

Supporting Materials

Northeast/Northwest European Bewick’s Swans
Cygnus columbianus bewickii: a population in decline

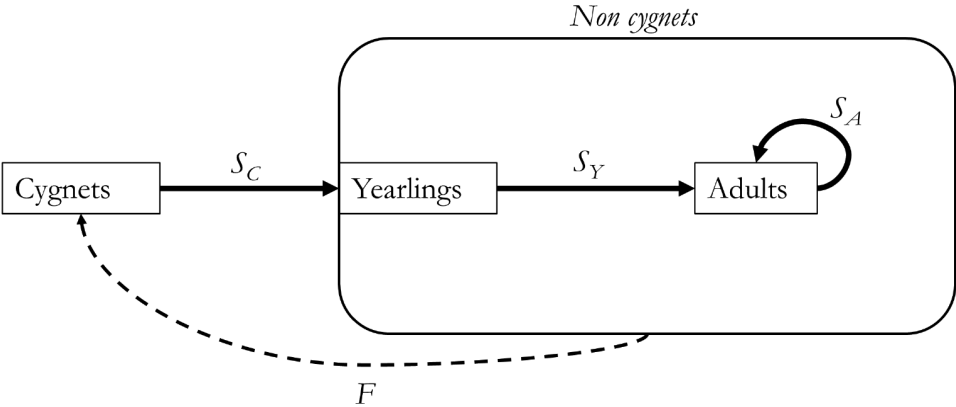


Figure S1. A life cycle diagram illustrating the structure of our Bewick’s Swan population model. Parameters S_A , S_Y and S_C refer to the survival rates of adults, yearlings and cygnets, whilst F refers to fecundity (*i.e.* the numbers of cygnets produced by the population each year).

Table S1. Percentage of cygnets for each breeding year since 2008, assessed by eye counts of Bewick's Swan flocks on the wintering grounds in December, with the proportion reported during the January international census also given for census years (*i.e.* 2010, 2015, 2020). Note: some figures differ from previously published data, following validation of all existing data for inclusion in this paper.

Breeding year	% Cygs. (Dec. same year)	No. aged (for Dec. age counts)	% Cygs. (January census)	No. aged (in Jan. census)	Source
2008	6.0	4,277			Wim Tijssen, <i>in litt.</i>
2009	6.7	2,600	9.6	6,469	Wim Tijssen <i>in litt.</i> ; Beekman <i>et al.</i> 2019
2010	10.5	7,618			Wim Tijssen <i>in litt.</i>
2011	9.6	8,445			Wim Tijssen <i>in litt.</i>
2012	13.9	12,281			Wim Tijssen <i>in litt.</i>
2013	13.0	12,918			Wim Tijssen <i>in litt.</i>
2014	7.5	11,503	10.0	11,229	Koffijberg 2024
2015	9.3	11,304			Koffijberg 2024
2016	8.2	10,962			Koffijberg 2024
2017	3.9	8,360			Koffijberg 2024
2018	8.7	9,262			Koffijberg 2024
2019	6.6	9,269	6.9	7,198	Koffijberg 2024; this paper
2020	8.3	9,197			Koffijberg 2024
2021	11.0	10,194			Tijssen & Koffijberg 2022
2022	13.4	9,661			Prior <i>et al.</i> 2023
2023	9.1	12,564			Koffijberg 2024
2024	3.3	8,404			K. Koffijberg <i>in litt.</i>
2025	To be determined	To be determined	t.b.d.	t.b.d.	

Table S2. Habitat codes used to describe habitat use by Bewick's Swans in the International Bewick's Swan Census (IBSC).

Habitat	Code no.	Habitat	Code no.
Natural permanent lake	1	Arable: winter cereal	17
Artificial lake/reservoir	2	Arable: oil seed rape	18
Gravel pit	3	Arable: potatoes	19
Non-tidal river	4	Arable: carrots	20
Canal	5	Arable: sugar beet	21
Freshmarsh	6	Improved pasture (flooded)	22
Tidal river/estuary (on water)	7	Rough/unimp. pasture (flooded)	23
Saltmarsh/merse	8	Reseeded pasture (flooded)	24
Mudflats	9	Turlough – improved pasture	25
Brackish Lake	10	Turlough – rough/unimproved	26
Sea Loch	11	Callow – improved pasture	27
Open coast	12	Callow – rough/unimproved	28
Improved pasture (dry)	13	Raised bog	29
Rough/unimproved past. (dry)	14	Blanket bog/moorland	30
Reseeded pasture (dry)	15		
Arable: stubble	16	Other (please specify)	

Table S3. Percentage of cygnets and mean brood sizes recorded in each country during the International Bewick's Swan Censuses, 1995–2020 inclusive. Data for the 1995–2015 IBSCs are also presented in Beekman *et al.* 2019¹. Productivity data for the Netherlands (formerly the main wintering area for the population) were available only for the January 2015 and 2020 census, because Dutch annual age assessments are generally made earlier in the winter (in November–December). *Data from the Netherlands (in *italics*) therefore are for November (winters 1994/95, 1999/2000) and December (winters 2004/05, 2009/2010; Hornman *et al.* 2019²), and as such are not included in the total numbers aged during the IBSC for these years. **Brood size figure reported for the Netherlands in 1999/2000 is for swans in several countries in November 1999, not just the Netherlands.

Year	Country	Aged	Cygs	% cygs	(95% CI)	No. broods	No. cygs in broods	Mean brood size (95% CI)
1995	Belgium	60	9	18	(7.1–26.6)	n/a	n/a	n/a (n/a)
	Denmark	818	59	7.2	(5.5–9.2)	33	59	1.8 (1.5–2.1)
	Estonia	5	0	0	(0.0–52.2)	0	0	n/a (n/a)
	GB	1,631	203	12.4	(10.9–14.1)	71	140	2.0 (1.8–2.2)
	Ireland	580	52	9.0	(6.8–11.6)	18	35	1.9 (1.3–2.5)
	Lithuania	12	3	25.0	(5.5–57.2)	–	–	–
	<i>Netherlands*</i>	<i>8,070</i>	<i>670</i>	<i>8.3</i>	–	–	–	–
	Poland	10	5	50.0	(18.7–81.3)	1	5	5.0 (n/a)
	Total (1995)	3,116	331	10.6	(9.6–11.8)	123	239	1.9 (1.8–2.1)
2000	Belgium	89	5	5.6	(1.8–12.6)	1	1	1.0 (n/a)
	Estonia	29	1	3.4	(0.1–17.8)	1	1	1.0 (n/a)
	GB	704	91	12.9	(10.5–15.6)	45	85	1.9 (1.6–2.2)
	Germany	965	123	12.7	(10.7–15.0)	23	47	2.0 (1.6–2.4)
	Ireland	120	20	16.7	(10.5–24.6)	9	17	1.9 (1.3–2.5)
	<i>Netherlands*</i>	<i>6,033</i>	<i>452</i>	<i>7.7</i>	–	<i>237</i>	<i>377</i>	<i>1.6**</i>
	Poland	30	1	3.3	(0.1–17.2)	1	1	1.0 (n/a)
	Total (2000)	1,937	241	12.4	(11.0–14.0)	80	152	1.9 (1.7–2.1)

Table S3 (continued)

Year	Country	Aged	Cygs	% cygs	(95% CI)	No. broods	No. cygs in broods	Mean brood size (95% CI)
2005	Belgium	51	12	23.5	(12.8–37.5)	4	9	2.3 (1.5–3.0)
	Denmark	396	46	11.6	(8.6–15.2)	24	42	1.8 (1.4–2.1)
	Estonia	12	6	50.0	(21.1–78.9)	2	6	3.0 (n/a)
	GB	420	61	14.5	(11.3–18.3)	22	44	2.0 (1.6–2.4)
	Germany	3,319	422	12.7	(11.6–13.9)	99	189	1.9 (1.8–2.1)
	Ireland	201	34	16.9	(12.0–22.8)	19	34	1.8 (1.4–2.3)
	Lithuania	2	0	0	(0.0–84.2)	0	0	0
	Netherlands*	3,000	288	9.6	–	200	312	1.6
	Poland	74	9	12.2	(5.7–21.8)	4	7	1.8 (0.3–3.3)
	Total (2005)	4,475	590	13.2	(12.2–14.2)	174	331	1.9 (1.8–2.0)
2010	Belgium	492	64	13.0	(10.2–16.3)	11	21	1.9 (1.1–2.7)
	Denmark	7	0	0	(0.0–41.0)	0	0	0
	Estonia	1	0	0	(0.0–97.5)	0	0	0
	GB	5,491	504	9.2	(8.4–10.0)	327	489	1.5 (1.4–1.6)
	Germany	440	48	10.9	(8.2–14.2)	21	42	2.0 (1.4–2.6)
	Ireland	34	4	11.8	(3.3–27.5)	2	4	2.0 (0.0–4.0)
	Lithuania	2	0	0	(0.0–84.2)	0	0	0
	Netherlands*	2,600	174	6.7	–	90	161	1.8
	Poland	2	0	0	(0.0–84.2)	0	0	0
	Total (2010)	6,469	620	9.6	(8.9–10.3)	361	556	1.5 (1.4–1.6)

Table S3 (continued)

Year	Country	Aged	Cygs	% cygs	(95% CI)	No. broods	No. cygs in broods	Mean brood size (95% CI)
2015	Belgium	687	59	8.6	(6.6–10.9)	6	10	1.7 (0.8–2.5)
	Denmark	308	33	10.7	(7.5–14.7)	14	33	2.4 (1.7–3.1)
	Estonia	6	0	0	(0.0–45.9)	0	0	0
	GB	3,690	377	10.2	(9.3–11.2)	222	334	1.5 (1.4–1.6)
	Germany	4,967	499	10	(9.2–10.9)	91	175	1.9 (1.7–2.1)
	Ireland	16	2	12.5	(1.6–38.3)	2	2	1.0 (n/a)
	Netherlands	1,554	157	10.1	(8.6–11.7)	–	–	–
	Switzerland	1	0	0	(0.0–97.5)	0	0	0
	Total (2015)	11,229	1,127	10.0	(9.5–10.6)	335	554	1.7 (1.6–1.8)
2020	Belgium	118	13	9.9		4	7	1.8
	Denmark	534	27	5.1		9	13	1.4
	Estonia	2	0	0		0	0	0
	GB	1,247	103	8.3		54	100	1.9
	Germany	4,797	317	6.6		52	101	1.9
	Ireland	12	4	33.3		2	4	2
	Netherlands	485	33	6.8		–	–	–
	Norway	3	2	66.7		1	2	2
	Total (2020)	7,198	499	6.9		122	227	1.9

¹Beekman, J., Koffijberg, K., Hornman, M., Wahl, J., Kowallik, C., Hall, C., Devos, K., Clausen, P., Laubek, B., Luiguijoe, L., Wieloch, M., Boland, H., Švařas, S., Nilsson, L., Stipnice, A., Keller, V., Degen, A., Shimmings, P., Larsen, B.-H., Portolou, D., Langendoen, T., Wood, K. & Rees, E.C. 2019. Long-term population trends and shifts in distribution of Bewick's Swans wintering in northwest Europe. *Wildfowl* (Special Issue No. 5): 73–102.

²Hornman, M., Hustings, F., Koffijberg, K., van Winden, E., van Els, P., van Kleunen, A., SOVON Ganzen- en zwanenwerkgroep & Soldaat, L. 2019. *Watervogels in Nederland in 2016/17*. SOVON Rapport 2019/01, RWSrapport BM 19/01. SOVON Vogelonderzoek Nederland, Nijmegen, the Netherlands.