	101	–1.738	0.085
Black-headed gull	SMP	0.068	0.028	24	2.428	0.023
Common tern	SMP	0.004	0.016	170	0.273	0.785
Cormorant	SMP	–0.020	0.009	144	–2.075	0.040
Eider	SMP	0.011	0.007	19	1.509	0.148
Northern fulmar	SMP	–0.006	0.005	261	–1.101	0.272
Great black-backed gull	SMP	0.077	0.010	144	7.769	0.000
Common guillemot	SMP	0.018	0.007	165	2.552	0.012
Herring gull	SMP	0.008	0.008	182	0.988	0.324
Black-legged kittiwake	SMP	–0.035	0.005	211	–7.842	0.000
Lesser black-backed gull	SMP	0.040	0.011	117	3.739	0.000
Atlantic puffin	SMP	0.008	0.013	60	0.610	0.544
Razorbill	SMP	0.021	0.004	177	4.872	0.000
Sandwich tern	SMP	–0.040	0.008	86	–5.059	0.000
European shag	SMP	–0.023	0.007	281	–3.104	0.002
Gannet summer	ESAS	0.070	0.015	28	4.701	0.000
Gannet winter	ESAS	0.013	0.019	23	0.654	0.520
Great black-backed gull winter	ESAS	–0.055	0.033	23	–1.637	0.115
Common guillemot summer	ESAS	0.011	0.013	28	0.909	0.371
Common guillemot winter	ESAS	0.002	0.014	23	0.161	0.874
Herring gull winter	ESAS	–0.030	0.033	23	–0.934	0.360
Razorbill summer	ESAS	0.028	0.017	28	1.667	0.107
Northern fulmar winter	ESAS	–0.013	0.011	23	–1.170	0.254
Northern fulmar summer	ESAS	–0.015	0.018	28	–0.847	0.404
Black-legged kittiwake summer	ESAS	0.009	0.017	28	0.494	0.625
Black-legged kittiwake winter	ESAS	–0.026	0.017	23	–1.520	0.142

Table S6. Relationships with time for productivity estimates based on Seabird Monitoring Programme (SMP) data. All models were fitted with temporal autocorrelation accounted for. Guillemot and razorbill were assessed qualitatively because of inconsistent trends and relationships with climate (see 'Methods' in the main text)

Species	Estimate	SE	df	*t*	p
Arctic tern	–0.008	0.021	46	–0.388	0.700
Common tern	–0.038	0.027	43	–1.423	0.162
Northern fulmar	–0.044	0.013	87	–3.249	0.002
Common guillemot	–0.006	0.026	33	–0.220	0.827
Herring gull	–0.036	0.023	17	–1.581	0.132
Black-legged kittiwake	–0.021	0.011	96	–1.957	0.053
Lesser black-backed gull	0.012	0.020	17	0.618	0.545
Atlantic puffin	–0.017	0.020	41	–0.848	0.401
Razorbill	–0.015	0.009	39	–1.671	0.103
European shag	0.023	0.015	70	1.595	0.115

Table S7. Relationships with time for adult survival estimates between 1986 and 2007 (based on Isle of May Long-term Study data). All models were fitted with temporal autocorrelation accounted for

Species	Est	SE	df	*t*	p
Black-legged kittiwake	–0.057	0.016	20	–3.598	0.002
European shag	–0.093	0.060	20	–1.550	0.137
Atlantic puffin	–0.058	0.036	20	–1.622	0.121
Razorbill	–0.034	0.028	20	–1.215	0.239
Common guillemot	–0.101	0.019	20	–5.227	0.000

VULNERABILITY ASSESSMENTS

Table S8. Quantitative assessments of vulnerability to climate were undertaken on 23 species (guillemot and razorbill were assessed qualitatively due to inconsistencies in relationships with climate between different data sets). Detailed break–down of the data sets analysed and the rationale behind each climate score are given. SMP: Seabird Monitoring Programme, WeBS: Wetlands Bird Survey, ESAS: European Seabirds at Sea, IMLOTS: Isle of May Long–term Study

Species	**Robust datasets available**	**No robust data-sets ana-lysed**	**Direction of significant trends**	**Climate regressions consistently in one direction? (no. models)**	**Climate relationship directions**	**Definitive trend direction**	**Definitive climate relation-ship**	**Lags?**	**Climate vulnera-bility**	**Index of popula-tion concern to future climate**
Great crested grebe *Podiceps cristatus*	WeBS winter	1	Decline	Yes (13 negative)	Negative	decline	negative	yes	3	4
Northern fulmar *Fulmarus glacialis*	ESAS winter & summer; SMP count; SMP productivity	4	Decline (productivity), no trend (counts)	Yes (productivity 9 negative; ESAS winter 6 negative); No (SMP counts 5 negative & 3 positive)	Negative (ESAS counts; productivity); Unknown (SMP counts)	decline	negative	yes	3	4
Northern gannet *Morus bassanus*	ESAS summer & winter	2	Increase (ESAS summer)	Yes (ESAS summer 8 positive)	Positive	increase	positive	yes	1	0
Great cormorant *Phalacrocorax carbo*	SMP count; WeBS winter	2	Decline (SMP & WeBS)	Yes (SMP 1 negative; WeBS 12 positive)	Positive	decline	positive	no	1	2
European shag *Phalacrocorax aristotelis*	SMP count; SMP productivity; IMLOTS	3	Decline (counts), no trend (productivity or survival)	Yes (survival 4 negative); No (counts 5 negative & 5 positive)	Negative (survival); none (productivity); unknown (counts)	decline	negative	yes	3	4
Greater scaup *Aythya marila*	WeBS winter	1	Decline	Yes (12 negative)	Negative	decline	negative	yes	3	4
Common eider *Somateria*	SMP (counts);	2	No trend	Yes (SMP 2 positive)	positive	no trend	positive	yes	1	1

mollissima	WeBS winter									
Long-tailed duck *Clangula hyemalis*	WeBS winter	1	No trend	Yes (3 positive)	positive	no trend	positive	yes	1	1
Black scoter *Melanitta nigra*	WeBS winter	1	No trend	Yes (7 negative)	Negative	no trend	negative	yes	3	3
Velvet scoter *Melanitta fusca*	WeBS winter	1	No trend	No significant relationships	No relationships	no trend	no relationship	no	2	2
Common goldeneye *Bucephala clangula*	WeBS winter	1	No trend	No significant relationships	No relationships	no trend	no relationship	no	2	2
Red–breasted merganser *Mergus serrator*	WeBS summer & winter	2	No trend	Yes (winter 2 negative)	negative	no trend	negative	yes	3	3
Goosander *Mergus merganser*	WeBS summer	1	No trend	No significant relationships (1 positive)	No relationships	no trend	no relationship	no	2	2
Black-headed gull *Chroicocephalus ridibundus*	SMP counts	1	Increasing (SMP)	Yes (3 positive)	positive	increase	positive	yes	1	0
Lesser black-backed gull *Larus fuscus*	SMP counts & productivity	2	Increase (counts), no trend (productivity)	No significant relationships	No relationships	increase	no relationship	yes	2	2
Herring gull *Larus argentatus*	ESAS winter; SMP counts & productivity	3	No trend (counts or productivity)	Yes (ESAS winter 6 negative)	Negative	no trend	negative	yes	3	3
Great black-backed gull *Larus marinus*	ESAS winter; SMP counts; WeBS summer	3	Increase (SMP), no trend (WeBS; ESAS)	Yes (WeBS 1 negative; ESAS 8 negative)	Negative	increase	negative	yes	3	3
Black-legged kittiwake *Rissa tridactyla*	ESAS summer & winter; SMP (counts & producti-vity); IMLOTS	5	Decline (SMP counts, survival & productivity)	Yes (productivity 7 negative; survival 7 negative; ESAS counts 75% negative); No (SMP 3 positive & 1 negative)	Negative	decline	negative	yes	3	4
Sandwich tern *Sterna sandvicensis*	SMP (counts); WeBS summer	2	Decline (SMP), no trend (WeBS)	No significant relationships	No relationships	decline	no relationship	no	2	2
Common tern *Sterna hirundo*	SMP (counts & pro-ductivity); WeBS summer	3	No trend (counts or productivity)	Yes (productivity 3 negative; WeBS 1 negative)	Negative	no trend	negative	yes	3	3
Arctic tern *Sterna paradisaea*	SMP (counts & pro-ductivity); WeBS summer	3	No trend (counts or productivity)	Yes (SMP 2 negative; productivity 5 negative)	Negative (productivity & SMP), no relationships (WeBS)	no trend	negative	yes	3	3
Little tern *Sternula albifrons*	WeBS summer	1	No trend	Yes (3 negative)	negative	no trend	negative	yes	3	3
Common guillemot *Uria aalge*	ESAS summer & winter; SMP (counts & producti-vity); IMLOTS	5	Increase (SMP counts); Decline (survival), no trend (ESAS)	Yes (ESAS summer 3 positive; ESAS winter 2 negative; survival 75% negative); no relationships (SMP counts; productivity)	Negative (winter ESAS & survival)	decline	negative	yes	?	?
Atlantic puffin *Fratercula arctica*	SMP (counts & pro-ductivity); IMLOTS	4	no trend (SMP, productivity or survival)	Yes (productivity 5 negative); No relationship (counts; survival 1 negative)	Negative (productivity & survival), no relationship (counts)	no trend	negative	yes	3	3
Razorbill *Alca torda*	ESAS summer; SMP (counts & pro-ductivity); IMLOTS	4	Positive (SMP counts), No trend (ESAS, productivity or survival)	Yes (SMP counts 2 positive; ESAS 2 positive); No relationships (productivity; survival 1 negative)	No relationships (productivity), negative (survival), unknown (SMP counts)	no trend	unknown	yes	?	?

CLIMATE (QUALITATIVE)

Qualitative assessment of vulnerability

Foraging sensitivity was calculated for the 22 species qualitatively assessed for climate vulnerability utilizing the scoring system detailed by Furness & Tasker (2000) based on species foraging ecology. This index is based on summation of scores (0–4 per parameter, with 4 being the highest in terms of vulnerability to climate and 0 the lowest) according to the following parameters:

1) Size (4 = adult body mass of <125 g; 3 = 125–250 g; 2 = 250–500 g; 1 = 500–1000 g; 0 = >1000 g)
2) Costs of foraging (4 = flapping flight with hovering; 3 = flapping flight and underwater swimming/ high wing loading; 2 = flapping flight with gliding; 1 = mainly gliding flight; 0 = economic gliding flight)
3) Foraging range (4 = forage within 5 km of nest; 3 = within 10 km of nest; 2 = within 20 km; 1 = within 50 km; 0 = >50 km)
4) Ability to dive (4 = surface feeders; 3 = feed within upper 1 m of sea; 2 = within upper 10 m; 1 = up to 30 m depth; 0 = up to 60 m)
5) Spare time (4 = very little time off duty during chick rearing; 0 = feed chicks infrequently with considerable time off duty)
6) Limited ability to switch diet (4 = specialists on 1 prey type; 3 = diet of a few prey types; 2 = moderate variety; 1 = wide range of prey; 0 = very wide range of prey)

MULTIPLE ANTHROPOGENIC THREATS

Table S9. Details of the scores of vulnerability for wind farms assigned to each species. Species were assigned collision and displacement scores based on the scoring system of Furness et al. (2013). These scores were then converted in the final 2 columns to a vulnerability scale of 1 (low), 2 (moderate) or 3 (high) in order to facilitate comparison with other threats. See Furness et al. (2013) for details of how collision and displacement scores were initially calculated.

Species	Flight height	Flight agility	% of time flying	Night flight	Collision score	Disturbance	Habitat use flexibility	Displacement score	Collision impacts with wind farms	Displacement/disturbance from wind farms
Red-throated diver	5	5	2	1	13	5	4	20	2	3
Black-throated diver	5	5	3	1	15	5	4	20	2	3
Great northern diver	5	5	2	1	13	5	3	15	2	3
Great crested grebe	4	4	3	2	12	3	4	12	2	2
Red-necked grebe	4	4	2	2	11	3	4	12	2	2
Slavonian grebe	4	4	2	2	11	3	4	12	2	2
Black–necked grebe	4	4	2	2	11	3	4	12	2	2
Northern fulmar	5	3	2	4	15	1	1	1	2	1
Sooty shearwater	0	3	3	3	0	1	1	1	1	1
Manx shearwater	0	3	3	3	0	1	1	1	1	1
European storm-petrel	2	1	3	4	5	1	1	1	1	1
Leach's storm-petrel	2	1	3	4	5	1	1	1	1	1
Northern gannet	16	3	3	2	43	2	1	2	3	1
Great cormorant	4	4	2	1	9	4	3	12	1	2
European shag	5	3	2	1	10	3	3	9	1	2
Greater scaup	3	4	2	5	11	4	4	16	2	3
Common eider	3	4	2	3	9	3	4	12	1	2
Long-tailed duck	3	3	2	3	8	3	4	12	1	2
Black scoter	3	3	2	3	8	5	4	20	1	3
Surf scoter	3	3	2	3	8	5	3	15	1	3

Velvet scoter	3	3	2	3	8	5	3	15	1	3
Common goldeneye	3	3	2	3	8	4	4	16	1	3
Red-breasted merganser	3	3	2	3	8	4	4	16	1	3
Goosander	3	3	2	3	8	4	4	16	1	3
Pomarine skua	10	1	5	1	23	1	2	2	3	1
Arctic skua	10	1	5	1	23	1	2	2	3	1
Long-tailed skua	10	1	5	1	23	1	2	2	3	1
Great skua	10	1	4	1	20	1	2	2	2	1
Mediterranean gull	23	1	2	3	46	2	2	4	3	1
Little gull	5	1	5	1	12	2	3	6	2	1
Black-headed gull	18	1	1	2	24	2	2	4	3	1
Common gull	23	1	2	3	46	2	2	4	3	1
Lesser black-backed gull	27	1	2	3	54	2	1	2	3	1
Herring gull	31	2	2	3	72	2	1	2	3	1
Great black-backed gull	35	2	2	3	82	2	2	4	3	1
Black-legged kittiwake	16	1	3	3	37	2	2	4	3	1
Sandwich tern	5	1	5	1	12	2	3	6	2	1
Roseate tern	5	1	5	1	12	2	3	6	2	1
Common tern	7	1	5	1	16	2	3	6	2	1
Arctic tern	5	1	5	1	12	2	3	6	2	1
Little tern	7	1	5	1	16	2	4	8	2	2
Common guillemot	4	4	1	2	9	3	3	9	1	2
Razorbill	5	4	1	1	10	3	3	9	1	2
Little auk	4	3	1	1	7	2	2	4	1	1
Atlantic puffin	1	3	1	1	2	2	3	6	1	1

Table S10. Scores assigned to anthropogenic risks in the Forth/Tay area based on the scoring system of Frederiksen (2010), including the 20 species not previously scored and revised scores for 17 species that were modified to account for local conditions according to Forrester et al. (2007) and our expert knowledge of the area. The scores in parentheses show the maximum score assigned to each threat in Frederiksen (2010), adjusted to be on the same scale as our vulnerability scores (no parentheses indicates that this species was not previously scored). As an example, Frederiksen (2010) gave a score of 2 to European shags for vulnerability to introduced predators, but because the majority of the population in the Forth and Tay region breed on accessible ledges on islands we considered them to have high vulnerability and gave the species a score of 3

Species	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance (non-wind farm related)
Red-throated diver	1	2	1	3	1	1	1	2
Black-throated diver	1	1	1	3	1	1	1	2
Great northern diver	1	1	1	3	1	1	1	2
Great crested grebe	1	2	1	3	1	1	1	1
Red-necked grebe	1	2	1	3	1	1	1	1
Slavonian grebe	1	2	1	3	1	1	1	1
Black-necked grebe	1	2	1	3	1	1	1	1
Northern fulmar	3(3)	2(3)	1(1)	2(2)	2(2)	3(3)	3(2)	2(1)
Sooty shearwater	2	2	1	2	1	3	1	1
Manx shearwater	2(1)	2(2)	1(1)	2(2)	1(1)	3(2)	1(3)	1(1)
European storm-petrel	1(1)	1(1)	1(1)	2(1)	1(1)	2(2)	1(3)	1(1)
Leach's storm-petrel	1(1)	1(1)	1(1)	2(1)	1(1)	2(2)	1(3)	1(1)
Northern gannet	3(3)	2(2)	2(2)	2(2)	2(2)	1(2)	1(2)	1(1)
Great cormorant	1(1)	2(2)	3(3)	2(2)	1(1)	1(2)	3(2)	2(2)
European shag	1(1)	2(2)	1(1)	2(2)	1(1)	1(2)	3(2)	2(2)
Greater scaup	1	1	2	3	1	1	1	1
Common eider	1(1)	2(2)	3(3)	2(2)	1(2)	1(2)	3(3)	2(3)
Long-tailed duck	1	1	2	3	1	1	1	2

Black scoter	1	1	2	3	1	1	1	2
Surf scoter	1	1	2	3	1	1	1	2
Velvet scoter	1	1	2	3	1	1	1	2
Common goldeneye	1	1	1	3	1	1	1	2
Red-breasted merganser	1	1	2	2	1	1	1	1
Goosander	1	1	3	1	1	1	1	1
Pomarine skua	3	1	2	1	1	1	1	1
Arctic skua	1(1)	1(1)	2(2)	1(1)	1(1)	1(1)	2(2)	1(1)
Long-tailed skua	1	1	2	1	1	1	1	1
Great skua	3(3)	2(2)	2(2)	1(1)	2(2)	1(1)	1(2)	1(2)
Mediterranean gull	1	1	1	2	1	1	1	1
Little gull	1(1)	1(1)	1(1)	2(1)	1(1)	1(1)	1(2)	1(1)
Black-headed gull	1(2)	1(1)	1(1)	2(2)	2(2)	1(1)	1(2)	1(1)
Common gull	1(2)	1(1)	1(1)	2(2)	2(2)	1(1)	1(2)	1(1)
Lesser black-backed gull	3(3)	2(2)	1(1)	2(2)	2(1)	1(1)	2(2)	1(1)
Herring gull	3(3)	2(2)	1(1)	2(2)	2(1)	1(1)	2(2)	1(1)
Great black-backed gull	3(3)	2(2)	1(2)	2(2)	2(2)	1(1)	2(2)	1(1)
Black-legged kittiwake	2(3)	1(1)	3(2)	2(2)	1(1)	1(1)	2(2)	1(1)
Sandwich tern	2(3)	1(1)	1(2)	1(1)	1(1)	1(1)	3(3)	2(3)
Roseate tern	2	1	1	1	1	1	3	3
Common tern	2(3)	1(1)	1(2)	1(1)	1(2)	1(1)	3(3)	3(3)
Arctic tern	2(3)	1(1)	1(2)	1(1)	1(1)	1(1)	3(3)	3(3)
Little tern	2(1)	1(1)	1(1)	1(1)	1(2)	1(1)	3(3)	3(3)
Common guillemot	1(1)	2(2)	2(2)	2(2)	1(1)	1(1)	3(2)	1(2)
Razorbill	1(1)	2(2)	1(2)	2(2)	1(1)	1(1)	3(2)	1(3)
Little auk	1(1)	1(1)	1(1)	1(2)	1(1)	1(1)	1(2)	1(1)
Atlantic puffin	1(1)	1(2)	2(2)	1(2)	1(1)	1(1)	3(3)	2(1)

LITERATURE CITED

Frederiksen M (2010) Appendix 1: seabirds in the North East Atlantic. A review of status, trends and anthropgenic impact. TemaNord 587:47–122

Forrester RW, Andrews IJ, McInerny CJ, Scott HI (2007) The birds of Scotland. Scottish Ornithologists' Club, Aberlady

Furness RW, Tasker ML (2000) Seabird–fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. Mar Ecol Prog Ser 202:253–264

Furness RW, Wade HM, Masden EA (2013) Assessing vulnerability of marine bird populations to offshore wind farms. J Environ Manag 119:56–66