The following supplement accompanies the article

Changes in the Norwegian breeding population of European shag correlate with forage fish and climate

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Supplement. Additional data

Table S1. Tests for linear trends in untransformed parameters used to identify drivers of yearly population growth rates in 3 shag colonies (Sklinna, Røst and Kamøy) along the Norwegian coast. Except for population growth rate, which was based on 24 year intervals, the sample size is 25 for all parameters (number of years from 1985 to 2009)

Parameter	Slope (±1 SE)	r^2	p
Pop. size Sklinna	0.06 (0.006)	0.83	<0.0001
Pop. size Røst	0.04 (0.01)	0.41	0.0007
Pop. size Kamøy	0.15 (0.06)	0.22	0.02
Pop. growth rate Sklinna	–0.005 (0.01)	0.01	0.63
Pop. growth rate Røst	0.005 (0.01)	0.01	0.66
Pop. growth rate Kamøy	0.03 (0.07)	0.01	0.68
Capelin (total stock)	0.04 (0.04)	0.06	0.32
Saithe (3 yr old)	0.01 (0.02)	0.02	0.53

Table S2. Comparison of all candidate models describing the variance in population growth rate of shags from the 3 study colonies (Sklinna, Røst and Kamøy) along the Norwegian coast in the period 1985 to 2009. The covariates entered are winter NAO (wNAO), winter NAO lagged by 1 yr ($wNAO_{lag1}$), population size (Pop.size), 1 yr old saithe (Saithe[1]) and 2 yr old saithe (Saithe[2]). For the Kamøy population, the total capelin stock in the Barents Sea (Capelin) was also entered. Models are sorted by ascending ΔAICc. For each model, we also give the model likelihood (ML = exp(–0.5 × ΔAICc)) and r^2

Sklinna

Rank	Model (age of fish)	AICc	ΔAICc	ML	r^2
1	Pop.size + $wNAO_{lag1}$ + Saithe[1]	–72.82	0.00	1.00	0.67
2	Pop.size + wNAO + $wNAO_{lag1}$ + Saithe[1]	–71.75	1.07	0.59	0.70
3	Pop.size + $wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–70.44	2.38	0.30	0.68
4	Pop.size + wNAO + $wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–69.09	3.73	0.15	0.70
5	wNAO + $wNAO_{lag1}$ + Saithe[1]	–68.29	4.53	0.10	0.61
6	$wNAO_{lag1}$ + Saithe[1]	–67.93	4.89	0.09	0.56
7	wNAO + $wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–67.01	5.81	0.05	0.63
8	$wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–67.00	5.83	0.05	0.59
9	Pop.size + Saithe[1] + Saithe[2]	–60.18	12.64	0.00	0.46
10	Pop.size + Saithe[1]	–59.33	13.50	0.00	0.38
11	Saithe[1] + Saithe[2]	–59.32	13.51	0.00	0.38
12	Pop.size + wNAO + $wNAO_{lag1}$	–59.00	13.82	0.00	0.43
13	wNAO + $wNAO_{lag1}$	–58.44	14.38	0.00	0.35
14	wNAO + Saithe[1] + Saithe[2]	–58.27	14.55	0.00	0.41
15	Pop.size + wNAO + Saithe[1] + Saithe[2]	–58.17	14.66	0.00	0.48
16	Pop.size + wNAO + Saithe[1]	–57.43	15.39	0.00	0.39
17	Saithe[1]	–56.58	16.24	0.00	0.23
18	wNAO + $wNAO_{lag1}$ + Saithe[2]	–56.57	16.25	0.00	0.37
19	Pop.size + wNAO + $wNAO_{lag1}$ + Saithe[2]	–56.30	16.52	0.00	0.44
20	Pop.size + $wNAO_{lag1}$	–56.11	16.72	0.00	0.29
21	wNAO + Saithe[1]	–55.73	17.09	0.00	0.28
22	Pop.size + wNAO	–54.80	18.02	0.00	0.25
23	wNAO + Saithe[2]	–54.68	18.14	0.00	0.25
24	Pop.size	–54.11	18.72	0.00	0.15
25	$wNAO_{lag1}$	–54.06	18.76	0.00	0.15
26	Pop.size + wNAO + Saithe[2]	–54.05	18.77	0.00	0.31
27	wNAO	–54.05	18.78	0.00	0.15
28	Pop.size + wNAOlag1 + Saithe[2]	–53.63	19.20	0.00	0.29
29	Pop.size + Saithe[2]	–53.05	19.77	0.00	0.20
30	$wNAO_{lag1}$ + Saithe[2]	–52.45	20.37	0.00	0.18
31	Saithe[2]	–52.39	20.43	0.00	0.09

Røst

Rank	Model (age of fish)	AICc	ΔAICc	ML	r^2
1	Pop.size + $wNAO_{lag1}$ + Saithe[1]	–59.46	0.00	1.00	0.56
2	Pop.size + wNAO + Nao_{lag1} + Saithe[1]	–56.61	2.85	0.24	0.56
3	Pop.size + $wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–56.55	2.91	0.23	0.56
4	$wNAO_{lag1}$ + Saithe[1]	–55.08	4.38	0.11	0.41
5	Pop.size + wNAO + $wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–53.39	6.07	0.05	0.56

6	Pop.size + $wNAO_{lag1}$	–53.14	6.32	0.04	0.36
7	$wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–52.80	6.66	0.04	0.42
8	wNAO + $wNao_{lag1}$ + Saithe[1]	–52.49	6.97	0.03	0.41
9	Pop.size + wNAO + NAO_{lag1}	–51.26	8.20	0.02	0.38
10	Pop.size + $wNAO_{lag1}$ + Saithe[2]	–50.52	8.94	0.01	0.36
11	$wNAO_{lag1}$	–50.22	9.24	0.01	0.21
12	wNAO + $wNAO_{lag1}$ + Saithe[1] + Saithe[2]	–49.94	9.52	0.01	0.42
13	Pop.size + Saithe[1]	–49.41	10.05	0.01	0.26
14	Pop.size	–49.28	10.18	0.01	0.18
15	wNAO + $wNAO_{lag1}$	–48.49	10.97	0.00	0.23
16	Pop.size + wNAO + $wNAO_{lag1}$ + Saithe[2]	–48.36	11.10	0.00	0.38
17	Pop.size + Saithe[1] + Saithe[2]	–48.27	11.19	0.00	0.30
18	$wNAO_{lag1}$ + Saithe[2]	–48.04	11.42	0.00	0.21
19	Pop.size + Saithe[2]	–47.73	11.73	0.00	0.20
20	Pop.size + wNAO	–47.05	12.41	0.00	0.18
21	Saithe[1] + Saithe[2]	–46.93	12.53	0.00	0.18
22	Pop.size + wNAO + Saithe[1]	–46.85	12.61	0.00	0.26
23	Saithe[1]	–46.76	12.70	0.00	0.08
24	Saithe[2]	–46.34	13.12	0.00	0.07
25	wNAO + $wNAO_{lag1}$ + Saithe[2]	–46.05	13.41	0.00	0.23
26	Pop.size + wNAO + Saithe[1] + Saithe[2]	–45.47	13.99	0.00	0.31
27	Pop.size + wNAO + Saithe[2]	–45.28	14.18	0.00	0.21
28	wNAO	–44.80	14.66	0.00	0.01
29	wNAO + Saithe[1]	–44.43	15.03	0.00	0.09
30	wNAO + Saithe[1] + Saithe[2]	–44.39	15.07	0.00	0.18
31	wNAO + Saithe[2]	–44.14	15.32	0.00	0.08

Kamøy

Rank	Model (age of fish)	AICc	ΔAICc	ML	r^2
1	Pop.size + Capelin	33.64	0.00	1.00	0.46
2	Pop.size + Capelin + Saithe[2]	34.29	0.66	0.72	0.50
3	$wNAO_{lag1}$ + Pop.size + Capelin	35.90	2.27	0.32	0.46
4	Pop.size + Capelin + Saithe[1]	36.05	2.42	0.30	0.46
5	wNAO + Pop.size + Capelin	36.23	2.60	0.27	0.46
6	wNAO + Pop.size + Capelin + Saithe[2]	37.13	3.50	0.17	0.50
7	Pop.size + Capelin + Saithe[1] + Saithe[2]	37.14	3.50	0.17	0.50
8	$wNAO_{lag1}$ + Pop.size + Capelin + Saithe[2]	37.19	3.56	0.17	0.50
9	Pop.size	37.64	4.00	0.14	0.29
10	Pop.size + Saithe[1]	38.14	4.51	0.11	0.34
11	$wNAO_{lag1}$ + Pop.size + Capelin + Saithe[1]	38.41	4.77	0.09	0.47
12	$wNAO_{lag1}$ + wNAO + Pop.size + Capelin	38.79	5.16	0.08	0.46
13	wNAO + Pop.size + Capelin + Saithe[1]	38.80	5.17	0.08	0.46
14	Pop.size + Saithe[2]	39.55	5.92	0.05	0.30
15	wNAO + Pop.size	40.00	6.37	0.04	0.29
16	$wNAO_{lag1}$ + Pop.size	40.02	6.38	0.04	0.29
17	wNAO + Pop.size + Capelin + Saithe[1] + Saithe[2]	40.22	6.59	0.04	0.50
18	$wNAO_{lag1}$ + Pop.size + Capelin + Saithe[1] + Saithe[2]	40.34	6.70	0.04	0.50
19	$wNAO_{lag1}$ + wNAO + Pop.size + Capelin + Saithe[2]	40.36	6.72	0.03	0.50
20	Pop.size + Saithe[1] + Saithe[2]	40.38	6.74	0.03	0.35
21	wNAO + Pop.size + Saithe[1]	40.58	6.94	0.03	0.35
22	wNAOlag1 + Pop.size + Saithe[1]	40.64	7.01	0.03	0.35
23	$wNAOl_{ag1}$ + wNAO + Pop.size + Capelin + Saithe[1]	41.49	7.86	0.02	0.48

24	$wNAO_{lag1}$ + Pop.size + Saithe[2]	42.00	8.37	0.02	0.31
25	wNAO + Pop.size + Saithe[2]	42.16	8.53	0.01	0.30
26	$wNAO_{lag1}$ + wNAO + Pop.size	42.62	8.99	0.01	0.29
27	Saithe[2]	43.05	9.41	0.01	0.11
28	wNAO + Pop.size + Saithe[1] + Saithe[2]	43.09	9.46	0.01	0.36
29	$wNAO_{lag1}$ + Pop.size + Saithe[1] + Saithe[2]	43.28	9.64	0.01	0.35
30	$wNAO_{lag1}$ + wNAO + Pop.size + Saithe[1]	43.36	9.72	0.01	0.35
31	$wNAO_{lag1}$ + wNAO + Pop.size + Capelin + Saithe[1] + Saithe[2]	43.80	10.17	0.01	0.50
32	Capelin + Saithe[2]	44.27	10.64	0.00	0.15
33	$wNAO_{lag1}$ + wNAO + Pop.size + Saithe[2]	44.90	11.26	0.00	0.31
34	$wNAO_{lag1}$ + Saithe[2]	45.00	11.37	0.00	0.12
35	wNAO + Saithe[2]	45.42	11.79	0.00	0.11
36	Saithe[1] + Saithe[2]	45.43	11.80	0.00	0.11
37	Capelin	45.72	12.08	0.00	0.00
38	Saithe[1]	45.78	12.14	0.00	0.00
39	wNAO	45.80	12.16	0.00	0.00
40	$wNAO_{lag1}$	45.81	12.18	0.00	0.00
41	$wNAO_{lag1}$ + wNAO + Pop.size + Saithe[1] + Saithe[2]	46.31	12.68	0.00	0.36
42	Capelin + Saithe[1] + Saithe[2]	46.44	12.80	0.00	0.17
43	$wNAO_{lag1}$ + Capelin + Saithe[2]	46.60	12.97	0.00	0.16
44	wNAO + Capelin + Saithe[2]	46.81	13.17	0.00	0.15
45	$wNAO_{lag1}$ + wNAO + Saithe[2]	47.59	13.95	0.00	0.13
46	$wNAO_{lag1}$ + Saithe[1] + Saithe[2]	47.61	13.97	0.00	0.13
47	Capelin + Saithe[1]	47.90	14.27	0.00	0.01
48	wNAO + Saithe[1] + Saithe[2]	48.05	14.41	0.00	0.11
49	wNAO + Capelin	48.06	14.43	0.00	0.01
50	$wNAO_{lag1}$ + Capelin	48.08	14.44	0.00	0.01
51	wNAO + Saithe[1]	48.16	14.53	0.00	0.00
52	$wNAO_{lag1}$ + Saithe[1]	48.17	14.53	0.00	0.00
53	$wNAO_{lag1}$ + wNAO	48.18	14.55	0.00	0.00
54	$wNAO_{lag1}$ + Capelin + Saithe[1] + Saithe[2]	48.77	15.13	0.00	0.19
55	wNAO + Capelin + Saithe[1] + Saithe[2]	49.34	15.71	0.00	0.17
56	$wNAO_{lag1}$ + wNAO + Capelin + Saithe[2]	49.36	15.73	0.00	0.17
57	$wNAO_{lag1}$ + wNAO + Saithe[1] + Saithe[2]	50.49	16.85	0.00	0.13
58	$wNAO_{lag1}$ + Capelin + Saithe[1]	50.53	16.89	0.00	0.01
59	wNAO + Capelin + Saithe[1]	50.53	16.90	0.00	0.01
60	$wNAO_{lag1}$ + wNAO + Capelin	50.67	17.03	0.00	0.01
61	$wNAO_{lag1}$ + wNAO + Saithe[1]	50.79	17.16	0.00	0.00
62	$wNAO_{lag1}$ + wNAO + Capelin + Saithe[1] + Saithe[2]	51.99	18.35	0.00	0.19
63	$wNAO_{lag1}$ + wNAO + Capelin + Saithe[1]	53.43	19.80	0.00	0.01