Supplementary Information

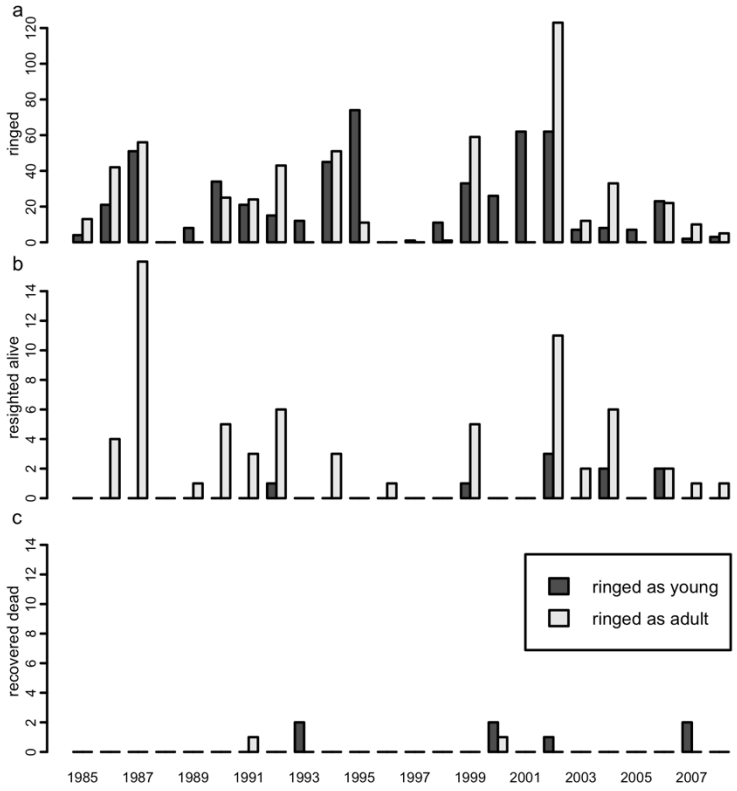

Fig. S1. Ringing and re-encounters from 1985 until 2008, by age-class ringed. a. Total number of ringed individuals; young birds are ringed as flightless chicks and adults are typically breeding birds caught on the nest. b. Total number of live re-encounters from 1985 until 2008. c. Total number of individuals recovered dead from 1985 until 2008.

Appendix 1. Modelling process workflow.

1. **Age Classes.** Survival probability was modelled as an annual estimate for two age classes (Young and Adults) with the assumption that once birds are full-grown immatures, after 1 year, they will have the same mortality as breeding adults.
2. **Basic Model.** A single survival probability generated over all years for Young and Adult
3. **GOF, Transience and Trap Dependence (CJS).** The Basic CJS model encounter histories was tested using UCARE.
4. **Linear covariates (Temporal Trends & Environmental Indices).** We included linear temporal trends of survival rates for both age-classes combined and for each age-class independently; and the effects of the two environmental covariates directly or as a time-lagged effect from the previous year (ONI, ONI(t-1), NAO, NAO(t-1)).

Table S1. Parameter estimates for model C1, which combined temporal trends and environmental covariates: S(2Age + $Trend_{Adult}$ + $ONI(t-1)_{Young}$), p($3Age_{Young=Imm=0}$), r($3Age_{Imm=0}$), F(.). This was one of the top three models which were equally supported (Table 1).

Index	Label	Estimate	SE	LCI	UCI	
1	Intercept	2.952853	1.024757	0.94433	4.961376	
2	Age	-3.30956	1.170375	-5.6035	-1.01563	
3	Adult trend	-0.07685	0.046505	-0.168	0.014301	
4	ONI (t-1) young	0.975774	0.673861	-0.34499	2.296542	
5	Recapture young	-5.28786	1864.865	-3660.42	3649.848	Fixed
6	Recapture immatures	-0.24205	403.5296	-791.16	790.6759	Fixed
7	Recapture adults	-3.45144	0.186772	-3.81751	-3.08537	
8	Recovery young	-4.60501	0.630517	-5.84082	-3.3692	
9	Recovery immatures	-2.30189	979.2815	-1921.69	1917.09	Fixed
10	Recovery adults	-4.55623	0.423411	-5.38612	-3.72635	
11	Fidelity	2.786192	1.19165	0.450557	5.121826	

Table S2. Parameter estimates for model T1: S(2Age + $Trend_{Adult}$), p($3Age_{Young=Imm=0}$), r($3Age_{Imm=0}$), F(.). This was one of the top three models which were equally supported (Table 1).

Index	Label	Estimate	SE	LCI	UCI	
1	Intercept	3.0159022	1.053873	0.950311	5.081493	
2	Age	-3.195031	1.157379	-5.46349	-0.92657	
3	Adult trend	-0.082368	0.048113	-0.17667	0.011933	
4	Recapture young	-0.144142	0	-0.14414	-0.14414	Fixed
5	Recapture immatures	-0.144363	0	-0.14436	-0.14436	Fixed
6	Recapture adults	-3.455888	0.187155	-3.82271	-3.08906	
7	Recovery young	-4.554322	0.641781	-5.81221	-3.29643	
8	Recovery immatures	-0.144353	0	-0.14435	-0.14435	Fixed
9	Recovery adults	-4.565737	0.42246	-5.39376	-3.73772	
10	Fidelity	2.8429757	1.250611	0.391778	5.294173	

Table S3. Parameter estimates for model T2: S(2Age + $Trend_{2Age}$), p($3Age_{Young=Imm=0}$), r($3Age_{Imm=0}$), F(.). This was one of the top three models which were equally supported (Table 1). Back transformed estimates were used to visualise trends in Fig. 3a,b.

Index	Label	Estimate	SE	LCI	UCI	
1	Intercept	2.737658	0.859846	1.05236	4.422956	
2	Adult trend	-2.2485	0.821269	-3.85819	-0.63881	
3	Young trend	-0.06448	0.036067	-0.13517	0.006209	
4	Recapture young	-0.02347	3E-07	-0.02347	-0.02347	Fixed
5	Recapture immatures	-0.02347	4.2E-06	-0.02348	-0.02346	Fixed
6	Recapture adults	-3.45447	0.18673	-3.82046	-3.08848	
7	Recovery young	-4.59911	0.639979	-5.85346	-3.34475	
8	Recovery immatures	3.936313	0	3.936313	3.936313	Fixed
9	Recovery adults	-4.54837	0.425205	-5.38177	-3.71497	
10	Fidelity	2.891914	1.372113	0.202572	5.581255	

Table S4. Parameter estimates for model E1 S(2Age + $ONI(t-1)_{Young}$), p($3Age_{Young=Imm=0}$), r($3Age_{Imm=0}$), F(.). Back transformed estimates were used to visualise trends in Fig. 3c.

Index	Label	Estimate	SE	LCI	UCI	
1	Intercept	2.4230526	1.0097595	0.4439239	4.4021813	
2	Age	-2.8333182	1.1261593	-5.0405905	-0.6260458	
3	ONI (t-1) young	1.0755829	0.6801406	-0.2574928	2.4086586	
4	Recapture young	-0.1045219	0	-0.1045219	-0.1045219	Fixed
5	Recapture immatures	1.3047824	0	1.3047824	1.3047824	Fixed
6	Recapture adults	-3.4774494	0.1850274	-3.840103	-3.1147958	
7	Recovery young	-4.6200625	0.6260448	-5.8471103	-3.3930146	
8	Recovery immatures	1.7162662	0	1.7162662	1.7162662	Fixed
9	Recovery adults	-4.2216151	0.6151004	-5.4272118	-3.0160184	
10	Fidelity	2.2758548	0.93235	0.4484488	4.1032609	

Table S5. Annual survival model results for Arctic Skuas comparing the joint live and dead data, Burnham model and apparent survival results for live re-encounter only data, CJS model for the top five supported models. All models are ranked in the same order and trends are in the same direction. We report differences in Akaike's information criterion values adjusted for median-$\hat{c}$; (AICc), and number of estimable parameters to allow direct comparison of modelling approaches. Model structures include temporal trends and environmental parameterization variables: 2Age represents 2 age-classes; ONI(t-1) is the time lagged (-1 year) Oceanic Niño index. Live capture probability (p) for Burnham and CJS models, and dead recovery probability (r) and fidelity (F) for Burnham models remain constant: p(3Age$_{Young=Imm=0}$), r(3Age$_{Imm=0}$), F(.). § Basic model

		Burnham model – Live and Dead data			CJS model – Live only data		
	Model	**ΔAICc**	**Model Likelihood**	**no. Parameters**	**ΔAICc**	**Model Likelihood**	**no. Parameters**
1	2Age + Trend$_{Adult}$ + ONI(t-1)$_{Young}$	0.00	1.00	8	0.00	1.00	5
2	2Age + Trend$_{Adult}$	0.70	0.71	7	2.00	0.37	4
3	2Age + Trend$_{2Age}$	1.38	0.50	7	3.98	0.14	5
4	2Age + ONI(t-1)$_{Young}$	2.19	0.33	7	2.36	0.30	4
5	2Age §	3.56	0.17	6	5.18	0.08	3

Table S6. Parameter estimates for the best supported model using live only data (CJS): Φ(2Age + Trend$_{Adult}$ + ONI(t-1)$_{Young}$), p(3Age$_{Young=Imm=0}$).

Index	**Label**	**Estimate**	**SE**	**LCI**	**UCI**	
1	Intercept	2.37768	0.45355	1.48872	3.26664	
2	Age	-3.85439	0.8845	-5.58805	-2.12072	
3	ONI (t-1) young	1.489752	0.91806	-0.309651	3.289156	
4	Adult trend	-0.060072	0.02981	-0.118513	-0.00163	
5	Recapture young	0.00000	0.00000	0.00000	0.00000	Fixed
6	Recapture immatures	0.00000	0.00000	0.00000	0.00000	Fixed
7	Recapture adults	-3.450204	0.183774	-3.810402	-3.090007	