Supporting Information

Population Ecology

Individual heterogeneity in life-history trade-offs with age at first reproduction in capital breeding elephant seals

W. Chris Oosthuizen[1], Martin Postma[1], Res Altwegg[2,3], Marie Nevoux[1,4,5], Roger Pradel[6], Marthán N. Bester[1], P. J. Nico de Bruyn[1]

[1] Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Hatfield, South Africa.

[2] Centre for Statistics in Ecology Environment and Conservation, Department of Statistical Sciences, University of Cape Town, Rondebosch, South Africa.

[3] African Climate and Development Initiative, University of Cape Town, Rondebosch, South Africa.

[4] INRA, UMR 0985 Ecology and Health of Ecosystems, Rennes, France.

[5] Agrocampus Ouest, UMR 0985 Ecology and Health of Ecosystems, Rennes, France.

[6] Biostatistics and Population Biology Group, CEFE, CNRS, Univ Montpellier, Univ Paul Valéry Montpellier 3, EPHE, IRD, Montpellier, France.

Correspondence

W. Chris Oosthuizen, Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Hatfield, South Africa.

Email: wcoosthuizen@zoology.up.ac.za

ORCID

W. Chris Oosthuizen 0000-0003-2905-6297

Res Altwegg 0000-0002-4083-6561

Roger Pradel 0000-0002-2684-9251

Marthán N. Bester 0000-0002-2265-764X

P.J. Nico de Bruyn 0000-0002-9114-9569

Supporting Information 1

Illustration of the annual haulout cycle of female southern elephant seals at Marion Island

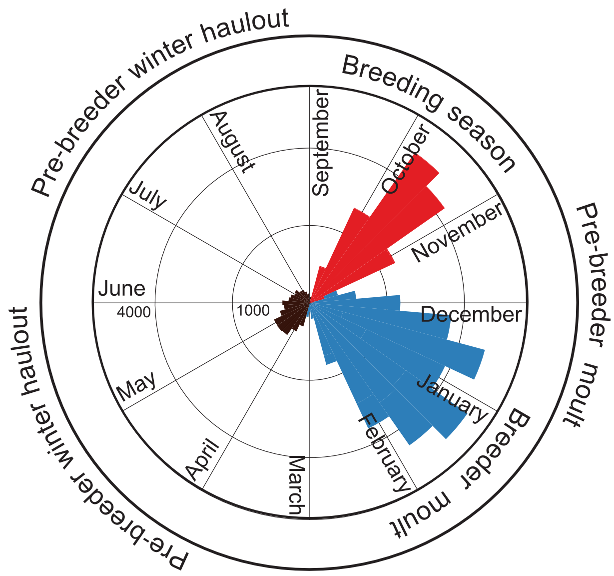

Figure S1.1. Annual cycle of female southern elephant seals symbolised by the temporal distribution of resights of individually marked southern elephant seals at Marion Island. Resights of weaned pups prior to their first foraging trip to sea are excluded; values correspond to the cumulative number of resights per day (1984 – 2014). Adults are generally only observed during the breeding season (red bars) and the moult (blue bars). Pre-breeders are observed in the moult and to a lesser extent, during the winter (brown bars).

Supporting Information 2

Multievent-robust design model structure

Each elephant seal breeding season comprised $j = 8$ secondary surveys (weekly island-wide surveys). We collapsed alternating secondary surveys within each breeding season to generate two distinct capture periods (κ) per breeding season (Figure S2.1). Surveys conducted during 'uneven' survey weeks ($j = 1, 3, 5, 7$) of the breeding season collapsed to generate capture period U (κ^U), whereas surveys conducted during 'even' weeks ($j = 2, 4, 6, 8$) collapsed to capture period E (κ^E). Female elephant seals arrive and depart in a staggered fashion through a breeding season, and collapsing secondary surveys in this way ensured that every breeding female was exposed to survey effort in both κ^U and κ^E. All recaptures made outside of the breeding season (whether during the moult, winter or both these non-breeding periods) were summarized as a single observation and assigned to capture period M (κ^M). Oosthuizen et al. (In press) gives a detailed description of this multievent-robust design model.

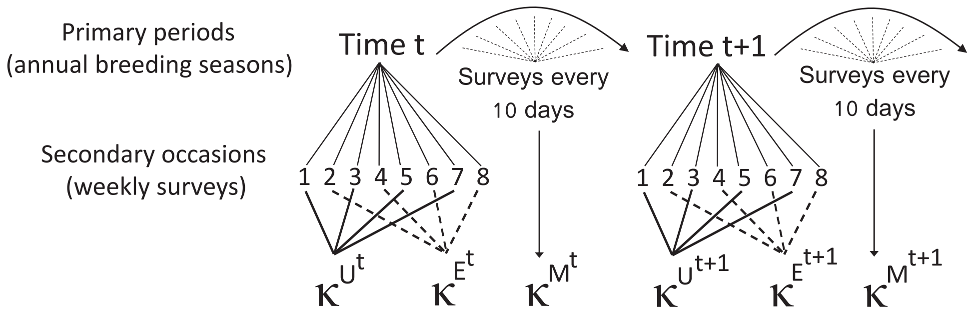

Figure S2.1. Robust design-like structure of the model. We collapsed alternating secondary surveys within each breeding season to generate two distinct capture periods (κ) per breeding season. Recaptures made outside of the breeding season were assigned to κ^M.

Probability structure of events

We defined 15 composite events by integrating resighting data collected for every individual during all three capture periods, and by partitioning observations according to the number of flipper tags remaining (Table S2.1). The encounter history matrix thus simply encoded the particular combination of field observations that was made, and not the states of the model (Figure S2.2).

Table S2.1. The 15 possible events assigned to a female elephant seal and encoded in the encounter history matrix based on multiple capture periods in a year.

Description	Index	Event code: Marked with 2 flipper tags	Event code: Marked with 1 flipper tag
Not seen during any capture period	NS	0	0
Seen in all three capture periods ($\kappa^U, \kappa^E, \kappa^M$)	UEM	1	8
Seen in κ^U (breeding season 'uneven' sampling weeks) and κ^M	UM	2	9
Seen in κ^E (breeding season 'even' sampling weeks) and κ^M	EM	3	10
Only seen in κ^M (outside of the breeding season)	M	4	11
Seen in κ^U and κ^E	UE	5	12
Only seen in κ^U	U	6	13
Only seen in κ^E	E	7	14

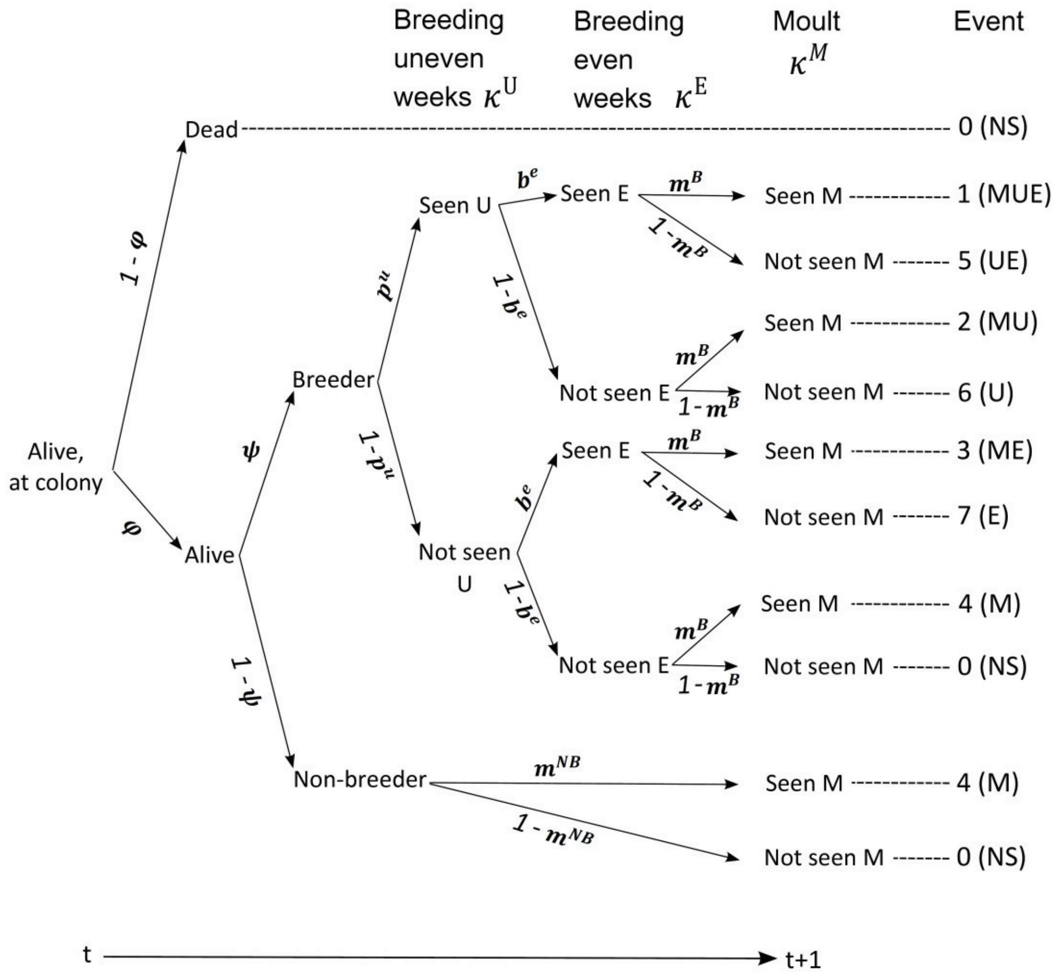

Figure S2.2. Fate diagram describing the probability structure of events. The transition probabilities correspond to annual survival (φ) and annual breeding probability (ψ). The event probabilities correspond to encounter probabilities outside of the breeding season (m), the encounter probability during 'uneven' survey weeks of the breeding season (p^u), and the encounter probability during 'even' survey weeks of the breeding season (b^e). For each event (the particular combination of field observations made during capture periods κ^U, κ^E and κ^M) there are two possible event codes. Event codes in the first column refer to individuals observed marked with two tags; event codes in the second column refer to individuals observed marked with only one tag.

References

Oosthuizen, W.C., Pradel, R. Bester, M.N. and De Bruyn, P.J.N. In press. Making use of multiple surveys: estimating breeding probability using a multievent-robust design capture-recapture model. Ecology and Evolution

Supporting Information 3

Goodness-of-fit testing of southern elephant seal capture-recapture data at Marion Island

Information-theoretic approaches to model selection (Burnham and Anderson 2002) assume that the set of models considered includes a general model that adequately fits the data. Lack-of-fit or overdispersion tends to inflate the deviance, erroneously favouring selection of overparametrized models (Pradel et al. 2005). No formal goodness of fit (GOF) tests exist for multievent models (Pradel et al. 2005), but we verified whether the data reasonably fitted the assumptions of the Jolly-MoVe (JMV) multistate model (Pradel et al. 2003). Permanent transitions (e.g., pre-breeder to 'adult', where 'adult' refers to all individuals that have bred at least once) are not allowed in the JMV model, therefore we partitioned the individual capture histories into distinct pre-breeder (single state) and 'adult' (breeder and non-breeder) components. GOF tests were conducted separately for each of the two sub-samples using program U-CARE 2.2.2 (Choquet et al. 2009).

Pre-breeder capture histories displayed significant departures of the model assumptions. First, newly marked individuals in our sample were less likely to survive (and be re-encountered) than previously marked individuals (transience *sensu lato*, Test 3G.SR; Pradel et al. 2005). Secondly, individuals seen at occasion t were more likely to be re-encountered at $t+1$ than individuals who were not seen at occasion t (trap-happiness *sensu lato*, Test M.ITEC) (Table S3.1). The first case results from high first-year mortality (e.g., Pistorius and Bester 2002) and necessitated a generalization of the JMV model incorporating age structure in the survival parameter. We interpreted the results of Test M.ITEC as evidence for Markovian temporary emigration (i.e., that the probability of being temporarily absent is non-random and dependent on an individual's state at $t-1$) and therefore specified our capture-recapture model with "observable" and "unobservable" states between which pre-breeders were allowed to move (Schaub et al. 2004). GOF testing revealed similar trends for the adult capture histories, but model violations were of smaller magnitude. Because we separately estimated the survival rates of first-time breeders and experienced breeders, we disregarded the contribution of Test 3G.SR to the overall GOF statistic. Having structurally dealt with lack-of-fit in the pre-breeder component, analyses proceeded with the use of a variance inflation factor ($\hat{c} = \chi^2/df$; $\hat{c} = 1.25$) to account for the remaining capture heterogeneity (Table S3.1).

Table S3.1. Testing the homogeneity assumptions of the Jolly-MoVe (JMV) multistate model for pre-breeders and adults respectively, using component tests implemented in U-CARE. A temporary emigration model was used to model pre-breeder Markovian emigration. A variance inflation factor ($\hat{c}$) of 1.25 was used in analyses.

Test	Pre-breeder			Adult		
	χ^2	df[1]	$\hat{c}$	χ^2	df[1]	$\hat{c}$
Test WBWA	-	-		39.76	42	
Test 3G.SR	**100.80**	**26**		**49.13**	**26**	
Test 3G.Sm	**141.79**	**39**		107.47	131	
Test M.ITEC	**160.25**	**28**		**97.60**	**23**	
Test M.LTEC	26.32	27		13.64	10	
JMV Model	**429.15**	**120**	3.58	**307.60**	**232**	1.33
Temporary emigration model	**328.35**	**94**	3.49	**258.47**	**206.00**	1.25

[1]Degrees of freedom. Significant χ^2 statistics ($p < 0.05$) are in boldface.

References

Choquet, R et al. 2009. U-CARE: Utilities for performing goodness of fit tests and manipulating capture-recapture data. Ecography 32: 1071-1074.

Pradel, R. et al. 2003. A proposal for a goodness-of-fit test to the Arnason-Schwarz multistate capture-recapture model. Biometrics 59: 43-53.

Pradel, R. et al. 2005. Principles and interest of GOF tests for multistate capture–recapture models. Anim. Biodivers. Conserv. 28: 189-204.

Supporting Information 4

Multievent model structure of southern elephant seal capture-recapture analysis at Marion Island

All females observed ashore during the breeding season were assigned to the breeder state. We assumed that non-breeders were only available for capture outside of the breeding season (i.e., during the winter or moult). However, because detection of breeders was not perfect during all breeding seasons, females of breeding age that were only observed outside of the breeding season could not with certainty be defined as non-breeders during the previous breeding season. Consequently, the breeding status of individuals observed only in the winter or moult were considered to be unknown and the model considered that either (1) the individual was a pre-breeder or non-breeder, or (2) the individual was present and breeding, but escaped detection.

The biological states (E) are:
PB2 – pre-breeder with 2 tags
PB1 – pre-breeder with 1 tag
PB2_AE – pre-breeder with 2 tags, alive elsewhere
PB1_AE – pre-breeder with 1 tag, alive elsewhere
FTB2 – first-time breeder with 2 tags
FTB1 – first-time breeder with 1 tag
EB2 – experienced breeder with 2 tags
EB1 – experienced breeder with 1 tag
NB2 – non-breeder with 2 tags
NB1 – non-breeder with 1 tag
DEAD – dead or permanently emigrated

The events (field observations) are:

Description	Index	Event code: Marked with 2 flipper tags	Event code: Marked with 1 flipper tag
Not seen during any capture period	NS	0	0
Seen in all three capture periods (κ^U, κ^E, κ^M)	UEM	1	8
Seen in κ^U (breeding season 'uneven' sampling weeks) and κ^M	UM	2	9
Seen in κ^E (breeding season 'even' sampling weeks) and κ^M	EM	3	10
Only seen in κ^M (outside of the breeding season)	M	4	11
Seen in κ^U and κ^E	UE	5	12
Only seen in κ^U	U	6	13
Only seen in κ^E	E	7	14

Matrix design

The GEPAT matrix structure (Choquet et al. 2009) is used to specify the matrix parameters that will be estimated. Parameters to be estimated are assigned with alphabetical letters, "-" means the parameters corresponding to this matrix entry will always be set to 0, and "*" means (1 - $\sum$ (all other parameters on the same row)). Matrices are row-stochastic and there must be one (and only one) "*" per row.

The matrix structure for a model with no heterogeneity is:

Initial state matrix

Initial state probability

Π	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1
	I	*	-	-	-	-	-	-	-	-

State transition matrices (state process)

Tag loss probability (from two tags to one tag)

τ^{21}	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	t	*	-	-	-	-	-	-	-	-	-
PB1	-	*	-	-	-	-	-	-	-	-	-
PB2_AE	-	-	t	*	-	-	-	-	-	-	-
PB1_AE	-	-	-	*	-	-	-	-	-	-	-
FTB2	-	-	-	-	t	*	-	-	-	-	-
FTB1	-	-	-	-	-	*	-	-	-	-	-
EB2	-	-	-	-	-	-	t	*	-	-	-
EB1	-	-	-	-	-	-	-	*	-	-	-
NB2	-	-	-	-	-	-	-	-	t	*	-
NB1	-	-	-	-	-	-	-	-	-	*	-
Dead	-	-	-	-	-	-	-	-	-	-	*

Tag loss probability (from one tag to zero tags)

τ^{10}	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	*	-	-	-	-	-	-	-	-	-	-
PB1	-	t	-	-	-	-	-	-	-	-	*
PB2_AE	-	-	*	-	-	-	-	-	-	-	-
PB1_AE	-	-	-	t	-	-	-	-	-	-	*
FTB2	-	-	-	-	*	-	-	-	-	-	-
FTB1	-	-	-	-	-	t	-	-	-	-	*
EB2	-	-	-	-	-	-	*	-	-	-	-
EB1	-	-	-	-	-	-	-	t	-	-	*
NB2	-	-	-	-	-	-	-	-	*	-	-
NB1	-	-	-	-	-	-	-	-	-	t	*
Dead	-	-	-	-	-	-	-	-	-	-	*

Survival probability

S	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	y	-	-	-	-	-	-	-	-	-	*
PB1	-	y	-	-	-	-	-	-	-	-	*
PB2_AE	-	-	y	-	-	-	-	-	-	-	*
PB1_AE	-	-	-	y	-	-	-	-	-	-	*
FTB2	-	-	-	-	y	-	-	-	-	-	*
FTB1	-	-	-	-	-	y	-	-	-	-	*
EB2	-	-	-	-	-	-	y	-	-	-	*
EB1	-	-	-	-	-	-	-	y	-	-	*
NB2	-	-	-	-	-	-	-	-	y	-	*
NB1	-	-	-	-	-	-	-	-	-	y	*
Dead	-	-	-	-	-	-	-	-	-	-	*

Breeding probability

R	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	*	-	-	-	r	-	-	-	-	-	-
PB1	-	*	-	-	-	r	-	-	-	-	-
PB2_AE	-	-	*	-	r	-	-	-	-	-	-
PB1_AE	-	-	-	*	-	r	-	-	-	-	-
FTB2	-	-	-	-	-	-	r	-	*	-	-
FTB1	-	-	-	-	-	-	-	r	-	*	-
EB2	-	-	-	-	-	-	r	-	*	-	-
EB1	-	-	-	-	-	-	-	r	-	*	-
NB2	-	-	-	-	-	-	r	-	*	-	-
NB1	-	-	-	-	-	-	-	r	-	*	-
Dead	-	-	-	-	-	-	-	-	-	-	*

Temporary emigration probability

TE	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	*	-	k	-	-	-	-	-	-	-	-
PB1	-	*	-	k	-	-	-	-	-	-	-
PB2_AE	*	-	k	-	-	-	-	-	-	-	-
PB1_AE	-	*	-	k	-	-	-	-	-	-	-
FTB2	-	-	-	-	*	-	-	-	-	-	-
FTB1	-	-	-	-	-	*	-	-	-	-	-
EB2	-	-	-	-	-	-	*	-	-	-	-
EB1	-	-	-	-	-	-	-	*	-	-	-
NB2	-	-	-	-	-	-	-	-	*	-	-
NB1	-	-	-	-	-	-	-	-	-	*	-
Dead	-	-	-	-	-	-	-	-	-	-	*

Event matrices (observation process)

Recapture probability during the moult

		2 tags	2 tags	2 tags	1 tag	1 tag	1 tag
	NS	M_B	$\overline{M_B}$	$M_{PB/NB}$	M_B	$\overline{M_B}$	$M_{PB/NB}$
PB2	*	-	-	m	-	-	-
PB1	*	-	-	-	-	-	m
PB2_AE	*	-	-	-	-	-	-
PB1_AE	*	-	-	-	-	-	-
FTB2	-	m	*	-	-	-	-
FTB1	-	-	-	-	m	*	-
EB2	-	m	*	-	-	-	-
EB1	-	-	-	-	m	*	-
NB2	*	-	-	m	-	-	-
NB1	*	-	-	-	-	-	m
Dead	*	-	-	-	-	-	-

Recapture probability during the 'uneven' weekly breeding season surveys

		2 tags	2 tags	2 tags	2 tags	1 tag	1 tag	1 tag	1 tag		2 tags	1 tag
		UM	$\bar{U}M$	U	$\bar{U}$	UM	$\bar{U}M$	U	$\bar{U}$	NS	$M_{PB/NB}$	$M_{PB/NB}$
	NS	-	-	-	-	-	-	-	-	*	-	-
2 tags	M_B	p	*	-	-	-	-	-	-	-	-	-
2 tags	$\overline{M_B}$	-	-	p	*	-	-	-	-	-	-	-
2 tags	$M_{PB/NB}$	-	-	-	-	-	-	-	-	-	*	-
1 tag	M_B	-	-	-	-	p	*	-	-	-	-	-
1 tag	$\overline{M_B}$	-	-	-	-	-	-	p	*	-	-	-
1 tag	$M_{PB/NB}$	-	-	-	-	-	-	-	-	-	-	*

Recapture probability during the 'even' weekly breeding season surveys

			2 tags	2 tags	2 tags	2 tags	2 tags	2 tags	2 tags	1 tag	1 tag	1 tag	1 tag	1 tag	1 tag	1 tag
		NS	MUE	MU	ME	M	UE	U	E	MUE	MU	ME	M	UE	U	E
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2 tags	UM	-	b	*	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	$\bar{U}M$	-	-	-	b	*	-	-	-	-	-	-	-	-	-	-
2 tags	U	-	-	-	-	-	b	*	-	-	-	-	-	-	-	-
2 tags	$\bar{U}$	*	-	-	-	-	-	-	b	-	-	-	-	-	-	-
1 tag	UM	-	-	-	-	-	-	-	-	b	*	-	-	-	-	-
1 tag	$\bar{U}M$	-	-	-	-	-	-	-	-	-	-	b	*	-	-	-
1 tag	U	-	-	-	-	-	-	-	-	-	-	-	-	b	*	-
1 tag	$\bar{U}$	*	-	-	-	-	-	-	-	-	-	-	-	-	-	b
	NS	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	$M_{PB/NB}$	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-
1 tag	$M_{PB/NB}$	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-

Supporting Information 5

Model constraints on recapture, tag loss and migration parameters

Recapture probabilities (p): Within each of the capture periods κ^M, κ^U and κ^E, recapture probabilities were allowed to vary with time, the number of tags an individual was marked with, and reproductive state. This parameterization was simplified by assessing the fit of simpler, nested models (e.g., modelling only time dependence or assuming constant detection).

Tag loss probabilities (τ): Nearly all recently weaned female elephant seal pups born at Marion Island were uniquely marked with two hind-flipper tags. Cohorts born from 1983 to 1999 were tagged in the inner-interdigital webbing of each hind-flipper, but from 2000 to 2009 all tags were placed in the outer-interdigital webbing of hind-flippers. We incorporated tag loss rates within the multievent framework, avoiding pitfalls associated with post-hoc correction of survival estimates (Laake et al. 2014). The realistic assumption that the number of tags retained had no influence on survival probability enabled us to estimate unique probabilities for tag loss rates from two to one tag (τ^{21}) as well as from one to zero tags (τ^{10}), even though individuals with zero tags are unobservable. Estimates of τ^{21} and τ^{10} were obtained from two consecutive matrices and the direct transition from two tags to zero tags (τ^{20}) is derived as the product of τ^{21} and τ^{10}. The umbrella model structure of τ^{21} and τ^{10} included age-dependent (*a*) tag loss interacting with a two-level factor (group, g) that allowed different tag loss rates for seals marked in the inner and outer webbing of the hind-flipper, respectively. In an attempt to simplify this parameterization we examined models with simpler age-class structures, models with only a group effect, and constant tag loss.

Migration probabilities $(\psi^{OO}\, and\ \psi^{UO})$: To account for Markovian temporary emigration among pre-breeders, we defined an observable (O) and unobservable (U) state that individuals can assume, and between which they can transfer from year to year, given survival. Introducing an unobservable state yielded improved estimates of the survival and on-site capture probabilities of pre-breeders (Schaub et al. 2004). Individuals in the unobservable state had encounter probabilities of zero and we assumed that those present and temporarily absent had equal survival probabilities. We compared models with and without age dependence in temporary emigration probability.

References

Laake JL, Johnson DS, Diefenbach DR, Ternent MA (2014) Hidden Markov model for dependent mark loss and survival estimation. J. Agric. Biol. Environ. Stat. 19:524-540.

Schaub M, Gimenez O, Schmidt BR, Pradel R (2004) Estimating survival and temporary emigration in the multistate capture-recapture framework. Ecology 85:2107-2113.

Supporting Information 6

Finite mixture model structure of southern elephant seal capture-recapture analysis at Marion Island

The biological states (E) are:

Mixture class A:
PB2 – pre-breeder with 2 tags
PB1 – pre-breeder with 1 tag
PB2_AE – pre-breeder with 2 tags, alive elsewhere
PB1_AE – pre-breeder with 1 tag, alive elsewhere
FTB2 – first-time breeder with 2 tags
FTB1 – first-time breeder with 1 tag
EB2 – experienced breeder with 2 tags
EB1 – experienced breeder with 1 tag
NB2 – non-breeder with 2 tags
NB1 – non-breeder with 1 tag

Mixture class B:
PB2 – pre-breeder with 2 tags
PB1 – pre-breeder with 1 tag
PB2_AE – pre-breeder with 2 tags, alive elsewhere
PB1_AE – pre-breeder with 1 tag, alive elsewhere
FTB2 – first-time breeder with 2 tags
FTB1 – first-time breeder with 1 tag
EB2 – experienced breeder with 2 tags
EB1 – experienced breeder with 1 tag
NB2 – non-breeder with 2 tags
NB1 – non-breeder with 1 tag

DEAD – dead or permanently emigrated

The events (field observations) are:

Description	Index	Event code: Marked with 2 flipper tags	Event code: Marked with 1 flipper tag
Not seen during any capture period	NS	0	0
Seen in all three capture periods ($\kappa^U, \kappa^E, \kappa^M$)	UEM	1	8
Seen in κ^U(breeding season 'uneven' sampling weeks) and κ^M	UM	2	9
Seen in κ^E(breeding season 'even' sampling weeks) and κ^M	EM	3	10
Only seen in κ^M(outside of the breeding season)	M	4	11
Seen in κ^U and κ^E	UE	5	12
Only seen in κ^U	U	6	13
Only seen in κ^E	E	7	14

Matrix design

The GEPAT matrix structure (Choquet et al. 2009) is used to specify the matrix parameters that will be estimated. Parameters to be estimated are assigned with alphabetical letters, "-" means the parameters corresponding to this matrix entry will always be set to 0, and "*" means (1 - $\sum$ (all other parameters on the same row)). Matrices are row-stochastic and there must be one (and only one) "*" per row. The matrix design for the finite mixture model is shown below.

Initial state matrix

Mixture class initial state probability

IS (i)	A	B
	i	*

Entry with two or one tag initial state probability

IS (ii)	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1
A	i	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	i	*	-	-	-	-	-	-	-	-

State transition matrices (state process)

First tag loss probability

T2	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	*	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB2_AE	-	-	*	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1_AE	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FTB2	-	-	-	-	*	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FTB1	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB2	-	-	-	-	-	-	*	t	-	-	-	-	-	-	-	-	-	-	-	-	-
EB1	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-
NB2	-	-	-	-	-	-	-	-	*	t	-	-	-	-	-	-	-	-	-	-	-
NB1	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-
PB2	-	-	-	-	-	-	-	-	-	-	*	t	-	-	-	-	-	-	-	-	-
PB1	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
PB2_AE	-	-	-	-	-	-	-	-	-	-	-	-	*	t	-	-	-	-	-	-	-
PB1_AE	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-
FTB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	t	-	-	-	-	-
FTB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-
EB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	t	-	-	-
EB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-
NB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	t	-
NB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-
Dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

Second tag loss probability

T1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	w
PB2_AE	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1_AE	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	w
FTB2	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FTB1	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	w
EB2	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB1	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	w
NB2	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
NB1	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	w
PB2	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-
PB1	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	w
PB2_AE	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
PB1_AE	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	w
FTB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-
FTB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	w
EB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-
EB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	w
NB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-
NB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	w
Dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

Survival probability

S	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
PB1	-	y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
PB2_AE	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
PB1_AE	-	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
FTB2	-	-	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
FTB1	-	-	-	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
EB2	-	-	-	-	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-	-	*
EB1	-	-	-	-	-	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-	*
NB2	-	-	-	-	-	-	-	-	y	-	-	-	-	-	-	-	-	-	-	-	*
NB1	-	-	-	-	-	-	-	-	-	y	-	-	-	-	-	-	-	-	-	-	*
PB2	-	-	-	-	-	-	-	-	-	-	y	-	-	-	-	-	-	-	-	-	*
PB1	-	-	-	-	-	-	-	-	-	-	-	y	-	-	-	-	-	-	-	-	*
PB2_AE	-	-	-	-	-	-	-	-	-	-	-	-	y	-	-	-	-	-	-	-	*
PB1_AE	-	-	-	-	-	-	-	-	-	-	-	-	-	y	-	-	-	-	-	-	*
FTB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y	-	-	-	-	-	*
FTB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y	-	-	-	-	*
EB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y	-	-	-	*
EB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y	-	-	*
NB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y	-	*
NB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y	*
Dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

Breeding probability

B	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	*	-	-	-	u	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1	-	*	-	-	-	u	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB2_AE	-	-	*	-	u	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1_AE	-	-	-	*	-	u	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FTB2	-	-	-	-	-	-	u	-	*	-	-	-	-	-	-	-	-	-	-	-	-
FTB1	-	-	-	-	-	-	-	u	-	*	-	-	-	-	-	-	-	-	-	-	-
EB2	-	-	-	-	-	-	u	-	*	-	-	-	-	-	-	-	-	-	-	-	-
EB1	-	-	-	-	-	-	-	u	-	*	-	-	-	-	-	-	-	-	-	-	-
NB2	-	-	-	-	-	-	u	-	*	-	-	-	-	-	-	-	-	-	-	-	-
NB1	-	-	-	-	-	-	-	u	-	*	-	-	-	-	-	-	-	-	-	-	-
PB2	-	-	-	-	-	-	-	-	-	-	*	-	-	-	u	-	-	-	-	-	-
PB1	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	u	-	-	-	-	-
PB2_AE	-	-	-	-	-	-	-	-	-	-	-	-	*	-	u	-	-	-	-	-	-
PB1_AE	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	u	-	-	-	-	-
FTB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u	-	*	-	-
FTB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u	-	*	-
EB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u	-	*	-	-
EB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u	-	*	-
NB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u	-	*	-	-
NB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u	-	*	-
Dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

Temporary emigration probability

TE	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	PB2	PB1	PB2_AE	PB1_AE	FTB2	FTB1	EB2	EB1	NB2	NB1	Dead
PB2	m	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1	-	m	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB2_AE	m	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB1_AE	-	m	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FTB2	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FTB1	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB2	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB1	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-
NB2	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
NB1	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-
PB2	-	-	-	-	-	-	-	-	-	-	m	-	*	-	-	-	-	-	-	-	-
PB1	-	-	-	-	-	-	-	-	-	-	-	m	-	*	-	-	-	-	-	-	-
PB2_AE	-	-	-	-	-	-	-	-	-	-	m	-	*	-	-	-	-	-	-	-	-
PB1_AE	-	-	-	-	-	-	-	-	-	-	-	m	-	*	-	-	-	-	-	-	-
FTB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-
FTB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-
EB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-
EB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-
NB2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-
NB1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-
Dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

Event matrices (observation process)

Recapture probability during the moult

Tags		2 tags	2 tags	2 tags	1 tag	1 tag	1 tag	2 tags	2 tags	2 tags	1 tag	1 tag	1 tag
p(M)	NS	{FTB&EB}(M)	{FTB&EB}(X)	{PB&NB}(M)	{FTB&EB}(M)	{FTB&EB}(X)	{PB&NB}(M)	{FTB&EB}(M)	{FTB&EB}(X)	{PB&NB}(M)	{FTB&EB}(M)	{FTB&EB}(X)	{PB&NB}(M)
PB2	*	-	-	p	-	-	-	-	-	-	-	-	-
PB1	*	-	-	-	-	-	p	-	-	-	-	-	-
PB2_AE	*	-	-	-	-	-	-	-	-	-	-	-	-
PB1_AE	*	-	-	-	-	-	-	-	-	-	-	-	-
FTB2	-	p	*	-	-	-	-	-	-	-	-	-	-
FTB1	-	-	-	-	p	*	-	-	-	-	-	-	-
EB2	-	p	*	-	-	-	-	-	-	-	-	-	-
EB1	-	-	-	-	p	*	-	-	-	-	-	-	-
NB2	*	-	-	p	-	-	-	-	-	-	-	-	-
NB1	*	-	-	-	-	-	p	-	-	-	-	-	-
PB2	*	-	-	-	-	-	-	-	-	p	-	-	-
PB1	*	-	-	-	-	-	-	-	-	-	-	-	p
PB2_AE	*	-	-	-	-	-	-	-	-	-	-	-	-
PB1_AE	*	-	-	-	-	-	-	-	-	-	-	-	-
FTB2	-	-	-	-	-	-	-	p	*	-	-	-	-
FTB1	-	-	-	-	-	-	-	-	-	-	p	*	-
EB2	-	-	-	-	-	-	-	p	*	-	-	-	-
EB1	-	-	-	-	-	-	-	-	-	-	p	*	-
NB2	*	-	-	-	-	-	-	-	-	p	-	-	-
NB1	*	-	-	-	-	-	-	-	-	-	-	-	p
Dead	*	-	-	-	-	-	-	-	-	-	-	-	-

Recapture probability during the 'uneven' weekly breeding season surveys

Tags	Tags	2 tags	2 tags	2 tags	2 tags	1 tag	1 tag	1 tag	1 tag		2 tags	1 tag	2 tags	2 tags	2 tags	2 tags	1 tag	1 tag	1 tag	1 tag	2 tags	1 tag
		uM	u(X)M	uM(X)	u(X)M(X)	uM	u(X)M	uM(X)	u(X)M(X)	NS	Monly	Monly	uM	u(X)M	uM(X)	u(X)M(X)	uM	u(X)M	uM(X)	u(X)M(X)	Monly	Monly
	NS	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	{FTB&EB}(M)	p	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	{FTB&EB}(X)	-	-	p	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	{PB&NB}(M)	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-
1 tag	{FTB&EB}(M)	-	-	-	-	p	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 tag	{FTB&EB}(X)	-	-	-	-	-	-	p	*	-	-	-	-	-	-	-	-	-	-	-	-	-
1 tag	{PB&NB}(M)	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-
2 tags	{FTB&EB}(M)	-	-	-	-	-	-	-	-	-	-	-	p	*	-	-	-	-	-	-	-	-
2 tags	{FTB&EB}(X)	-	-	-	-	-	-	-	-	-	-	-	-	-	p	*	-	-	-	-	-	-
2 tags	{PB&NB}(M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-
1 tag	{FTB&EB}(M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	*	-	-	-	-
1 tag	{FTB&EB}(X)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	*	-	-
1 tag	{PB&NB}(M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

Recapture probability during the 'even' weekly breeding season surveys

			2 tags	2 tags	2 tags	2 tags	2 tags	2 tags	2 tags	1 tag	1 tag	1 tag	1 tag	1 tag	1 tag	1 tag
	Event code		MUE	MU	ME	M	UE	U	E	MUE	MU	ME	M	UE	U	E
	Event	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2 tags	uM	-	p	*	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	u(X)M	-	-	-	p	*	-	-	-	-	-	-	-	-	-	-
2 tags	uM(X)	-	-	-	-	-	p	*	-	-	-	-	-	-	-	-
2 tags	u(X)M(X)	*	-	-	-	-	-	-	p	-	-	-	-	-	-	-
1 tag	uM	-	-	-	-	-	-	-	-	p	*	-	-	-	-	-
1 tag	u(X)M	-	-	-	-	-	-	-	-	-	-	p	*	-	-	-
1 tag	uM(X)	-	-	-	-	-	-	-	-	-	-	-	-	p	*	-
1 tag	u(X)M(X)	*	-	-	-	-	-	-	-	-	-	-	-	-	-	p
	NS	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	Monly	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-
1 tag	Monly	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-
2 tags	uM	-	p	*	-	-	-	-	-	-	-	-	-	-	-	-
2 tags	u(X)M	-	-	-	p	*	-	-	-	-	-	-	-	-	-	-
2 tags	uM(X)	-	-	-	-	-	p	*	-	-	-	-	-	-	-	-
2 tags	u(X)M(X)	*	-	-	-	-	-	-	p	-	-	-	-	-	-	-
1 tag	uM	-	-	-	-	-	-	-	-	p	*	-	-	-	-	-
1 tag	u(X)M	-	-	-	-	-	-	-	-	-	-	p	*	-	-	-
1 tag	uM(X)	-	-	-	-	-	-	-	-	-	-	-	-	p	*	-
1 tag	u(X)M(X)	*	-	-	-	-	-	-	-	-	-	-	-	-	-	p
2 tags	Monly	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-
1 tag	Monly	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-

Supporting Information 7

Table S7.1. Model selection for recapture, tag loss and migration probabilities of female southern elephant seals at Marion Island. The effects of time (t), age (a), number of flipper tags remaining (tag), position of flipper tag (g) and reproductive state ($state$; PB, FTB, EB, NB) were considered. Numerical superscripts indicate variation in specific age classes. The structure of the umbrella model (model 1) was
${\tau^{21}}_{g.a}\ {\tau^{10}}_{g.a}\ \varphi_a^{state}\ \psi_a^{state}\ \ \psi^{OU,UO}a^{0,1,2,>3}\ p_{\kappa^M}.t^{PB,FTB=EB,NB}.tag\ p_{\kappa^{U,E}}.t^{FTB=EB}.tag.$
The number of parameters (np), model deviance, ΔQAICc and the QAICc weight (w_i; the relative support by the data of a model, in relation to the other models), are given. Models in bold font were selected. ΔQAICc and QAICc weights are given relative to models of survival (φ) and breeding probability (ψ) selection (Table 1 in the accompanying paper).

Model	Assumption of model	np	Deviance	Δ QAICc	w_i
Breeding season encounter probability ($p_{\kappa^{U,E}}$)					
1	$p_{\kappa^{U,E}}.t^{FTB=EB}.tag$	347	59438.74	156.31	0.00
2	$\boldsymbol{p_{\kappa^{U,E}}.t^{FTB=EB}}$	**291**	**59534.77**	**121.14**	**0.00**
3	$p_{\kappa^{U,E}}.^{FTB=EB}$	237	61549.93	1625.26	0.00
Moult encounter probability (p_{κ^M})					
4	$\boldsymbol{p_{\kappa^M}.t^{PB,FTB=EB,NB}}$	**207**	**59627.29**	**27.15**	**0.00**
5	$p_{\kappa^M}.t^{PB=FTB=EB=NB}$	153	59959.70	185.08	0.00
6	$p_{\kappa^M}.^{PB,FTB=EB,NB}$	126	60042.71	197.49	0.00
7	$p_{\kappa^M}.^{PB=FTB=EB=NB}$	124	60264.84	371.19	0.00
First tag loss probability (τ^{21})					
8	$\boldsymbol{\tau^{21}.g.a^{0,1-4,,\geq 5}}$	**199**	**59637.02**	**18.94**	**0.00**
9	$\tau^{21}.g.a^{0,\geq 1}$	197	59643.59	20.19	0.00
10	$\tau^{21}.g$	195	59649.23	20.70	0.00
11	$\tau^{21}.$	194	59712.61	69.41	0.00
Second tag loss probability (τ^{10})					
12	$\tau^{10}.g.a^{0,1-4,,\geq 5}$	191	59651.72	14.70	0.00
13	$\tau^{10}.g.a^{0,\geq 1}$	189	59652.66	11.45	0.00
14	$\boldsymbol{\tau^{10}.g}$	**187**	**59653.81**	**8.37**	**0.01**
15	$\tau^{10}.$	186	59656.45	8.48	0.01
Migration probabilities (ψ^{OU} *and* ψ^{UO})					
16	$\psi^{OU,UO}.$	182	59723.03	53.75	0.00

Table S7.2. Mean and 95% confidence interval estimates of annual tag loss probabilities (τ) in double-tagged southern elephant seal females at Marion Island. Column headings refer to tags placed in the inner-interdigital webbing of the hind flipper (1983 - 1999) and the outer-interdigital webbing of the hind flipper (2000 - 2009), respectively. Estimates were obtained from the most parsimonious model which included heterogeneity in survival, breeding and recapture probabilities (model H8 of Table 2 in the accompanying paper).

Parameter	Inner-interdigital	Outer-interdigital
Tag loss probability (τ^{21}) (transition from two tags to one tag)		
Age 0	0.04 [0.03 - 0.05]	0.09 [0.08 - 0.12]
Age 1 – 4	0.04 [0.04 - 0.05]	0.08 [0.07 - 0.10]
Age > 5	0.06 [0.05 - 0.07]	0.11 [0.08 - 0.15]
Tag loss probability (τ^{10}) (transition from one tag to zero tags)		
	0.04 [0.02 - 0.10]	0.08 [0.05 - 0.14]

Table S7.3. Mean and 95% confidence interval estimates for temporary emigration of pre-breeder southern elephant seal females at Marion Island. Estimates were obtained from the most parsimonious model which included heterogeneity in survival, breeding and recapture probabilities (model H8 of Table 2 in the accompanying paper).

Age	Probability to remain in the observable state (ψ^{OO})	Probability to return to the observable state (ψ^{UO})
Age 0	1.00 [0.96 – 1.00]	-
Age 1	0.99 [0.95 - 1.00]	0.26 [0.07 - 0.63]
Age 2	0.98 [0.88 - 1.00]	0.16 [0.01 - 0.80]
Age ≥ 3	0.74 [0.56 – 0.86]	0.13 [0.01 - 0.68]

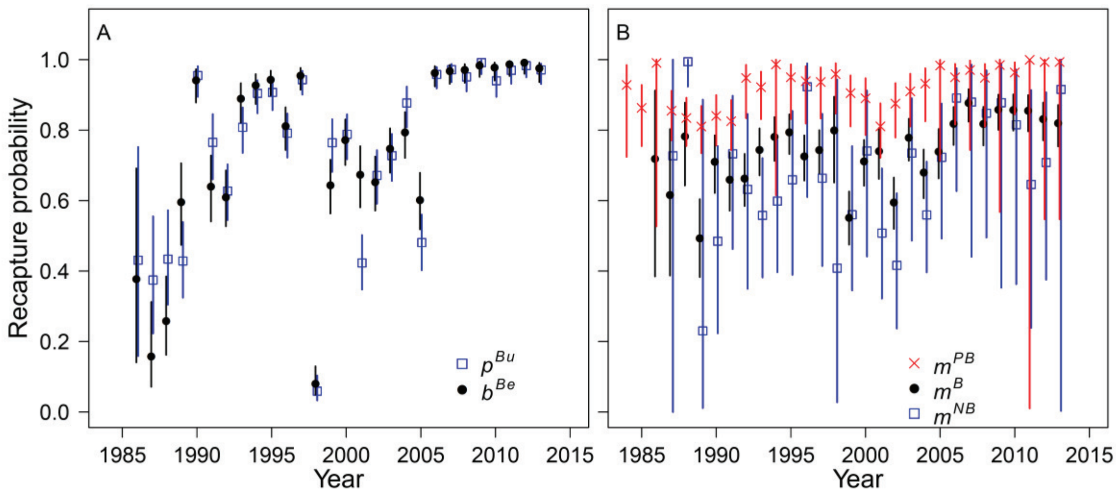

Figure S7.1. Recapture probabilities (mean and 95% confidence interval) of female elephant seals at Marion Island estimated using a multievent-robust design approach. Estimates were obtained from model 10 (Table 1) in the accompanying paper. (A) Recapture probabilities (p^{Bu}; b^{Be}) of breeders in the "uneven" (κ^{U}) and "even" (κ^{E}) capture" capture periods of every breeding season. (B) Capture probabilities of pre-breeders (m^{PB}; red crosses), breeders (m^{B}, black circles) and non-breeders (m^{NB}, blue squares) outside of the breeding season (i.e., through the moult and winter).

Supporting Information 8

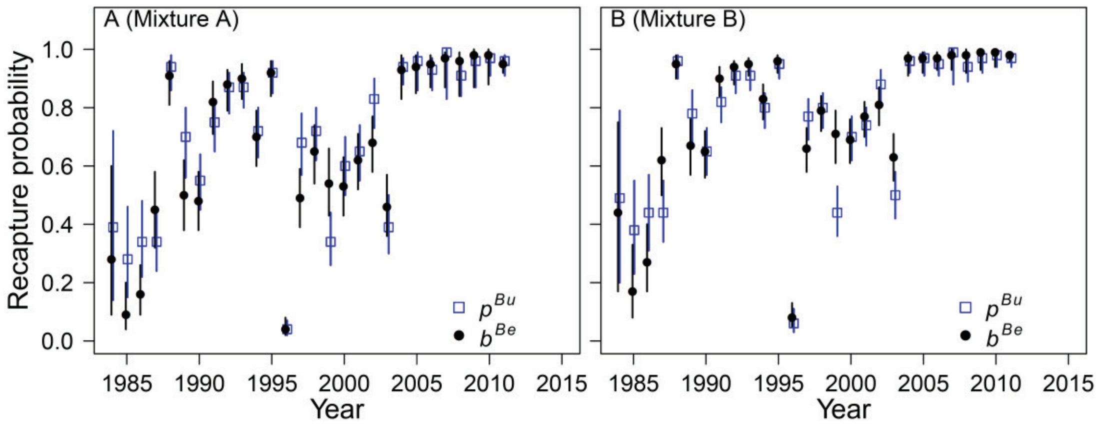

Figure S8.1. Recapture probabilities (mean and 95% confidence interval) of female elephant seals at Marion Island estimated using a finite mixture model with two heterogeneity classes. Estimates were obtained from model H8 (Table 2) in the accompanying paper. (A) Recapture probabilities (p^{Bu}; b^{Be}) of breeders belonging to mixture class A in the "uneven" (κ^{U}) and "even" (κ^{E}) capture" capture periods of every breeding season. (B) Recapture probabilities (p^{Bu}; b^{Be}) of breeders belonging to mixture class B in the "uneven" (κ^{U}) and "even" (κ^{E}) capture" capture periods of every breeding season.

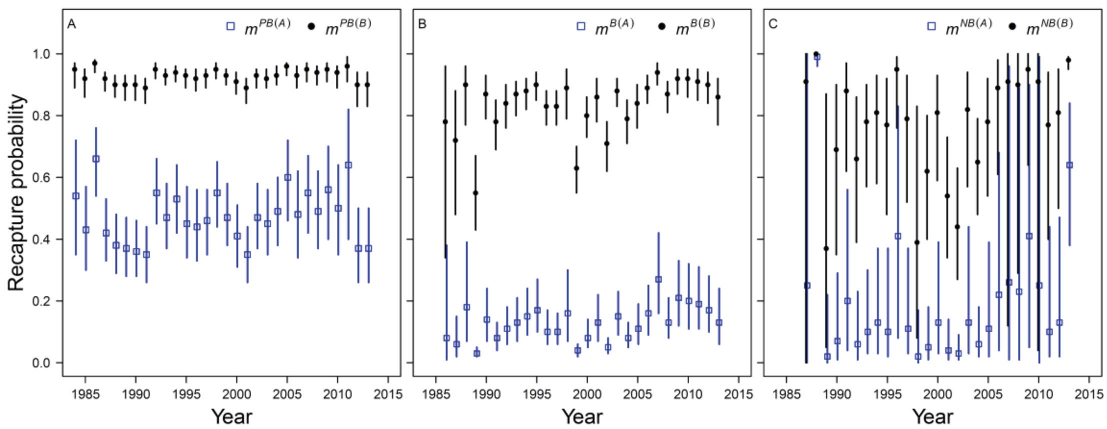

Figure S8.2. Recapture probabilities (mean and 95% confidence interval) of female elephant seals at Marion Island estimated using a finite mixture model with two heterogeneity classes. Estimates were obtained from model H8 (Table 2) in the accompanying paper. (A) Recapture probabilities of pre-breeders belonging to mixture classes A (blue squares) and B (black circles), respectively, outside of the breeding season (i.e., through the moult and winter). (B) Recapture probabilities of breeders belonging to mixture classes A (blue squares) and B (black circles), respectively, outside of the breeding season (i.e., through the moult and winter). (C) Recapture probabilities of non-breeders belonging to mixture classes A (blue squares) and B (black circles), respectively, outside of the breeding season (i.e., through the moult and winter).