

Estimating the size of the UK grey seal population between 1984 and 2016.

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Abstract

We estimated grey seal population size in 2016 by projecting forwards one year from the outputs of the population model derived in last year's briefing paper. That model is a Bayesian state-space model of seal population dynamics, fitted to regional estimates of pup production from 1984-2014 and two independent estimates of total population size in 2008 and 2014. Estimated adult population size in regularly monitored colonies in 2016 is 128,200 (95% CI 106,200-154,400), an increase of approximately 1% on the 2015 estimate.

Introduction

This paper presents estimates of British grey seal population size, building on the model fitted by Thomas (2016). No new data were available, and no information came to light requiring revision of the model priors; hence, estimates for 2016 were obtained by projecting forwards from the 2015 estimates, using parameter estimates from the fitted model.

Methods

Full details of the population dynamics model, data and fitting methods are given by Thomas (2015) and references therein. Model fitting in Thomas (2015) used a stochastic simulation-based procedure, which yielded a set of 28,500,000 weighted samples from the joint posterior distribution of model parameters and states, including age-specific population size in each year 1984-2015. To generate population estimates for 2016, we (1) extracted 100,000 samples from this distribution by sampling with replacement and probability proportional to the weights; (2) projected each sample forward stochastically using the population dynamics model, and the demographic parameter values and 2015 population size for that sample. Estimates given here are the posterior predictive mean (i.e., mean of the projected samples), with 95% equal-tailed credible interval (2.5th and 97.5th percentile of projected samples).

Results and Discussion

Estimated pup production was 50,700 (95% CI 44,200-58,700) and adult population size was 128,200 (95% CI 106,200-154,400). These estimates are shown in Figures 1 and 2, together with those for previous years from Thomas (2016). Estimated adult population size in 2015, from Thomas (2016), was 127,100 (95%CI 105,900-151,900), so the estimate for 2016 is approximately 1% higher. Adult population estimates for each year are given in the Appendix, from which it is clear that population growth is not uniform across regions: the populations are estimated to be stable in Inner Hebrides, Outer Hebrides and Orkney, but growing (approx. 3% per year) in North Sea.

References

Thomas, L. 2016. Estimating the size of the UK grey seal population between 1984 and 2015. SCOS Briefing Paper 16/02

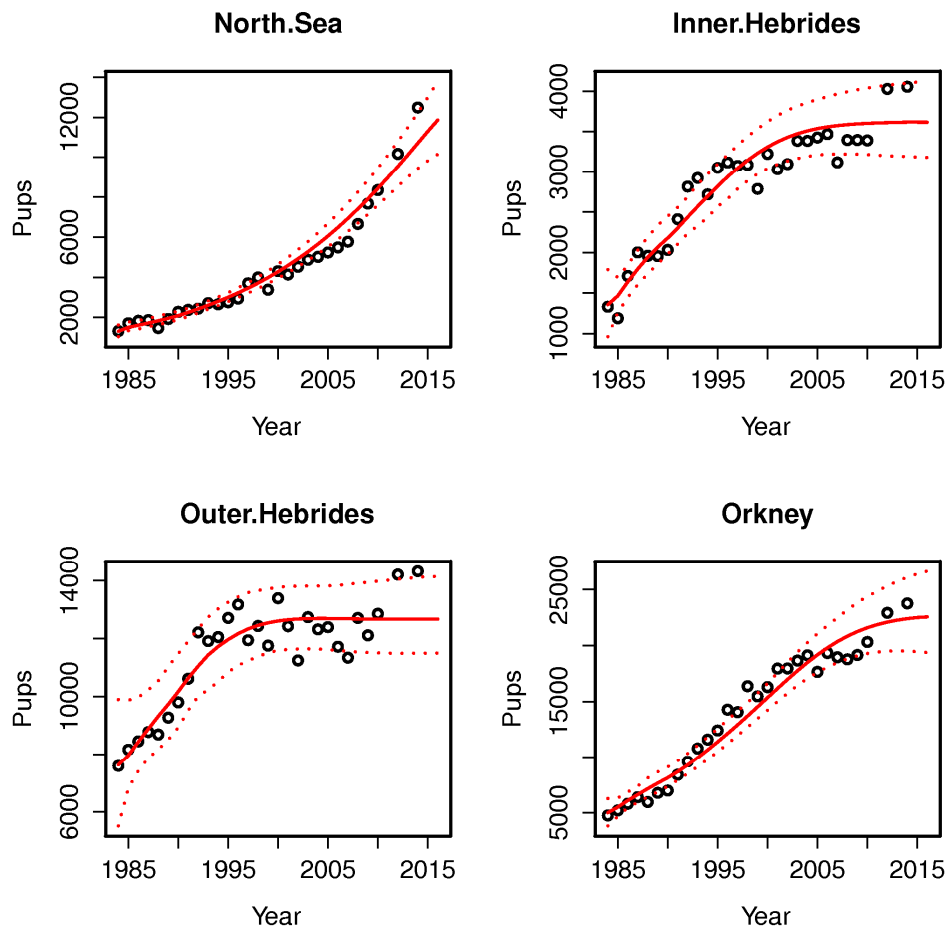


Figure 1. Posterior mean estimates of pup production (solid lines) and 95%CI (dashed lines) from the model of grey seal population dynamics, fitted to pup production estimates from 1984-2014 (circles) and the total population estimates from 2008 and 2014. Fit is taken from Thomas (2016), with estimates for 2016 added by simulating forwards from the fitted model.

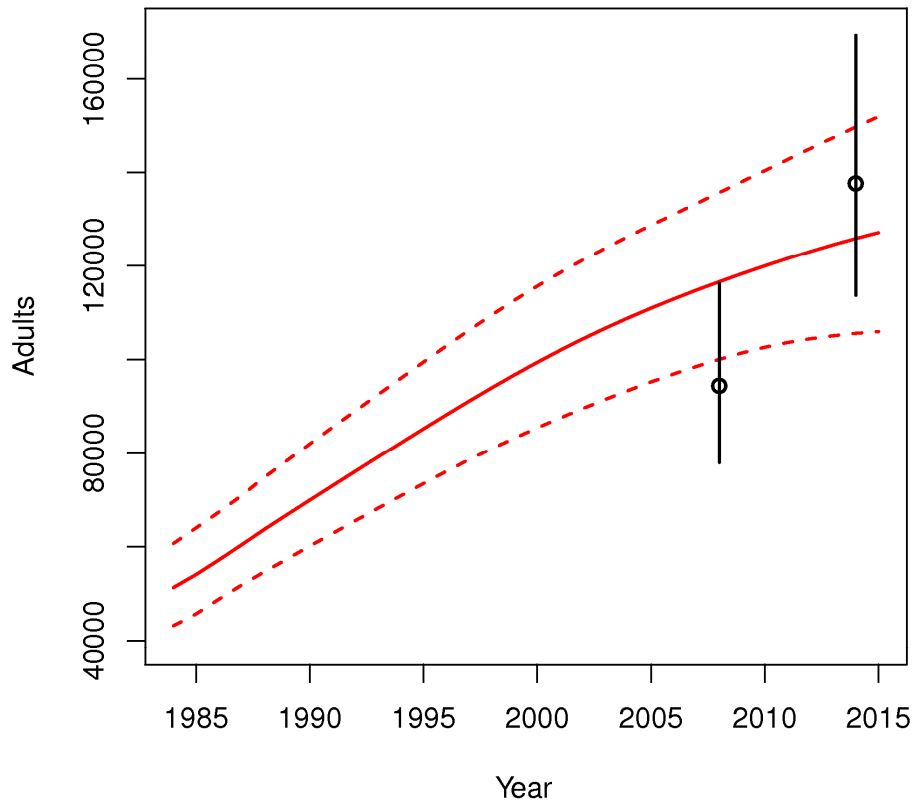


Figure 2. Posterior mean estimates (solid lines) and 95%CI (dashed lines) of total population size in 1984-2016 from the model of grey seal population dynamics, fit to pup production estimates from 1984-2014 and total population estimates from 2008 and 2014 (circles, with vertical lines indicating 95% confidence interval on the estimates). Blue lines show the fit to pup production estimates alone; red lines show the fit to pup production estimates plus the total population estimates. Fit is taken from Thomas (2016), with estimates for 2016 added by simulating forwards from the fitted model.

Appendix

Estimates of total population size, in thousands, at the beginning of each breeding season from 1984-2015, made using the model of British grey seal population dynamics fit to pup production estimates from 1984-2014 and total population estimates from 2008 and 2014. Numbers are posterior means followed by 95% credible intervals in brackets. Estimates are taken from Thomas (2016), with estimates for 2016 added by simulating forwards from the fitted model.

Year	North Sea	Inner Hebrides	Outer Hebrides	Orkney	Total
1984	4.7 (4 5.5)	5 (4.2 5.9)	23.3 (19.7 27.6)	18.4 (15.4 21.7)	51.4 (43.2 60.7)
1985	5 (4.2 5.8)	5.2 (4.4 6.2)	24.4 (20.6 29)	19.5 (16.5 23)	54.1 (45.8 64)
1986	5.4 (4.6 6.3)	5.5 (4.7 6.5)	25.5 (21.8 30.3)	20.8 (17.7 24.3)	57.2 (48.9 67.4)
1987	5.8 (5 6.7)	5.8 (5 6.9)	26.5 (22.8 31.4)	22.3 (19.1 25.9)	60.4 (51.9 70.9)
1988	6.3 (5.4 7.2)	6.2 (5.3 7.3)	27.4 (23.5 32.6)	23.9 (20.5 27.7)	63.7 (54.7 74.8)
1989	6.7 (5.8 7.8)	6.5 (5.6 7.7)	28.1 (24.1 33.3)	25.6 (21.9 29.6)	66.9 (57.4 78.4)
1990	7.2 (6.2 8.3)	6.8 (5.9 8)	28.7 (24.6 34)	27.3 (23.4 31.6)	70 (60.2 82)
1991	7.7 (6.7 8.9)	7 (6.2 8.3)	29.2 (25.1 34.5)	29.1 (25 33.7)	73 (62.9 85.6)
1992	8.3 (7.2 9.6)	7.3 (6.4 8.6)	29.6 (25.5 35)	30.9 (26.6 35.8)	76.1 (65.6 89.1)
1993	8.9 (7.7 10.3)	7.5 (6.5 8.9)	29.9 (25.8 35.2)	32.9 (28.2 38)	79.2 (68.2 92.5)
1994	9.6 (8.3 11.1)	7.8 (6.7 9.2)	30.1 (26 35.4)	34.8 (29.8 40.3)	82.2 (70.9 96)
1995	10.3 (8.9 11.9)	7.9 (6.8 9.4)	30.2 (26.2 35.5)	36.8 (31.5 42.6)	85.2 (73.5 99.5)
1996	11 (9.6 12.8)	8.1 (7 9.6)	30.3 (26.4 35.5)	38.8 (33.1 45)	88.2 (76.1 102.9)
1997	11.8 (10.3 13.7)	8.2 (7.1 9.7)	30.4 (26.5 35.5)	40.7 (34.8 47.2)	91.1 (78.6 106.2)
1998	12.6 (11 14.7)	8.3 (7.1 9.9)	30.4 (26.5 35.5)	42.6 (36.3 49.4)	94 (81 109.5)
1999	13.5 (11.8 15.8)	8.4 (7.2 9.9)	30.4 (26.5 35.4)	44.3 (37.8 51.5)	96.7 (83.2 112.6)
2000	14.5 (12.6 16.9)	8.5 (7.2 10)	30.4 (26.5 35.3)	46 (39.1 53.4)	99.4 (85.4 115.6)
2001	15.5 (13.5 18.2)	8.5 (7.3 10)	30.4 (26.5 35.2)	47.4 (40.3 55.1)	101.9 (87.5 118.5)
2002	16.6 (14.4 19.4)	8.6 (7.3 10.1)	30.4 (26.4 35.2)	48.8 (41.5 56.6)	104.4 (89.5 121.2)
2003	17.8 (15.3 20.8)	8.6 (7.3 10.1)	30.4 (26.4 35.1)	49.9 (42.5 57.9)	106.7 (91.5 123.8)
2004	19 (16.3 22.2)	8.6 (7.3 10.1)	30.4 (26.4 35.1)	50.9 (43.4 59)	108.8 (93.4 126.3)
2005	20.2 (17.4 23.6)	8.6 (7.3 10.1)	30.4 (26.4 35)	51.7 (44.2 59.9)	110.9 (95.2 128.7)
2006	21.5 (18.4 25.2)	8.6 (7.3 10.1)	30.3 (26.3 35)	52.4 (44.8 60.7)	112.9 (96.9 131)
2007	22.9 (19.6 26.8)	8.6 (7.3 10.2)	30.3 (26.3 35)	52.9 (45.3 61.4)	114.8 (98.5 133.4)
2008	24.2 (20.7 28.5)	8.7 (7.3 10.2)	30.3 (26.3 35)	53.3 (45.7 62)	116.5 (100 135.7)
2009	25.6 (21.8 30.2)	8.7 (7.3 10.2)	30.3 (26.3 35)	53.6 (46 62.6)	118.3 (101.4 138)
2010	27.1 (22.8 31.9)	8.7 (7.3 10.2)	30.4 (26.3 35.1)	53.9 (46.2 63.2)	119.9 (102.6 140.4)
2011	28.5 (23.7 33.8)	8.7 (7.3 10.2)	30.4 (26.3 35.1)	54 (46.3 63.7)	121.5 (103.6 142.7)
2012	29.9 (24.5 35.6)	8.7 (7.3 10.2)	30.4 (26.3 35.1)	54.1 (46.3 64.1)	123 (104.4 145.1)
2013	31.2 (25.2 37.5)	8.7 (7.3 10.3)	30.4 (26.3 35.1)	54.2 (46.2 64.5)	124.5 (105 147.4)
2014	32.5 (25.8 39.5)	8.7 (7.3 10.3)	30.4 (26.3 35.2)	54.3 (46.1 64.8)	125.8 (105.5 149.7)
2015	33.7 (26.2 41.4)	8.7 (7.3 10.3)	30.4 (26.3 35.2)	54.3 (46.1 65.1)	127.1 (105.9 151.9)
2016	34.8 (26.6 43.5)	8.7 (7.3 10.3)	30.4 (26.3 35.2)	54.3 (46.0 65.4)	128.2 (106.2 154.4)