

METHODS AND RESULTS

General statistical procedures

R version 3.5.1¹ was used for all statistical analyses, the 'coxme' R package² for replicating Kubelka et al.'s³ models and the 'lme4' R package⁴ for fitting all other mixed-effect models. We used the 'sim' function from the 'arm' R package and non-informative prior-distribution^{5,6} to create a sample of 5,000 simulated values for each model parameter (i.e. posterior distribution). We report effect sizes and model predictions by the medians, and the uncertainty of the estimates and predictions by the Bayesian 95% credible intervals represented by 2.5 and 97.5 percentiles (95%CI) from the posterior distribution of the 5,000 simulated or predicted values. We estimated the variance components with the 'lmer' function from the 'lme4' R package⁴. The models were fitted with restricted maximum likelihood and controlled for number of nests (ln-transformed). Following Kubelka et al.'s procedure, dependent variable 'daily predation rate' was ln-transformed (after adding 0.01) and 'total predation rate' was left as a proportion. We have checked whether the assumptions of all models were met (see the online material).

In all model comparisons we assessed the model fit by Akaike's Information Criterion using maximum likelihood and the 'AIC' function in R⁷.

Testing global patterns

Geographical zones – Using Kubelka et al.'s data and model (see their Table S2A), we first tested for the difference in patterns of predation rates between the geographical zones by testing for the interaction between 'mean year' of the study and five 'geographical zones' (Table S1A). We also specified a similar model, but with widely used 'lmer' function from 'lme4' package^{4,8} including species as a single random factor (intercept; Table S1B). The results of the two models resulted in virtually identical estimates for the fixed effects, so in the subsequent analyses we specified all models only within the 'lmer' framework, while also fitting study site as random intercept to control for non-independence of data points (to avoid problems of pseudo-replication arising from using multiple data points collected from the same study site).

We then attempted to replicate Kubelka et al.'s tests (their Figure 2AB and Table S2), while explicitly testing the evidence for differences in predation rates across geographic zones (i.e. using interactions). We thus fitted 'mean year' (quadratic) in interaction with 'geographical zone' (five-level factor). We then compared this model with three simpler models (Table S2, S4, Table 1): first, identical to the previous model but without the interaction; second model with the linear term 'mean year' in interaction with 'geographical zone', and a third model without this interaction (i.e. models we expected to find, but did not find, in Kubelka et al.'s Table S2). As the presumed increase in the Arctic predation rates (Figure 2AB³) occurred only after the year 2000, we also used the best fitting of the two interaction models (Table 1, Table S4) on data limited to after the year 1999 (Table S5A, $N = 94$ populations).

We found that predation rates were similar across geographical zones, except for the Southern Temperate zone, which had lower predation rates than the other zones (Figure 1AB, Table S2). Overall, the temporal change in predation rates was also similar across geographical zones (Figure 1AB, Table S2), even if we limit the data to the period after year 1999 when the change - according to Kubelka et al. - should have occurred (Table S5A). Importantly, the models without interaction were about 18 to 34 times more likely to be supported by the data than models with the interaction (Table 1 and S4).

Latitude – Using Kubelka et al.'s model (see their Table S6A), we first tested how patterns of predation rates changed over latitude by including a three-way interaction between 'hemisphere' (Northern or Southern), 'mean year' and 'absolute latitude' (Table S1C). We then also specified a similar model but using 'lmer' and species as a single random factor (intercept; Table S1D). The results of the two models were also identical, so in the subsequent analyses we specify all models only within 'lmer' framework, while fitting also study site as random intercept to account for non-independence of data collected in the same study site.

We then attempted to replicate the Kubelka et al.'s tests (from their Figure 3AB and Table S6), while explicitly testing whether temporal trends in predation rates varied with latitude (i.e. using interactions). We thus fitted (Table S3) one model with 'latitude' (third-order polynomial) in interaction with 'mean year' of the study; second model with three-way interaction of 'hemisphere' (Southern or Northern), 'absolute latitude' and 'mean year'; third model with 'latitude' (third-order polynomial) in interaction with 'period' (before or after year 2000); and fourth model with three-way interaction of 'hemisphere' (Southern or Northern), 'absolute latitude' and 'period' (before or after year 2000). We then compared these models to their simpler alternatives without any interactions (Table 2 and S4). Note that we have used a third-order polynomial of latitude to mimic the relationship Kubelka et al. depicted in their Fig.3.

In accordance with the results on geographical zones (Table S2), we found that predation rates were lower in the Southern hemisphere and increased globally over time, but without changing the latitudinal pattern (Table S3, S4 and 2). Importantly,

the models without interactions were better supported by the data than models with interactions and models with ‘period’ (i.e. testing for the relationship presented by Kubelka et al.’s Figure 3) performed the worst of all models, receiving 60 to 130 times less empirical support than the best-supported models (Table 2 and S4).

Overall – Comparing the model for ‘Geographical zones’ together with the models for ‘Latitude’, we found that simple models without interactions fit the data better than models with interactions (Table 2 and S4).

Table S1 | Predation rates in relation to mean year of the study and geography without controlling for study site

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
A. Zone ‘Imekin’ (Kubelka’s Table S2A but with interaction)	Fixed	Intercept (Arctic)	-3.285	-3.544	-3.026	0.502	0.389	0.614
		ln (# of nests)	-0.007	-0.07	0.056	-0.001	-0.028	0.026
		Mean year of the study	0.274	0.16	0.389	0.111	0.063	0.16
		Zone - N. Temperate	-0.052	-0.227	0.124	-0.003	-0.078	0.072
		Zone - N. Tropics	0.102	-0.199	0.404	0.055	-0.076	0.185
		Zone - S. Temperate	-0.507	-0.756	-0.258	-0.193	-0.3	-0.085
		Zone - S. Tropics	-0.179	-0.493	0.136	-0.045	-0.179	0.089
		Mean year × N. Temperate	-0.076	-0.231	0.08	-0.016	-0.082	0.05
		Mean year × N. Tropics	-0.195	-0.489	0.099	-0.084	-0.209	0.042
		Mean year × S. Temperate	-0.154	-0.435	0.127	-0.069	-0.188	0.051
		Mean year × S. Tropics	-0.136	-0.432	0.159	-0.048	-0.173	0.077
	Random (species)	Reciprocal of # of nests matrix	8%			5%		
		Phylogenetic matrix	1%			1%		
		Geographical distance matrix	0%			0%		
		Residual variance	91%			94%		
B. Zone ‘Imer’	Fixed	Intercept (Arctic)	-3.244	-3.512	-2.98	0.523	0.412	0.635
		ln (# of nests)	-0.018	-0.083	0.048	-0.006	-0.034	0.021
		Mean year of the study	0.273	0.153	0.389	0.11	0.061	0.16
		Zone - N. Temperate	-0.041	-0.234	0.146	0.002	-0.079	0.081
		Zone - N. Tropics	0.116	-0.193	0.423	0.066	-0.073	0.198
		Zone - S. Temperate	-0.501	-0.766	-0.245	-0.189	-0.302	-0.075
		Zone - S. Tropics	-0.146	-0.472	0.19	-0.027	-0.167	0.116
		Mean year × N. Temperate	-0.079	-0.233	0.088	-0.018	-0.087	0.051
		Mean year × N. Tropics	-0.206	-0.51	0.097	-0.088	-0.216	0.041
		Mean year × S. Temperate	-0.163	-0.442	0.133	-0.074	-0.195	0.045
		Mean year × S. Tropics	-0.126	-0.434	0.182	-0.038	-0.168	0.096
	Random	Species (intercept)	10%	9%	11%	13%	12%	15%
		Residual variance	90%	89%	91%	87%	85%	88%
C. Latitude ‘Imekin’ (Kubelka’s Table S6A but with interaction)	Fixed	Intercept (Northern)	-3.263	-3.525	-3.001	0.517	0.402	0.632
		ln (# of nests)	-0.017	-0.076	0.042	-0.004	-0.029	0.021
		Hemisphere (Southern)	-0.662	-1.005	-0.319	-0.271	-0.418	-0.125
		Mean Year of the study	0.218	0.144	0.291	0.094	0.063	0.125
		Latitude (absolute)	-0.014	-0.1	0.072	-0.01	-0.048	0.028
		Year × Hemisphere	-0.229	-0.628	0.17	-0.114	-0.283	0.054
		Latitude × Hemisphere	-0.256	-0.539	0.027	-0.109	-0.23	0.011
		Year × Latitude	0.072	-0.007	0.152	0.027	-0.007	0.061
		Year × Latitude × Hemisphere	-0.181	-0.489	0.126	-0.084	-0.213	0.046
	Random (species)	Reciprocal of # of nests matrix	11			6		
		Phylogenetic matrix	0			0		
		Geographical distance matrix	0			0		
		Residual variance	89			93		
D. Latitude ‘Imer’	Fixed	Intercept (Northern)	-3.209	-3.477	-2.938	0.546	0.428	0.662
		ln (# of nests)	-0.028	-0.091	0.033	-0.01	-0.036	0.017
		Hemisphere (Southern)	-0.687	-1.023	-0.328	-0.281	-0.427	-0.136
		Mean Year of the study	0.212	0.134	0.289	0.09	0.057	0.123
		Latitude (absolute)	-0.014	-0.103	0.075	-0.015	-0.053	0.023
		Year × Hemisphere	-0.248	-0.658	0.146	-0.125	-0.3	0.047
		Latitude × Hemisphere	-0.278	-0.566	0.012	-0.117	-0.239	0.007
		Year × Latitude	0.075	-0.006	0.158	0.029	-0.005	0.064
		Year × Latitude × Hemisphere	-0.202	-0.528	0.108	-0.099	-0.236	0.033
	Random	Species (intercept)	12%	11%	14%	15%	13%	16%
		Residual variance	88%	86%	89%	85%	84%	87%

Shown are model estimates and 95% confidence intervals (CI) and random variances calculated from ‘Imekin’ model output² (**A**, **C**) and the posterior estimates (medians) of the effect sizes with the 95% credible intervals (CI) from a posterior distribution of 5,000 simulated values generated by the ‘sim’ function in R⁶ (**B**, **D**). Mean year and absolute latitude were z-transformed (by subtracting the mean and dividing by standard deviation).

N = 237 populations representing 111 species.

Table S2 | Predation rates in relation to mean year of the study and geographical zone, controlling for study site

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
A. Simple & linear (Year + Zone)	Fixed	Intercept (Arctic)	-3.473	-3.746	-3.207	0.433	0.313	0.551
		ln (# of nests)	0.048	-0.011	0.104	0.021	-0.004	0.047
		Mean year of the study	0.147	0.067	0.225	0.065	0.031	0.099
		Zone - N. Temperate	-0.085	-0.308	0.139	-0.016	-0.111	0.079
		Zone - N. Tropics	0.07	-0.262	0.405	0.043	-0.1	0.181
		Zone - S. Temperate	-0.542	-0.842	-0.249	-0.211	-0.338	-0.082
		Zone - S. Tropics	-0.211	-0.565	0.157	-0.062	-0.212	0.093
	Random	Study site (intercept)	66%	65%	66%	66%	65%	67%
		Species (intercept)	1%	1%	1%	2%	1%	2%
		Residual variance	33%	32%	34%	32%	31%	33%
B. Interaction & linear (Year × Zone)	Fixed	Intercept (Arctic)	-3.488	-3.753	-3.212	0.431	0.313	0.549
		ln (# of nests)	0.044	-0.015	0.104	0.02	-0.006	0.045
		Mean year of the study	0.243	0.082	0.401	0.093	0.021	0.164
		Zone - N. Temperate	-0.058	-0.288	0.17	-0.007	-0.102	0.093
		Zone - N. Tropics	0.112	-0.219	0.454	0.059	-0.086	0.204
		Zone - S. Temperate	-0.512	-0.815	-0.216	-0.197	-0.33	-0.068
		Zone - S. Tropics	-0.174	-0.524	0.19	-0.052	-0.207	0.11
		Mean year × N. Temperate	-0.111	-0.298	0.085	-0.027	-0.11	0.056
		Mean year × N. Tropics	-0.139	-0.46	0.195	-0.05	-0.187	0.095
		Mean year × S. Temperate	-0.214	-0.544	0.102	-0.098	-0.235	0.043
		Mean year × S. Tropics	-0.145	-0.497	0.204	-0.035	-0.183	0.114
	Random	Study site (intercept)	67%	66%	68%	67%	66%	67%
		Species (intercept)	2%	1%	2%	2%	2%	2%
		Residual variance	31%	30%	32%	31%	30%	32%
C. Simple & quadratic (Year (quadratic) + Zone)	Fixed	Intercept (Arctic)	-3.45	-3.717	-3.185	0.443	0.323	0.559
		ln (# of nests)	0.043	-0.014	0.1	0.019	-0.006	0.045
		Mean year (1 st polynomial)	2.191	0.943	3.442	0.963	0.446	1.499
		Mean year (2 nd polynomial)	-0.586	-1.673	0.536	-0.384	-0.857	0.081
		Zone - N. Temperate	-0.082	-0.294	0.137	-0.014	-0.108	0.079
		Zone - N. Tropics	0.074	-0.243	0.396	0.047	-0.083	0.184
		Zone - S. Temperate	-0.554	-0.854	-0.26	-0.218	-0.348	-0.09
		Zone - S. Tropics	-0.212	-0.568	0.143	-0.061	-0.211	0.094
	Random	Study site (intercept)	67%	66%	67%	68%	67%	68%
		Species (intercept)	1%	1%	2%	1%	1%	2%
D. Interaction & quadratic (Year(quadratic) × Zone)	Fixed	Residual variance	32%	31%	33%	31%	30%	32%
		Intercept (Arctic)	-3.459	-3.743	-3.188	0.442	0.325	0.563
		ln (# of nests)	0.046	-0.012	0.107	0.019	-0.006	0.045
		Mean year (1 st polynomial)	1.717	-1.798	5.218	0.785	-0.662	2.274
		Mean year (2 nd polynomial)	3.221	-0.648	7.169	1.035	-0.611	2.683
		Zone - N. Temperate	-0.097	-0.325	0.127	-0.018	-0.118	0.08
		Zone - N. Tropics	0.088	-0.272	0.424	0.052	-0.096	0.203
		Zone - S. Temperate	-0.577	-0.894	-0.26	-0.224	-0.356	-0.092
		Zone - S. Tropics	-0.185	-0.553	0.18	-0.048	-0.206	0.112
		Year (1 st poly) × N. Temperate	-0.46	-4.559	3.61	-0.115	-1.815	1.526
		Year (2 nd poly) × N. Temperate	-4.643	-8.747	-0.528	-1.683	-3.444	0.069
		Year (1 st poly) × N. Tropics	-0.795	-7.124	5.583	-0.182	-2.829	2.595
		Year (2 nd poly) × N. Tropics	-1.413	-10.246	7.864	-0.726	-4.64	3.054
		Year (1 st poly) × S. Temperate	-0.405	-6.407	5.709	-0.446	-2.951	2.141
		Year (2 nd poly) × S. Temperate	-5.612	-12.488	1.14	-2.172	-5.008	0.73
		Year (1 st poly) × S. Tropics	0.452	-5.437	6.533	0.351	-2.228	2.915
		Year (2 nd poly) × S. Tropics	-8.385	-15.634	-0.892	-3.3	-6.396	-0.185
	Random	Study site (intercept)	71%	70%	71%	71%	70%	71%
		Species (intercept)	0%	0%	0%	1%	1%	1%
		Residual variance	29%	28%	30%	28%	28%	29%

Shown are the posterior estimates (medians) of the effect sizes with the 95% credible intervals from a posterior distribution of 5,000 simulated values generated by the 'sim' function in R⁶. Unless quadratics, mean year was z-transformed (by subtracting the mean and dividing by standard deviation).

N = 237 populations representing 111 species.

Table S3year | Predation rates in relation to mean year and latitude of the study, controlling for study site

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
A. Simple & linear Hemisphere + Year + Latitude (absolute)	Fixed	Intercept (Northern)	-3.364	-3.782	-2.972	0.506	0.335	0.674
		ln (# of nests)	0.039	-0.017	0.097	0.019	-0.006	0.042
		Hemisphere (Southern)	-0.419	-0.659	-0.185	-0.173	-0.276	-0.071
		mean Year of the study	0.156	0.08	0.234	0.067	0.034	0.101
		Latitude (absolute)	-0.002	-0.007	0.003	-0.001	-0.004	0.001
	Random	Study site (intercept)	66%	65%	66%	66%	65%	67%
		Species (intercept)	2%	2%	2%	2%	1%	2%
		Residual variance	32%	32%	33%	32%	31%	33%
B. Interaction & linear Hemisphere × Year × Latitude (absolute)	Fixed	Intercept (Northern)	-3.417	-3.839	-2.963	0.487	0.304	0.671
		ln (# of nests)	0.039	-0.02	0.094	0.017	-0.007	0.042
		Hemisphere (Southern)	0.119	-0.59	0.816	0.057	-0.252	0.365
		mean Year of the study	0.022	-0.276	0.33	0.025	-0.107	0.153
		Latitude (absolute)	-0.001	-0.007	0.005	-0.001	-0.003	0.002
		Hemisphere × Mean year	0.259	-0.525	0.978	0.128	-0.182	0.449
		Hemisphere × Latitude	-0.015	-0.033	0.003	-0.006	-0.014	0.002
		Year × Latitude	0.003	-0.003	0.008	0.001	-0.001	0.003
	Random	Hemisphere × Year × Latitude	-0.01	-0.03	0.011	-0.005	-0.014	0.003
		Study site (intercept)	66%	65%	66%	66%	65%	66%
		Species (intercept)	2%	2%	3%	2%	2%	3%
		Residual variance	32%	31%	33%	31%	31%	32%
C. Simple & 3rd polynomial Year + Latitude(3 rd polynomial)	Fixed	Intercept ()	-3.55	-3.798	-3.299	0.412	0.3	0.517
		ln (# of nests)	0.043	-0.014	0.1	0.02	-0.005	0.045
		mean Year of the study	0.145	0.068	0.226	0.064	0.03	0.098
		Latitude (1 st poly)	2.096	0.796	3.359	0.777	0.217	1.342
		Latitude (2 nd poly)	-0.801	-2.112	0.512	-0.432	-1.003	0.12
		Latitude (3 rd poly)	0.752	-0.453	2.005	0.283	-0.239	0.804
	Random	Study site (intercept)	66%	65%	66%	66%	65%	66%
		Species (intercept)	2%	2%	2%	2%	2%	2%
		Residual variance	32%	32%	34%	32%	32%	33%
D. Interaction & 3rd polynomial Year × Latitude(3 rd polynomial)	Fixed	Intercept ()	-3.548	-3.796	-3.301	0.413	0.303	0.519
		ln (# of nests)	0.041	-0.018	0.101	0.018	-0.006	0.044
		mean Year of the study	0.151	0.069	0.228	0.065	0.031	0.1
		Latitude (1 st poly)	1.976	0.669	3.277	0.738	0.181	1.313
		Latitude (2 nd poly)	-1.019	-2.33	0.356	-0.495	-1.061	0.079
		Latitude (3 rd poly)	0.808	-0.468	2.066	0.312	-0.221	0.84
		Year × Latitude (1 st poly)	1.135	-0.22	2.452	0.479	-0.076	1.051
		Year × Latitude (2 nd poly)	0.163	-1.088	1.461	-0.041	-0.583	0.51
		Year × Latitude (3 rd poly)	0.577	-0.727	2.003	0.218	-0.376	0.815
	Random	Study site (intercept)	66%	66%	67%	66%	66%	67%
		Species (intercept)	2%	2%	3%	3%	2%	3%
		Residual variance	32%	31%	32%	31%	30%	32%

Shown are the posterior estimates (medians) of the effect sizes with the 95% credible intervals from a posterior distribution of 5,000 simulated values generated by the 'sim' function in R⁶. Mean year and absolute latitude were z-transformed (by subtracting the mean and dividing by standard deviation). Mean year and absolute latitude were z-transformed (by subtracting the mean and dividing by standard deviation).

N = 237 populations representing 111 species.

Table S3period | Predation rates in relation to mean year and latitude of the study, controlling for study site

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
E. Simple & linear Hemisphere + Period + Latitude (absolute)	Fixed	Intercept (Northern & after 2000)	-3.307	-3.732	-2.894	0.526	0.347	0.713
		ln (# of nests)	0.045	-0.014	0.102	0.02	-0.004	0.045
		Hemisphere (Southern)	-0.393	-0.639	-0.157	-0.161	-0.27	-0.05
		Period (before 2000)	-0.174	-0.34	-0.013	-0.066	-0.134	0.003
		Latitude (absolute)	-0.002	-0.007	0.004	-0.001	-0.004	0.001
	Random	Study site (intercept)	66%	66%	66%	66%	66%	67%
		Species (intercept)	4%	3%	4%	5%	4%	5%
		Residual variance	30%	29%	31%	29%	28%	30%
F. Interaction & linear Hemisphere × period × Latitude (absolute)	Fixed	Intercept (Northern & after 2000)	-3.661	-4.218	-3.138	0.381	0.144	0.605
		ln (# of nests)	0.046	-0.013	0.104	0.02	-0.005	0.045
		Hemisphere (Southern)	0.586	-0.477	1.625	0.314	-0.138	0.764
		Period (before 2000)	0.356	-0.267	0.997	0.164	-0.096	0.442
		Latitude (absolute)	0.005	-0.003	0.014	0.002	-0.002	0.005
		Hemisphere × Period	-0.628	-2.094	0.831	-0.361	-0.984	0.27
		Hemisphere × Latitude	-0.03	-0.059	0	-0.015	-0.027	-0.002
		Period × Latitude	-0.011	-0.022	0	-0.005	-0.009	0
		Hemisphere × Period × Latitude	0.021	-0.017	0.06	0.012	-0.005	0.028
	Random	Study site (intercept)	66%	65%	66%	65%	65%	65%
		Species (intercept)	5%	4%	5%	6%	6%	7%
		Residual variance	29%	29%	30%	29%	28%	29%
G. Simple & 3rd polynomial Hemisphere + Year + Latitude(3 rd polynomial)	Fixed	Intercept (Northern)	-3.481	-3.751	-3.211	0.439	0.323	0.552
		ln (# of nests)	0.049	-0.01	0.109	0.021	-0.004	0.048
		Period (before 2000)	-0.161	-0.326	0.008	-0.059	-0.13	0.012
		Latitude (1 st poly)	2.062	0.7	3.373	0.754	0.192	1.314
		Latitude (2 nd poly)	-0.634	-1.993	0.635	-0.356	-0.936	0.227
		Latitude (3 rd poly)	0.937	-0.386	2.144	0.365	-0.163	0.92
	Random	Study site (intercept)	66%	65%	66%	66%	66%	66%
		Species (intercept)	4%	3%	4%	5%	4%	5%
		Residual variance	30%	30%	31%	29%	29%	30%
H. Interaction & 3rd polynomial Hemisphere × Period × Latitude(3 rd polynomial)	Fixed	Intercept (I)	-3.474	-3.742	-3.201	0.441	0.326	0.553
		ln (# of nests)	0.048	-0.011	0.106	0.021	-0.004	0.046
		Period (before 2000)	-0.176	-0.337	-0.009	-0.066	-0.135	0.006
		Latitude (1 st poly)	3.69	1.683	5.67	1.499	0.638	2.318
		Latitude (2 nd poly)	-0.207	-2.121	1.643	-0.21	-1.055	0.613
		Latitude (3 rd poly)	1.932	-0.195	4.113	0.873	-0.073	1.789
		Year × Latitude (1 st poly)	-2.857	-5.307	-0.46	-1.294	-2.339	-0.25
		Year × Latitude (2 nd poly)	-1.394	-3.906	1.169	-0.539	-1.622	0.538
		Year × Latitude (3 rd poly)	-1.48	-4.102	1.146	-0.714	-1.832	0.401
	Random	Study site (intercept)	66%	66%	66%	66%	66%	66%
		Species (intercept)	4%	4%	5%	6%	5%	7%
		Residual variance	29%	29%	30%	28%	28%	29%

Same as in Table S3year.

Table S4 | Model comparison for total nest predation rate.

Model ^a	Predictors	# of parameters ^b	AIC	ΔAIC ^c	w _i ^d	Cumulative w _i ^e	ER ^f
1	Year + Hemisphere +Latitude (absolute)	5	-53.50	0.00	0.28	0.28	1.00
2	Year + Latitude (3rd polynomial)	6	-52.99	0.51	0.21	0.49	1.29
3	Year (quadratic) + Geographical area	8	-52.92	0.58	0.21	0.70	1.34
4	Year + Geographical area	7	-52.42	1.08	0.16	0.86	1.71
5	Year × Hemisphere × Latitude (absolute)	9	-50.86	2.64	0.07	0.93	3.75
6	Year × Latitude (3rd polynomial)	9	-50.00	3.50	0.05	0.98	5.76
7	Year × Geographical area	11	-46.40	7.10	0.01	0.99	34.87
8	Year (quadratic) × Geographical area	16	-45.76	7.74	0.01	0.99	47.90
9	Period × Latitude (3rd polynomial)	9	-43.88	9.62	0	1	122.81
10	Period × Hemisphere × Latitude (absolute)	9	-43.28	10.22	0	1	165.44
11	Period + Hemisphere + Latitude (absolute)	5	-41.87	11.63	0	1	334.46
12	Period + Latitude (3rd polynomial)	6	-40.27	13.23	0	1	746.23

^aEach model is fitted with maximum likelihood and controlled for number of nests in a given population (ln-transformed) and for multiple populations at given site or for a given species using site and species as random intercepts (i.e. all models have same random structure). Predictors are Year (mean year of the study), Hemisphere (Northern vs Southern), Latitude (degrees), Geographical area (Arctic, North temperate, North tropics, South tropics, South temperate,,) and Period (historic: 1944-1999 vs. recent: 2000-2016). Models that include Period (instead of Year) are not supported by the data (69-320 times less likely than the best model). Models including the interaction between time and geographical/latitude do not improve the model fit or are much less supported by the data than models without the interaction. For model outputs see Table S2-3.

^bNumber of model parameters without the random effects. ^cThe difference in AICc between the first-ranked model and the given model.

^dAkaike weight – the weight of evidence that a given model is the best approximating model (i.e., probability of the model).

^eCumulative Akaike weight, ^fEvidence ratio – model weight of the first-ranked model relative to that of the given model (i.e., how many times is the first-ranked model more likely than the given model).

Table S5 | Predation rates in relation to mean year of the study and geographical zone for limited datasets

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
A. Interaction & linear (Year × Zone) Data with year >1999 N = 94 populations	Fixed	Intercept (Arctic)	-3.254	-3.64	-2.861	0.542	0.383	0.697
		ln (# of nests)	0.042	-0.039	0.122	0.017	-0.014	0.047
		Mean year of the study	0.202	0.02	0.38	0.059	-0.015	0.131
		Zone - N. Temperate	-0.173	-0.526	0.178	-0.057	-0.196	0.093
		Zone - N. Tropics	-0.091	-0.522	0.323	-0.03	-0.223	0.156
		Zone - S. Temperate	-0.644	-1.089	-0.199	-0.276	-0.467	-0.087
		Zone - S. Tropics	-0.276	-0.783	0.231	-0.08	-0.294	0.138
		Mean year × N. Temperate	-0.097	-0.417	0.22	-0.009	-0.141	0.121
		Mean year × N. Tropics	0.055	-0.319	0.433	0.044	-0.102	0.2
		Mean year × S. Temperate	-0.129	-0.506	0.267	-0.02	-0.179	0.14
		Mean year × S. Tropics	-0.595	-1.22	0.011	-0.217	-0.472	0.042
	Random	Study site (intercept)	78%	77%	78%	84%	84%	83%
		Species (intercept)	0%	0%	0%	2%	1%	2%
		Residual variance	22%	22%	23%	14%	14%	15%
B. Mean year > 1970 Data with year >1970 N = 226 populations	Fixed	Intercept (Arctic)	-3.534	-3.808	-3.273	0.419	0.313	0.531
		ln (# of nests)	0.044	-0.015	0.105	0.02	-0.004	0.045
		Mean year of the study	0.072	-0.018	0.161	0.029	-0.01	0.068
	Random	Study site (intercept)	70%	69%	70%	70%	70%	71%
		Species (intercept)	2%	2%	2%	2%	1%	2%
		Residual variance	28%	28%	29%	28%	27%	29%

Shown are the posterior estimates (medians) of the effect sizes with the 95% credible intervals from a posterior distribution of 5,000 simulated values generated by the ‘sim’ function in R⁶. Mean year was z-transformed (by subtracting the mean and dividing by standard deviation).

Exploring the temporal change in predation rates

The general increase in predation rates found by Kubelka et al. — and confirmed in our analyses — can arise if field protocols and/or statistical methods change over time. In Kubelka et al.’s dataset, 59% (total N = 237) of populations lack the number of exposure days (i.e. the total number of days that nests were followed from finding until the nest finished (hatched, depredated, failed to other causes) that are needed to calculate daily predation rates according to Mayfield⁹, the method used by the Kubelka et al.³. Kubelka et al. derive such exposure days using nesting period (egg-laying + incubation period) of the species and a conversion coefficient introduced by Beintema¹⁰, which indicates how much of the incubation period (in case of Kubelka et al. of the nesting period) was observed, i.e. indicating when the nests were generally found. Kubelka et al. assumed that 0.9 of nesting period was observed if nests were found close to laying or nests searched daily, 0.6 if nests were found early in the nesting period or nests searched once-twice a week, or 0.5 if nests were found in the middle of the nesting period ($N_{0.5} = 11$, $N_{0.6} = 114$, $N_{0.9} = 14$ populations). In other words, Kubelka et al. assumed that the vast majority of nests were found earlier than in the middle of the nesting period. However, such an assumption might be too optimistic for many populations. Even in a recent, intensive research scheme with multiple nest surveys per week by ~2-6-person teams at various Arctic sites, nests are rarely found at laying (mean across sites = 0.35 of nesting period, range: 0.22 – 0.49; $N = 10,716$ nests from 16 sites monitored after 2000; Figure S1; using open-access data from the Arctic Shorebird Demographics Network¹¹). Importantly, the need to use ‘Beintema conversions’ might have changed over time. We have thus explored five ways how such ‘Beintema conversions’ affect the temporal change in predation rates. Note that one Arctic population was indicated as transformed in the Kubelka et al.’s dataset but lacked the actual transformation value. Nevertheless, its exposure was indicated in the Kubelka et al.’s dataset and present also in the original reference, i.e. this population should have been indicated as not transformed and we use it in the subsequent analyses as such.

First, we visualized how the number of populations that required a ‘Beintema conversion’ changed over time (Figure 1G and S2; using locally estimated scatterplot smoothing). We reveal a steady decline in the number of studies lacking exposure data, i.e. studies where Kubelka et al. used the Beintema conversion. The decline is particularly dramatic after 2000, which corresponds with Kubelka et al.’s distinction between before and after 2000 period, and especially in Arctic which corresponds with reported exponential increase in the predation rates in Arctic.

Second, we used the Kubelka et al.’s populations with known (i.e., termed “true” below) number of exposure days, known nesting period length, and known fates ($N = 65$) and estimated daily predation rates with varying conversion coefficients ($0.5 \times \text{observed proportion of nesting period} \times \text{nesting period} \times (\text{number of nests depredated or failed to other causes}) + (\text{observed proportion of nesting period} \times \text{nesting period} \times (\text{number of hatched and infertile clutches}))$). We then visualized the new daily predation rates against the original values to investigate how this method over- or under-estimates the daily predation rates. Despite the strong correlation between true daily predation rates (i.e. those extracted from the literature) and the newly derived ones³, we found severe over- and under-estimation depending on the ‘proportion of nesting period’ assumed for the calculations (Figure 1I and S3). If we assume that only 0.1-0.4 of the nesting period is observed, the predation rates are severely over-estimated for all (in case of 0.4 for most) original values (Figure 1I and SB). Assuming that nests are observed for half of the nesting period, overestimates the low true values and underestimates the larger ones.

Assuming that nests are observed for longer than half of nesting period (>0.5), further overestimates the predation rates, including the lower true values.

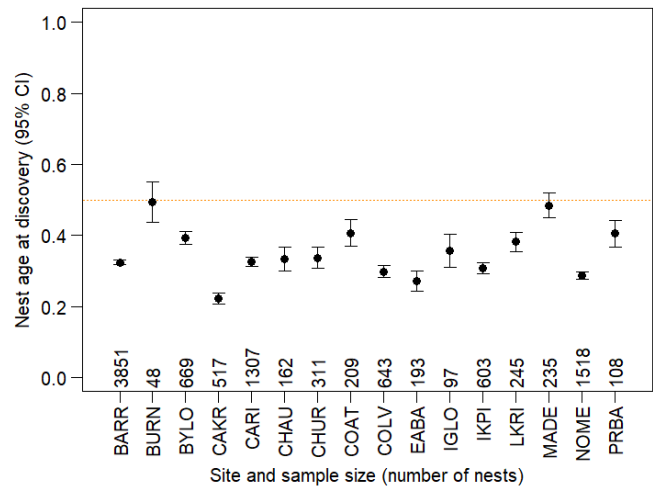


Figure S1 | Nest age (proportion of the nesting period elapsed) at the time of nest discovery. Points indicate means, bars 95% CIs for each of 16 sites in the Arctic Shorebird Demographics Network in Russia, Alaska, and Canada (2003-2014). Numbers indicate number of nests. Horizontal dotted line indicates 0.5 (midpoint of the nesting period). For further information on these sites and nest-searching protocols see ^{11,12}.

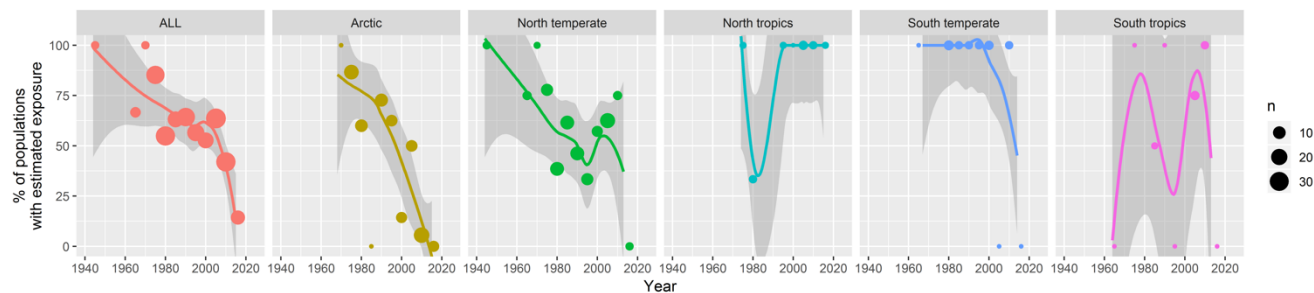


Figure S2 | Temporal change in percentage of populations needing ‘Beintema conversion’ to estimate exposure. Dots represent percentages for 5-year intervals, lines and shaded areas locally estimated scatterplot smoothing with 95% confidence intervals

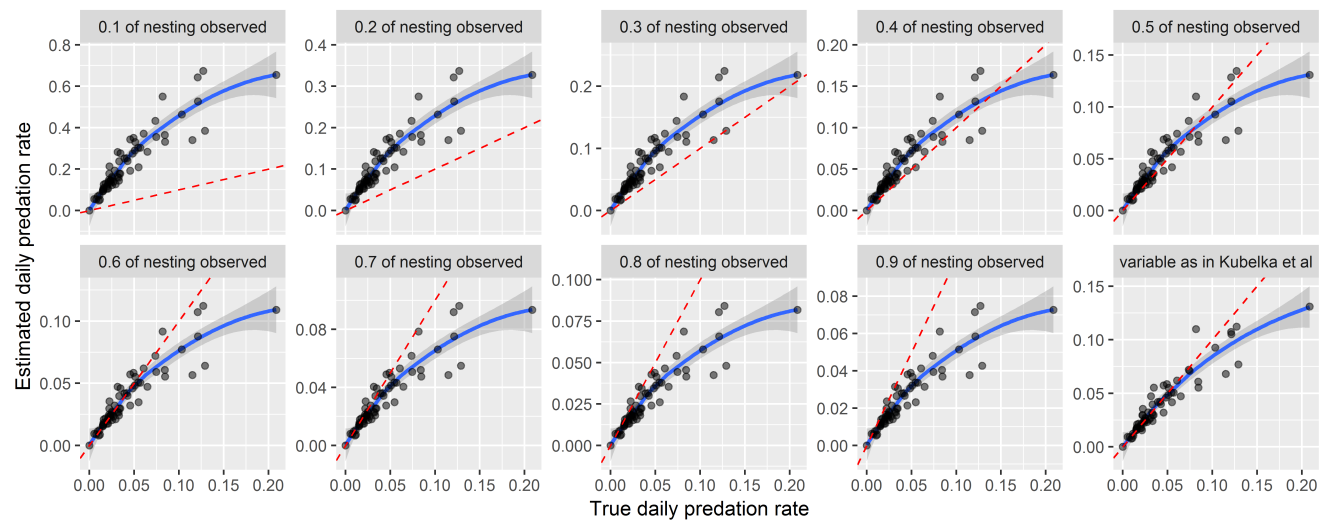


Figure S3 | The assumption about the proportion of nesting period being observed influences daily predation rate estimation. Each dot represents one of 65 populations with true daily predation rates from the literature and all information needed to estimate daily predation rates for various proportions of the nesting period that is on average assumed to be observed (panel titles; note that the last panel uses proportions specific to each population as used by Kubelka et al.). Red dashed line indicates no difference between true values (x-axis) and estimated values (y-axis). Blue line with shaded area indicates locally estimated scatterplot smoothing with 95% CIs. Note that points and lines below the dashed lines indicates underestimation and above overestimation of the true values.

Third, we explored how the increase in predation rates over time (Figure 1A-F) changes if we vary proportion of observed nesting period (i.e. Beintema’s coefficient) from 0.1 to 0.9 for populations with mean year <2000 and lacking exposure days

(i.e. populations where Kubelka et al. used Beintema coefficient to calculate exposure). In other words, we assumed that intensive nest searching used by Kubelka (i.e. nests found before or during mid- nesting period) is always valid for data >2000, but uncertain for data <2000. To each dataset we fitted a model with 'mean year' of the study as a fixed effect, controlling for number of nest (ln-transformed) and site and species as random intercepts. We then plotted the model predictions (Figure 1H). This exercise revealed sensitivity of the data to the 'Beintema conversion' (Figure 1H) with conversion factors <0.5 (which were never used by Kubelka) generating statistically non-significant year effects, sometimes even in the opposite direction than reported by Kubelka et al.

Fourth, we tested for the effect of mean year on predation rates by using only data with known exposure days or predation rates ($N = 98$ populations; Table S6). First, we fitted two models: first with latitude (3rd polynomial) in interaction with year, and second with three-way interaction of hemisphere, latitude (absolute) and year. Then, we fitted an additional two models using only Arctic ($N = 46$ populations) and North Temperate zone ($N = 42$) data (the other zones contained only 0-5 populations): first model with mean year (quadratic) in interaction with geographical zone, the second model with linear mean year in interaction with geographical zones. We then also fitted the same four models but without interactions (Table S6). We found no support for interactions, the geographical effect or the year effect (Table S6, Figure 1CF).

Fifth, we explored how the mean year effect changes when we exclude 10 sparsely distributed data points < 1970 (as all above mentioned models underestimate the effect of these populations). Using model with mean year as a predictor (same as Kubelka et al. in Table S2a) and site and species as random intercepts reduced the original Kubelka et al.'s year effect by 59% (Table S5B), revealing the influence of the 10 early data points.

Table S6a | Predation rates in relation to mean year of the study and region (Arctic or N. temperate) using non-transformed data

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
A. Simple & linear (Year + Zone)	Fixed	Intercept (Arctic)	-3.376	-3.728	-3.023	0.496	0.352	0.641
		ln (# of nests)	0.057	-0.018	0.134	0.02	-0.011	0.051
		Mean year of the study	0.102	-0.062	0.271	0.041	-0.025	0.107
		Zone - N. Temperate	-0.132	-0.483	0.217	-0.026	-0.166	0.117
	Random	Study site (intercept)	85%	84%	85%	82%	82%	83%
		Species (intercept)	0%	0%	0%	0%	0%	0%
		Residual variance	15%	15%	16%	18%	17%	18%
B. Interaction & linear (Year × Zone)	Fixed	Intercept (Arctic)	-3.379	-3.744	-3.022	-6.32	-20.539	7.611
		ln (# of nests)	0.055	-0.021	0.133	0.021	-0.012	0.053
		Mean year of the study	0.14	-0.084	0.361	0.003	-0.004	0.011
		Zone - N. Temperate	-0.137	-0.479	0.21	0.867	-19.315	21.277
		Mean year × N. Temperate	-0.086	-0.42	0.249	0	-0.011	0.01
	Random	Study site (intercept)	85%	84%	86%	83%	82%	83%
		Species (intercept)	0%	0%	0%	0%	0%	0%
C. Simple & quadratic (Year (quadratic) + Zone)	Fixed	Intercept (Arctic)	-3.376	-3.735	-3.017	0.497	0.345	0.649
		ln (# of nests)	0.057	-0.016	0.132	0.02	-0.012	0.052
		Mean year (1 st polynomial)	0.971	-0.601	2.544	0.392	-0.237	1.025
		Mean year (2 nd polynomial)	0.411	-0.807	1.689	0.013	-0.498	0.547
		Zone - N. Temperate	-0.115	-0.472	0.237	-0.028	-0.174	0.117
	Random	Study site (intercept)	85%	84%	85%	83%	82%	83%
		Species (intercept)	0%	0%	0%	0%	0%	0%
D. Interaction & quadratic (Year (quadratic) × Zone)	Fixed	Intercept (Arctic)	-3.375	-3.751	-3.022	0.494	0.338	0.648
		ln (# of nests)	0.056	-0.019	0.131	0.021	-0.012	0.053
		Mean year (1 st polynomial)	1.197	-1.091	3.405	0.405	-0.482	1.32
		Mean year (2 nd polynomial)	0.384	-1.521	2.228	0.031	-0.707	0.816
		Zone - N. Temperate	-0.13	-0.502	0.234	-0.029	-0.176	0.115
		Year (1 st poly) × N. Temperate	-0.584	-4.067	2.862	-0.07	-1.473	1.313
		Year (2 nd poly) × N. Temperate	-0.083	-2.852	2.705	-0.07	-1.195	1.046
	Random	Study site (intercept)	85%	84%	85%	83%	82%	83%
		Species (intercept)	0%	0%	0%	0%	0%	0%
		Residual variance	15%	15%	16%	17%	17%	18%

Shown are the posterior estimates (medians) of the effect sizes with the 95% credible intervals from a posterior distribution of 5,000 simulated values generated by the 'sim' function in R⁶. Mean year was z-transformed (by subtracting the mean and dividing by standard deviation).

$N = 89$ populations representing 43 species.

Table S6b | Predation rates in relation to mean year of the study and latitude using non-transformed data

Model	Effect type	Response Effect	ln(Daily predation rate + 0.01)			Total predation rate		
			Estimate	95%CI		Estimate	95% CI	
E. Simple & linear Hemisphere + Year + Latitude (absolute)	Fixed	Intercept (Northern)	-3.38	-3.734	-3.025	0.503	0.362	0.652
		ln (# of nests)	0.043	-0.033	0.118	0.015	-0.015	0.046
		Hemisphere (Southern)	-0.534	-1.165	0.102	-0.268	-0.531	-0.018
		mean Year of the study	0.08	-0.077	0.233	0.036	-0.024	0.096
		Latitude (absolute)	0.018	-0.17	0.216	-0.005	-0.081	0.07
	Random	Study site (intercept)	84%	83%	84%	82%	81%	82%
		Species (intercept)	0%	0%	0%	0%	0%	0%
		Residual variance	16%	16%	17%	18%	18%	19%
F. Interaction & linear Hemisphere × Year × Latitude (absolute)	Fixed	Intercept (Northern)	-3.415	-3.781	-3.053	0.495	0.342	0.641
		ln (# of nests)	0.046	-0.026	0.119	0.016	-0.013	0.047
		Hemisphere (Southern)	-2.175	-4.632	0.327	-0.89	-1.917	0.116
		mean Year of the study	0.09	-0.072	0.257	0.041	-0.031	0.111
		Latitude (absolute)	0.075	-0.131	0.295	0.011	-0.074	0.097
		Hemisphere × Mean year	1.595	-1.293	4.459	0.568	-0.591	1.774
		Hemisphere × Latitude	-0.708	-1.68	0.254	-0.262	-0.652	0.129
		Year × Latitude	0.076	-0.134	0.287	0.017	-0.068	0.099
		Hemisphere × Year × Latitude	0.65	-0.556	1.815	0.239	-0.242	0.742
	Random	Study site (intercept)	84%	83%	84%	82%	81%	82%
		Species (intercept)	0%	0%	0%	0%	0%	0%
		Residual variance	16%	16%	17%	18%	18%	19%
G. Simple & 3rd polynomial Year + Latitude(3 rd polynomial)	Fixed	Intercept ()	-3.426	-3.763	-3.079	0.487	0.346	0.627
		ln (# of nests)	0.045	-0.03	0.119	0.015	-0.016	0.045
		mean Year of the study	0.077	-0.077	0.229	0.036	-0.027	0.097
		Latitude (1 st poly)	1.597	0.288	2.863	0.657	0.125	1.172
		Latitude (2 nd poly)	-0.257	-1.769	1.298	-0.257	-0.871	0.365
		Latitude (3 rd poly)	0.08	-1.251	1.341	-0.018	-0.564	0.512
	Random	Study site (intercept)	84%	83%	85%	82%	81%	82%
		Species (intercept)	0%	0%	0%	0%	0%	0%
		Residual variance	16%	15%	17%	18%	18%	19%
H. Interaction & 3rd polynomial Year × Latitude(3 rd polynomial)	Fixed	Intercept ()	-3.452	-3.803	-3.1	0.48	0.325	0.629
		ln (# of nests)	0.045	-0.03	0.118	0.015	-0.017	0.048
		mean Year of the study	0.093	-0.066	0.25	0.041	-0.023	0.103
		Latitude (1 st poly)	1.667	-0.132	3.543	0.705	-0.025	1.436
		Latitude (2 nd poly)	-0.198	-1.838	1.542	-0.26	-0.932	0.434
		Latitude (3 rd poly)	-0.007	-1.804	1.763	-0.026	-0.756	0.691
		Year × Latitude (1 st poly)	0.587	-1.092	2.4	0.143	-0.533	0.858
		Year × Latitude (2 nd poly)	0.681	-1.109	2.4	0.169	-0.539	0.881
		Year × Latitude (3 rd poly)	-0.099	-2.306	2.179	-0.073	-0.974	0.806
	Random	Study site (intercept)	84%	83%	85%	82%	81%	82%
		Species (intercept)	0%	0%	0%	0%	0%	0%
		Residual variance	16%	15%	17%	18%	18%	19%

Shown are the posterior estimates (medians) of the effect sizes with the 95% credible intervals from a posterior distribution of 5,000 simulated values generated by the 'sim' function in R⁶. Mean year and absolute latitude were z-transformed (by subtracting the mean and dividing by standard deviation). N = 98 populations representing 49 species.

Estimating repeatability of extracting information from the sources about 'Beintema conversion'

For 38% of 128 populations (where Kubelka et al. assumed that more than 50% of nesting period was observed) we were unable to find information in the reference to suggest such assumption was appropriate. For sources where we found some relevant information about nest searching intensity and about when within nesting period most nests were found, a different person extracted the information a new for 73 sources. The conclusions differed in 30% of the sources.

Exploring within-population changes in predation rates over time

Kubelka et al. tested for within-population change between periods (before and after 2000) in 9 populations at 7 sites and found a significant effect of period on the daily predation rates, where daily predation rates increased after 2000. We reviewed the references used by Kubelka et al. using their criteria for including populations (≥ 2 years and ≥ 12 nests with known fate for each period). We found information for a total of 23 populations. The 23 included 7 of the 9 included by Kubelka et al; for the remaining two, we were unable to obtain the necessary information for one (*Vanellus vanellus* in Czech Republic; Kubelka in litt.) and we found that the other population included only 13 nests after 2000 and the observation period was not known for most of those, so we excluded that population from further consideration *Calidris melanotos* at Kuparuk, Alaska¹¹). One population not included by Kubelka et al. was from a low latitude (28° N); we excluded this population because, Kubelka et al. report the increased predation rates only for higher latitudes. For the remaining 22 populations (Table S7), we calculated daily predation rates based on the information we found in the literature or

unpublished datasets, using the Beintema transformation when necessary (using 0.5 when we found no information to indicate that most nests were found prior to the midpoint of incubation, or 0.6 if nest-searching was conducted at least weekly or nest age at discovery was less than half of the nesting period). Our predation rate values occasionally differed from Kubelka et al.'s when we found additional data (years or nests) that were excluded by the Kubelka et al. or when we applied a different value for the Beintema transformation (Table S7).

We repeated Kubelka et al.'s assessment of within-population change in predation rates for our 22 populations by applying the same linear mixed-effects model, including fixed effects of period and latitude (scaled by subtracting the mean and dividing by standard deviation) and random effects of species and locality. Like Kubelka et al., we applied the model with package lme4 in R (Bates et al. 2014; R Core Team 2018). With our expanded dataset, we likewise found a positive effect of period ($\beta_{\text{period}} = 0.29$, 95% CI = 0.05 to 0.53, $p = 0.03$), indicating an increase in daily predation rates after 2000, although 46% smaller than the increase estimated by Kubelka et al. ($\beta_{\text{period}} = 0.54$, 95% CI = 0.11 to 0.97).

With the 22 populations, we then explored the consequences of the Beintema transformation for the apparent within-population change. We applied the above model separately to two groups: first, the populations for which the Beintema transformation was consistently needed (applied to both periods, or never applied; $N = 13$ populations at 5 sites; Figure S4a); and second, the populations that required the transformation in only one period, which was before 2000 in all cases ($N = 9$ populations at 3 sites; Figure S4b). For population with the consistent transformation, the effect of period dropped by 50% from our initial effect ($\beta_{\text{period}} = 0.29$) and became statistically non-significant ($\beta_{\text{period}} = 0.14$, 95% CI = -0.11 to 0.39, $p = 0.28$). For populations where the transformation was necessary only for the period before year 2000, the effect increased by 34% from our initial effect and remained significant ($\beta_{\text{period}} = 0.49$, SE = 0.20, $p = 0.02$). This suggests that using the Beintema transformation during only one of the two periods could explain the apparent effect of period on daily predation rates in the larger dataset.

Finally, for the 9 populations that required the transformation only before 2000, we conducted a sensitivity analysis for the value of the Beintema coefficient (B). Originally, we used $B = 0.5$ for all 9 populations because nest-searching was conducted less than weekly or no information was provided. However, as discussed above, at least in Arctic populations values higher than $B = 0.6$ (when nests are on average found just before the midpoint of the nesting period) are unlikely to be valid even in modern studies (see above), and $B = 0.5$ is sometimes more appropriate even with extensive nest-searching effort (Figure S1). Values lower than $B = 0.5$ were not considered by Kubelka et al., but would be appropriate if nests were found late in incubation or near hatching (Beintema 1996), which is likely for studies with less than weekly nest searching effort or for cryptic species. We thus varied Beintema coefficient from 0.1 to 0.4 to evaluate the sensitivity of the change in predation rate between periods to the assumptions made for the Beintema transformation. We then fitted the same model as above, using each value of B in turn. For this sensitivity analysis, we excluded one population for which the pre-2000 values were calculated from two different references, only one of which required the transformation (Whimbrel *Numenius phaeopus* at Churchill, Manitoba). We found that all values < 0.5 resulted in a nonsignificant effect of period ($p \geq 0.14$), and in the most extreme case ($B = 0.1$), the direction of the effect was opposite to the one found by Kubelka et al. and of the same magnitude (Figure S5, Table S8). In other words, smaller B values often produced higher daily predation estimates for before 2000 data than for after 2000 data (Figure S5), which often resulted in a conclusion that predation rate was not higher after 2000 than before 2000.

With no information provided in the sources for nest-searching frequency or age at which nests were found, it is impossible to tell which B value is most appropriate for many published studies. However, it seems likely that values of $B < 0.5$ would sometimes be appropriate for the studies from the 1960s and 1970s, especially if nests were found opportunistically or with low nest-searching effort. Given the sensitivity of the apparent change in daily predation rates to the value of B that was selected, and the lack of any change in daily predation rates in populations for which predation rates were known or B was applied consistently, the apparent increase in predation rates after 2000 detected by Kubelka et al. might have been a methodological artefact.

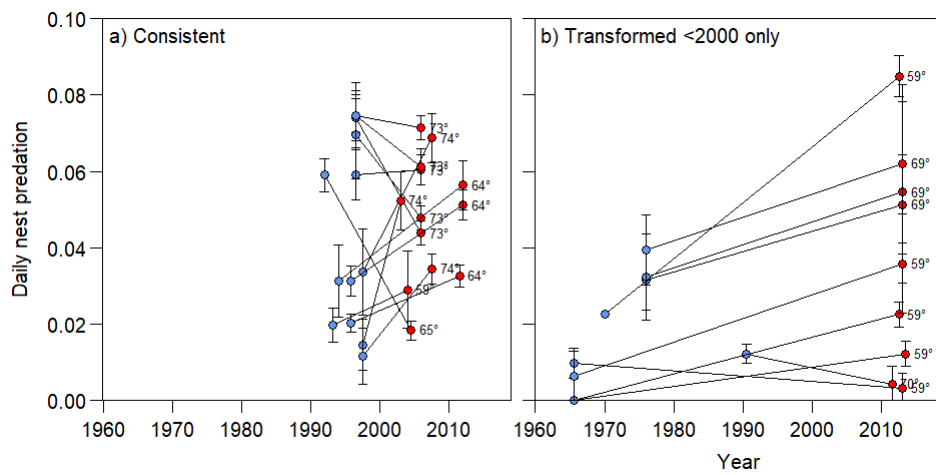


Figure S4 | Population-specific change in nest predation over time. **a,b.** Populations that either consistently required the Beintema transformation in both periods, or consistently reported observation time explicitly (**a**), and populations that required the Beintema transformation in only one period (always before 2000; **b**). Points indicate means, bars 95% CIs. Colour indicates before 2000 (blue) and after 2000 (red), lines connect the same populations and numbers next to red points indicate the latitude of each population. The data summary is in Table S7.

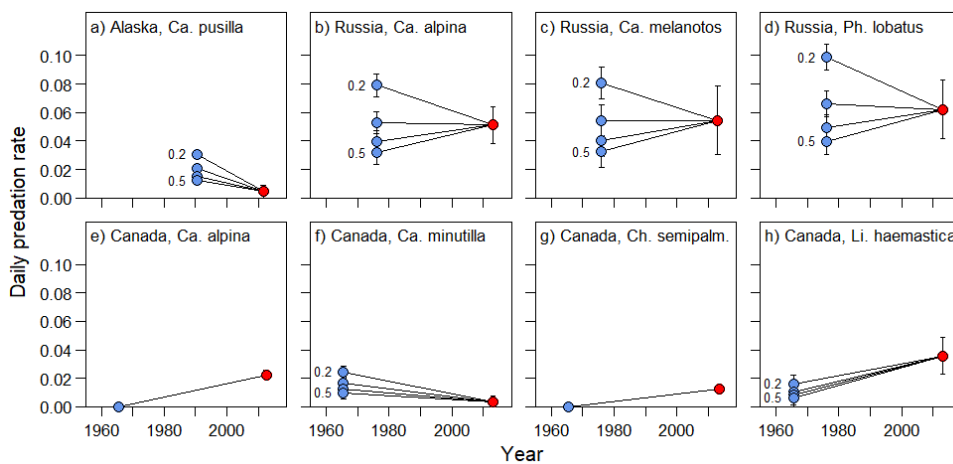


Figure S5 | Population-specific daily predation rate according to species, location and conversion coefficient B. **a-h.** Each panel represents one population that required the Beintema transformation in only one period (always before 2000). Points indicate means, bars 95% CIs (calculated following¹³). Colour indicates before 2000 (blue) and after 2000 (red), numbers next to blue points indicate the various values of conversion coefficient ($B = 0.2, 0.3, 0.4$, or 0.5) used to estimated daily predation rate for before 2000 data. $B = 0.1$ was tested but often produced much higher predation rate values and is not shown for clarity. For two populations (**e**, **g**), predation rate before 2000 was always zero regardless of the conversion coefficient because zero nests were depredated. Details for each population are provided in Table S7.

Table S7 | Shorebird populations used in re-analysis of within-population changes in daily predation rate from historic (<2000) to recent (≥2000) periods.

Species ^a	Location	Latitude	Longitude	Period	DPR	SEM	N years	Mean year	N nests	Exposure	B ^b	Included by Kubelka et al. ^c	Source ^d
<i>Charadrius semipalmatus</i>	Canada	58.698	-93.942	historic	0	0	4	1966	15	196.0	0.5	-	1
				recent	0.012	0.003	2	2014	67	1003.0	-	-	2
<i>Limosa haemastica</i>	Canada	58.698	-93.942	historic	0.006	0.006	4	1966	12	155.2	0.5	Yes	1
				recent	0.036	0.013	3	2013	20	201.5	-	Yes	2
<i>Numenius phaeopus</i>	Canada	58.698	-93.942	historic	0.023	NA	16	1970	90	1121.0	0.5	Yes ¹	1, 3
				recent	0.085	0.005	4	2012	149	1620.5	-	Yes ²	2
<i>Tringa nebularia</i>	Scotland	58.533	-4.232	historic	0.020	0.005	43	1993	71	918.3	0.5	Yes ¹	4, 5
				recent	0.029	0.010	7	2004	24	275.9	0.5	Yes	5
<i>Arenaria interpres</i>	Greenland	74.478	-20.555	historic	0.034	0.011	4	1998	38	338.5	-	-	6
				recent	0.069	0.006	16	2008	150	1238.0	-	-	6
<i>Philomachus pugnax</i>	Russia	72.906	106.104	historic	0.075	0.009	6	1996	79	810.9	0.6	-	7
				recent	0.061	0.005	12	2006	176	1952.3	0.6	-	2, 7
<i>Calidris alba</i>	Greenland	74.478	-20.555	historic	0.015	0.007	4	1998	35	387.3	-	Yes	6
				recent	0.052	0.008	7	2003	58	642.7	-	Yes ¹	6
<i>Calidris mauri</i>	Alaska	64.449	-164.977	historic	0.020	0.002	6	1996	219	3184.5	-	Yes ¹	2
				recent	0.033	0.003	6	2012	288	3767.0	-	Yes ¹	2
<i>Calidris temminckii</i>	Finland	65.021	24.72	historic	0.059	0.004	19	1992	464	3031.8	0.5	Yes ²	8
				recent	0.018	0.002	8	2004	153	2845.8	0.9	Yes ¹	9
<i>Calidris melanotos</i>	Russia	72.906	106.104	historic	0.075	0.004	6	1996	248	2675.4	0.6	-	7
				recent	0.071	0.003	12	2006	364	4058.9	0.6	-	2, 7
<i>Calidris melanotos</i>	Russia	68.610	171.241	historic	0.032	0.011	9	1976	23	247.0	0.5	-	10
				recent	0.055	0.024	3	2013	14	121.5	-	-	2
<i>Calidris alpina</i>	Canada	58.698	-93.942	historic	0	0	4	1966	13	162.5	0.5	Yes	1
				recent	0.023	0.003	4	2012	110	1493.5	-	Yes ³	2
<i>Calidris alpina</i>	Greenland	74.478	-20.555	historic	0.012	0.007	4	1998	28	332.1	-	-	6
				recent	0.034	0.004	16	2008	184	2037.3	-	-	6
<i>Calidris alpina</i>	Russia	72.906	106.104	historic	0.059	0.006	6	1996	129	1335.0	0.6	-	7
				recent	0.060	0.004	12	2006	180	2104.5	0.6	-	2, 7
<i>Calidris alpina</i>	Russia	68.610	171.241	historic	0.032	0.008	9	1976	51	506.2	0.5	-	10
				recent	0.051	0.013	3	2013	45	388.0	-	-	2
<i>Calidris minuta</i>	Russia	72.906	106.104	historic	0.070	0.012	6	1996	49	477.8	0.6	-	7
				recent	0.048	0.003	12	2006	228	2709.9	0.6	-	2, 7
<i>Calidris minutilla</i>	Canada	58.698	-93.942	historic	0.010	0.004	4	1966	56	612.0	0.5	-	1
				recent	0.003	0.004	3	2013	21	255.0	-	-	2
<i>Calidris pusilla</i>	Alaska	64.449	-164.977	historic	0.031	0.004	6	1996	187	2273.5	-	-	2
				recent	0.051	0.004	5	2012	213	2396.5	-	-	2
<i>Calidris pusilla</i>	Alaska	70.380	-149.534	historic	0.012	0.002	4	1990	179	1962.2	0.5	-	11
				recent	0.004	0.005	2	2012	21	303.0	-	-	2
<i>Phalaropus lobatus</i>	Alaska	64.449	-164.977	historic	0.031	0.009	3	1994	46	476.0	-	-	2
				recent	0.056	0.006	5	2012	149	1379.5	-	-	2
<i>Phalaropus lobatus</i>	Russia	68.610	171.241	historic	0.040	0.009	9	1976	52	455.6	0.5	-	10
				recent	0.062	0.021	2	2013	16	133.0	-	-	2
<i>Phalaropus fulicarius</i>	Russia	72.906	106.104	historic	0.074	0.006	6	1996	135	1354.3	0.6	-	7
				recent	0.044	0.003	12	2006	317	3395.6	0.6	-	2, 7

^a Taxonomic order in the IOC World Bird List has changed recently, so we ordered species to follow Table S4 of Kubelka et al. for ease of comparison.

^b B = value used in the Beintema transformation (see text) to calculate exposure days; shown only when the transformation was necessary.

^c “Yes” indicates populations included in Kubelka et al. with the following caveats: 1) fewer years and nests, 2) fewer nests from the same years, 3) assumed all nests that failed to unknown causes were depredated. In some cases, Kubelka et al. also used a different value for B (see their supporting data for the corresponding value). Populations not included by Kubelka et al., all of which met their criteria for inclusion, are indicated with “-”.

^d Sources from Kubelka et al.: 1) Jehl 1971, 2) Arctic Shorebird Demographics Network 2016, 3) Skeel 1983, 4) Christian & Hancock 2009, 5) Hancock in litt., 6) Hansen in litt., 7) Soloviev et al. 2010 (we assumed all nests that failed to unknown causes were depredated), 8) Rönkä et al. 2003, 9) Thompson et al. 2014, 10) Kondrjatev 1982, 11) Moitoret et al. 1996.

Table S8 | Daily predation rates in relation to period and Beintema conversion coefficient.

B	β _{period}	Intercept	β _{latitude}
0.5	0.50 (0.19)	-5.17 (6.31)	0.02 (0.10)
0.4	0.31 (0.20)	-6.42 (6.28)	0.04 (0.10)
0.3	0.16 (0.22)	-6.67 (7.47)	0.05 (0.10)
0.2	-0.07 (0.26)	-7.04 (6.69)	0.06 (0.10)
0.1	-0.51 (0.33)	-7.72 (6.97)	0.07 (0.11)

Results of linear mixed-effects models testing for an effect of period on daily predation rates under various assumptions for Beintema coefficients (B = 0.5, 0.4, 0.3, 0.2, or 0.1). Values in parentheses are SEs; bold values indicate estimates significantly different from zero. Latitude was scaled by subtracting the mean and dividing by 1 SD.

References

- 1 R Core Team. R: A language and environment for statistical computing - version 3.5.1. Internet. *R Foundation for Statistical Computing* [cited 2019 Jan 25], <http://www.R-project.org/> (2018).
- 2 Therneau, T. M. coxme: Mixed Effects Cox Models. . R package version 2.2-10. <https://CRAN.R-project.org/package=coxme> (2018).
- 3 Kubelka, V. *et al.* Global pattern of nest predation is disrupted by climate change in shorebirds. *Science* **362**, 680-683 (2018).
- 4 Bates, D., Maechler, M., Bolker, B. & Walker, S. Fitting Linear Mixed-Effects Models Using lme4. *J Stat Softw* **67**, 1-48 (2015).
- 5 Gelman, A. & Hill, J. *Data analysis using regression and multilevel/hierarchical models* (Cambridge University Press, 2007).
- 6 Gelman, A. & Su, Y.-S. arm: Data Analysis Using Regression and Multilevel/Hierarchical Models. R package version 1.8-6. <http://CRAN.R-project.org/package=arm> (2015).
- 7 R-Core-Team. R: A Language and Environment for Statistical Computing. Version 3.3.0. *R Foundation for Statistical Computing*, <http://www.R-project.org/> (2016).
- 8 Bates, D., Maechler, M., Bolker, B. & Walker, S. lme4: Linear mixed-effects models using Eigen and S4. R Package Version 1.0-6. <http://CRAN.R-project.org/package=lme4> (2014).
- 9 Mayfield, H. Nesting success calculated from exposure. *Wilson Bull* **73**, 255-261 (1961).
- 10 Beintema, A. J. Inferring nest success from old records. *Ibis* **138**, 568–570 (1996).
- 11 Lanctot, R. B., S. C. Brown, and B. K. Sandercock. Data from: Arctic Shorebird Demographics Network. *NSF Arctic Data Center* (2016). <https://arcticdata.io/catalog/view/doi:10.18739/A2CD5M>
- 12 Brown, S. C., H. R. Gates, J. R. Liebezeit, P. A. Smith, B. L. Hill, and R. B. Lanctot. Arctic Shorebird Demographics Network Breeding Camp Protocol, Version 5. *U.S. Fish and Wildlife Service and Manomet Center for Conservation Sciences* (2014).
- 13 Johnson, D. H. Estimating nest success: The Mayfield method and an alternative. *Auk* **96**, 651–661 (1979).