

Supplementary material

Summary of long-term capture-recapture-recovery data of nesting females from ten study sites used to analyse multi-colony survival rates and to assess the importance of potential drivers of variation in survival.

Data:				
Colony	Years of ringing First – last year	No. ringed (no. recaptured)	No. of recoveries	% recovered
Vlieland (NL)	1974-2003	4,223 (733)	1111	26.3%
Mandø (DK)	1971-1980	353 (348)	69	19.5%
Stavns Fjord (DK)	1970-2007	4,023 (1680)	917	22.8%
Hindsholm (DK)	1998-2014	1,814 (607)	129	7.1%
Helleholm (DK)	1982-2015	1,706 (914)	170	10.0%
Næbbet (DK)	1982-1996	873 (440)	61	7.0%
Saltholm (DK)	1993-2008	1,379 (300)	77	5.6%
Christiansø (DK)	1973-2015	5,759 (2735)	1101	19.1%
Utklippan (S)	1984-2004	531 (327)	54	10.2%
Tvärminne (FIN)	1996-2014	1,659 (662)	171	10.3%

Table of results from analysis of deviance of available potential drivers of variation in annual survival of nesting females at 10 study colonies: 1: Vlieland, 2: Mandø, 3: Stavns Fjord, 4: Hindsholm, 5: Helleholm, 6: Næbbet, 7: Saltholm, 8: Christiansø, 9: Utklippan, 10: Tvärminne. The table shows first-last year with available covariate data with a temporal overlap in the time series of colony-specific survival rates (Cov. years). The table also presents the intercept (Int.) and slope (Effect) $\pm$ 95% CI from the analysis of deviance tests, a derived R^2 -equivalent and the p-value (p-val), i.e. the level of statistical significance along with a p-value adjusted for multiple testing (p-val adj).

The first time a covariate appears in the table (from top to bottom) a short description is provided in brackets (for further details, see methods). Years with outbreaks of avian cholera were not included in the linear trend on survival in the affected colonies. AnODEV type 3 tests analyses how much variation a second predictor can explain once the first predictor has been accounted for.

Colony no.	Covariate	Cov. years	Int.	Effect	95% CI	95% CI R^2	p-val	p-val adj	
1	DJFM NAO (Dec-Jan-Feb-Mar NAO Index)	1974-2007	2.446	-0.208	-0.273	-0.142	8.3%	0.103	0.931
	DJFM NAO lag1y (Dec-Jan-Feb-Mar NAO Index lagged by 1 year)	1973-2006	2.480	-0.357	-0.423	-0.291	24.4%	0.004	0.039
	1 Killrate (the probability of dying due to hunting)	1974-2007	2.470	-0.342	-0.478	-0.206	5.7%	0.192	1.000
1	Sublittoral mussel stock (Mio kg fresh weight)	1977-2002	2.355	0.164	-0.559	0.887	5.1%	0.278	1.000
	1 Sublittoral mussel stock lag1y	1977-2002	2.380	-0.053	-0.122	0.016	0.5%	0.728	1.000
	1 <i>Mytilus spp.</i> body condition, DWS (Blue mussel body condition in the Danish Wadden Sea)	1997-2007	2.925	0.023	-0.131	0.177	0.0%	0.911	1.000
1	<i>Mytilus spp.</i> body condition, DWS lag1y	1997-2006	2.686	-0.244	-0.394	-0.093	24.2%	0.178	1.000
	1 Winter Temp NIOZ (Dec-Jan-Feb water temperature)	1974-2007	2.359	-0.285	-0.358	-0.212	13.2%	0.038	0.375
	1 Winter Temp NIOZ lag1y	1973-2006	2.361	-0.463	-0.535	-0.392	38.1%	0.000	0.001
1	Avian cholera at the site (confirmed outbreak(s) of cholera in the colony)	1984	2.387	-0.014	-0.065	0.037	0.0%	0.892	1.000
	1 Anodev Type 3: Winter Temp NIOZ lag1y + DJFM NAO lag1y	1973-2006					0.0%	0.665	1.000
	2 DJFM NAO	1971-1982	3.015	0.175	-0.172	0.522	4.9%	0.470	1.000
2	DJFM NAO lag1y	1970-1981	2.997	-0.129	-0.550	0.291	1.9%	0.655	1.000
	2 Killrate	1971-1982	2.736	0.191	-0.147	0.528	6.7%	0.395	1.000
	3 DJFM NAO	1970-1999	2.163	0.331	0.253	0.409	12.6%	0.064	0.578
3	DJFM NAO lag1y	1969-1998	2.174	0.524	0.449	0.598	34.3%	0.001	0.011
	3 Killrate	1970-1999	2.150	-0.038	-0.111	0.035	0.2%	0.824	1.000
	3 N tot DK (total annual nitrogen leakage into Danish waters)	1989-1999	1.436	0.677	0.529	0.825	22.3%	0.168	1.000
3	N tot DK lag1y (total annual nitrogen leakage into Danish waters lagged by 1 year)	1988-1999	1.099	1.470	1.226	1.713	60.1%	0.014	0.141
	3 Winter Temp DK	1987-1999	1.985	0.184	0.035	0.332	1.4%	0.712	1.000
	3 Winter Temp DK lag1y	1986-1999	1.678	0.971	0.820	1.123	52.5%	0.012	0.129
3	Avian cholera at the site	1996	1.981	-0.863	-1.039	-0.687	61.2%	0.000	0.001
	3 Anodev Type 3: Avian cholera at the site + DJFM NAO lag1y	1969-1999					9.9%	0.103	0.822
	3 Anodev Type 3: Avian cholera at the site + Temp 3 stations lag1y	1986-1999					8.5%	0.331	1.000
3	Anodev Type 3: Avian cholera at the site + Ntot lag1y	1988-1999					2.7%	0.698	1.000
	4 DJFM NAO	1997-2012	3.080	0.405	0.230	0.581	10.8%	0.232	0.930
	4 DJFM NAO lag1y	1996-2011	2.871	-0.207	-0.414	0.001	2.1%	0.607	1.000
4	Killrate	1997-2012	5.096	3.393	2.578	4.209	37.5%	0.015	0.137
	4 <i>Mytilus spp.</i> body condition (Blue mussel body condition in Danish waters)	1997-2012	3.028	1.994	1.537	2.451	20.3%	0.092	0.638
	4 <i>Mytilus spp.</i> body condition lag1y	1997-2011	2.761	0.992	0.678	1.306	27.2%	0.056	0.448
4	N tot DK	1997-2012	3.380	0.985	0.645	1.325	20.4%	0.091	0.638
	4 N tot DK lag1y	1996-2011	3.222	0.940	0.621	1.259	20.0%	0.095	0.638
	4 Winter Temp DK (Dec-Jan-Feb water temperature)	1997-2012	2.885	0.200	0.018	0.383	2.5%	0.576	1.000
4	Winter Temp DK lag1y (Dec-Jan-Feb water temperature lagged by 1 year)	1996-2011	2.988	-0.403	-0.595	-0.210	9.2%	0.272	0.930
	4 Avian cholera at the site	2008, 2009	3.150	-0.847	-0.991	-0.704	74.6%	0.000	0.001
	5 DJFM NAO	1982-2016	2.308	0.043	-0.088	0.174	0.4%	0.711	1.000
5	DJFM NAO lag1y	1981-2015	2.304	0.082	-0.057	0.221	1.4%	0.502	1.000
	5 Killrate	1982-2016	2.363	0.464	0.217	0.711	14.6%	0.026	0.205
	5 <i>Mytilus spp.</i> body condition (Blue mussel body condition in Danish waters)	1997-2013	2.002	-0.289	-0.462	-0.115	25.7%	0.045	0.316
5	<i>Mytilus spp.</i> body condition lag1y	1996-2012	2.078	-0.249	-0.436	-0.063	17.6%	0.106	0.635
	5 N tot DK	1989-2012	2.054	-0.105	-0.245	0.035	7.1%	0.221	0.882
	5 N tot DK lag1y	1989-2011	2.004	-0.036	-0.193	0.121	0.6%	0.728	1.000
5	Winter Temp DK	1987-2012	2.088	0.140	0.000	0.280	9.0%	0.144	0.721
	5 Winter Temp DK lag1y	1986-2011	2.045	0.213	0.073	0.352	20.6%	0.023	0.205
	6 DJFM NAO	1982-1997	3.824	-0.184	-0.454	0.086	8.7%	0.266	1.000
6	DJFM NAO lag1y	1981-1996	3.772	0.054	-0.196	0.303	0.8%	0.738	1.000
	6 Killrate	1982-1997	3.611	-0.571	-1.147	0.005	16.7%	0.116	0.809
	6 N tot DK	1989-1997	3.571	0.137	-0.170	0.444	9.7%	0.414	1.000
6	N tot DK lag1y	1989-1996	4.568	0.147	-0.193	0.487	56.6%	0.031	0.250
	6 Winter Temp DK	1987-1997	3.441	-0.137	-0.473	0.198	6.7%	0.442	1.000
	6 Winter Temp DK lag1y	1987-1996	3.481	-0.083	-0.420	0.253	2.6%	0.657	1.000
7	DJFM NAO	1993-2001	1.842	0.467	0.203	0.732	76.0%	0.005	0.038
	7 DJFM NAO lag1y	1992-2000	2.290	-0.159	-0.517	0.199	6.9%	0.530	1.000
	7 Killrate	1993-2001	2.088	-0.160	-1.497	1.178	0.4%	0.884	1.000
7	N tot DK	1993-2001	1.803	0.444	0.092	0.796	44.5%	0.071	0.495
	7 N tot DK lag1y	1992-2000	2.284	0.048	-0.311	0.407	0.5%	0.868	1.000
	7 Winter Temp DK	1993-2001	1.964	0.246	-0.120	0.612	9.8%	0.450	1.000
7	Winter Temp DK lag1y	1992-2000	1.933	-0.140	-0.567	0.287	3.0%	0.681	1.000
	8 DJFM NAO	1973-2016	2.328	-0.040	-0.098	0.019	1.2%	0.481	1.000
	8 DJFM NAO lag1y	1972-2015	2.323	0.035	-0.025	0.095	0.9%	0.542	1.000
8	Killrate	1973-2015	2.359	-0.105	-0.201	-0.008	3.1%	0.267	1.000
	8 <i>Mytilus spp.</i> body condition (Blue mussel body condition in Danish waters)	1997-2013	1.814	0.275	0.136	0.414	39.4%	0.009	0.093
	8 <i>Mytilus spp.</i> body condition lag1y	1996-2012	1.846	0.056	-0.086	0.197	2.2%	0.583	1.000
8	N tot DK	1989-2012	2.200	0.027	-0.061	0.116	0.5%	0.755	1.000
	8 N tot DK lag1y	1988-2011	2.092	0.143	0.052	0.233	11.2%	0.119	1.000
	8 Winter Temp DK	1987-2012	2.306	-0.143	-0.245	-0.041	9.6%	0.132	1.000
8	Winter Temp DK lag1y	1986-2011	2.304	-0.072	-0.174	0.029	2.1%	0.489	1.000
	9 DJFM NAO	1984-2006	2.486	0.273	0.039	0.508	14.8%	0.078	0.698
	9 DJFM NAO lag1y	1983-2006	2.598	-0.066	-0.339	0.206	0.7%	0.713	1.000
9	Killrate	1984-2006	2.567	0.260	-0.232	0.752	3.10%	0.433	1.000
	9 <i>Mytilus spp.</i> body condition (Blue mussel body condition in Danish waters)	1997-2006	1.940	0.053	-0.497	0.602	1.9%	0.723	1.000
	9 <i>Mytilus spp.</i> body condition lag1y	1997-2005	1.937	-0.049	-0.650	0.552	0.3%	0.891	1.000
9	N tot DK	1989-2006	2.399	0.104	-0.195	0.403	1.6%	0.627	1.000
	9 N tot DK lag1y	1989-2005	2.456	-0.037	-0.326	0.252	0.2%	0.864	1.000
	9 Winter Temp DK	1987-2006	2.540	0.110	-0.148	0.367	2.2%	0.547	1.000
9	Winter Temp DK lag1y	1987-2005	2.530	-0.230	-0.556	0.095	7.6%	0.268	1.000
	10 DJFM NAO	1996-2015	1.285	0.162	0.047	0.277	15.9%	0.091	1.000
	10 DJFM NAO lag1y	1995-2014	1.234	0.106	-0.010	0.221	6.6%	0.288	1.000
10	Killrate	1996-2015	0.971	-0.402	-0.772	-0.032	9.4%	0.201	1.000
	10 <i>Mytilus spp.</i> body condition (Blue mussel body condition in Danish waters)	1997-2013	1.189	-0.023	-0.140	0.094	0.5%	0.789	1.000
	10 <i>Mytilus spp.</i> body condition lag1y	1997-2013	1.174	-0.017	-0.138	0.104	2.9%	0.844	1.000
10	N tot DK	1996-2012	1.197	-0.021	-0.199	0.158	0.2%	0.874	1.000
	10 N tot DK lag1y	1995-2012	1.224	0.060	-0.121	0.240	1.4%	0.646	1.000
	10 Winter Temp DK	1996-2012	1.206	0.026	-0.099	0.151	0.6%	0.774	1.000
10	Winter Temp DK lag1y	1995-2012	1.206	0.103	-0.011	0.218	10.6%	0.203	1.000
	Predation index (no. of predated females / all active nests)	1996-2015	1.198	-0.016	-0.121	0.089	0.2%	0.859	1.000
	10, habitat Predation index	1996-2015					5.3%	0.397	1.000
10, forest	Predation index	1996-2015	1.289	-0.096	-0.202	0.009	8.5%	0.225	1.000
	10, open Predation index	1996-2015	0.953	0.092	-0.159	0.344	0.0%	0.598	1.000

Bray-Curtis matrices of dissimilarities

Early period 1975 - 1981

Colonies: 1) Christiansø, 2) Stavns Fjord, 3) Mandø, 4) Vlieland

Survival dissimilarity matrix:

	1	2	3
2	0.02706931		
3	0.02170659	0.02936114	
4	0.02774851	0.03081988	0.02256581

Recovery distribution dissimilarity matrix:

	1	2	3
2	0.6307049		
3	0.9242005	0.9413408	
4	0.6605156	0.7660513	0.9430918

Middle period 1985 - 2002

Colonies: 1) Utklippen, 2) Christiansø, 3) Helleholm, 4) Næbbet, 5) Stavns Fjord, 6) Vlieland

Survival dissimilarity matrix:

	1	2	3	4	5
2	0.03525763				
3	0.03323709	0.02291901			
4	0.03419192	0.03525148	0.03706676		
5	0.07241346	0.06495570	0.07034724	0.07442680	
6	0.03839773	0.03384907	0.03343509	0.05022210	0.06573454

Recovery distribution dissimilarity matrix:

	1	2	3	4	5
2	0.1947494				
3	0.6088608	0.5663877			
4	0.4517241	0.3942062	0.2767351		
5	0.6877095	0.6307049	0.1011951	0.2806781	
6	0.6584541	0.6605156	0.7560386	0.7208896	0.7660513

Late period 1997 - 2011

Colonies: 1) Tvärminne, 2) Christiansø, 3) Helleholm

Survival dissimilarity matrix:

	1	2
2	0.09311695	
3	0.07596500	0.04787340

Recovery distribution dissimilarity matrix:

	1	2
2	0.2270975	
3	0.4522882	0.5663877