 DOI: 10.1086/663194

Appendix from S. Bouwhuis et al., "The Forms and Fitness Cost of Senescence: Age-Specific Recapture, Survival, Reproduction, and Reproductive Value in a Wild Bird Population"

(Am. Nat., vol. 179, no. 1, p. E15)

Age-Specific Performance

To model female recapture and survival probability, we first modeled recapture probability (*p*), which was allowed to vary with time, age, age^2, and female immigrant status (table 1, step 1), while fixing survival probability to vary with immigrant status and age. This resulted in four similarly supported models, which we then used to model local survival probability (Φ), which was also allowed to vary with time, age, age^2, and female immigrant status. The best-supported model of recapture probability (table 1, step 1, model 1) was also associated with the three best-supported models of survival probability and is presented in the main text (table 1, step 2, models 1–3). Here we present the results of models run using the other three recapture probabilities (table A1, steps 3–5). Additionally, we provide the data we used to calculate age-specific reproductive values and their bias if age-specific recapture probabilities are not taken into account (table A2).

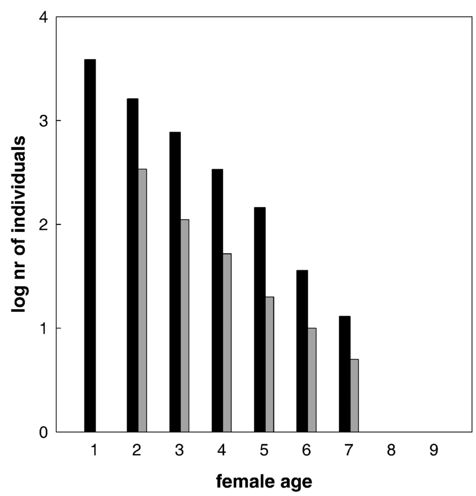

Figure A1: Age distributions for birds of known age (black bars) and birds first caught with adult plumage, which were of unknown age but assigned a minimal age of 2 (gray bars). These distributions are not identical, in that ages 3, 4, and 5 are slightly underrepresented in birds of unknown age compared to birds of known age, while age 2 is slightly overrepresented in birds of unknown age compared to birds of known age. Birds of unknown age were, however, kept in our sample to allow our estimates of age-specific survival to be combined with our previously published estimates of age-specific reproductive performance (Bouwhuis et al. 2009), which were based on birds of both known age and unknown age. Since 92% of birds were of exactly known age and most birds with an assigned minimal age of 2 should have indeed been 2 years old on first encounter, we expect little bias in our results.

Table A1. Model selection results for age effects on local survival (Φ) and recapture probability (*p*) in 4,935 female great tits

Step, model	Φ	*p*	No. estimated parameters	Deviance	ΔqAIC
3:					
1	$Age^2 + t$	Age + *t*	96	19,171.700	3.347
2	Status + $age^2 + t$	Age + *t*	97	19,171.361	5.056
3	*a* + *t*	Age + *t*	102	19,168.838	12.779
4	Status + *a* + *t*	Age + *t*	103	19,168.478	14.470
5	Age + *t*	Age + *t*	95	19,188.952	18.552
6	Status + age + *t*	Age + *t*	96	19,188.643	20.290
7	*t*	Age + *t*	94	19,200.955	28.507
8	Status + *t*	Age + *t*	95	19,200.494	30.093
9	Status × ($age^2 + t$)	Age + *t*	144	19,126.525	57.135
10	Status × (*a* + *t*)	Age + *t*	156	19,101.985	57.394
11	Status × (age + *t*)	Age + *t*	142	19,144.635	71.002
12	Status × *t*	Age + *t*	140	19,158.177	80.404
13	Status + age^2	Age + *t*	52	19,411.652	153.689
14	Status × *a*	Age + *t*	66	19,386.544	156.989
15	*a*	Age + *t*	57	19,409.276	160.448
16	Status + *a*	Age + *t*	58	19,408.160	162.360
17	Status + age	Age + *t*	51	19,430.069	170.081
18	*i*	Age + *t*	49	19,441.157	177.120
19	Status	Age + *t*	50	19,441.098	179.085
20	Age	Age + *t*	49	19,450.082	186.045
21	Age^2	Age + *t*	50	19,449.892	187.879
22	Status × age	Age + *t*	50	19,450.076	188.063
23	Status × age^2	Age + *t*	52	19,448.952	190.990
4:					
1	$Age^2 + t$	Status + $age^2 + t$	98	19,168.581	4.324
2	Status + $age^2 + t$	Status + $age^2 + t$	99	19,168.583	6.375
3	Age + *t*	Status + $age^2 + t$	97	19,175.281	8.975
4	*t*	Status + $age^2 + t$	96	19,178.032	9.679
5	Status + age + *t*	Status + $age^2 + t$	98	19,175.222	10.965
6	Status + *t*	Status + $age^2 + t$	97	19,177.917	11.611
7	*a* + *t*	Status + $age^2 + t$	104	19,165.357	13.400
8	Status + *a* + *t*	Status + $age^2 + t$	105	19,165.356	15.451
9	Status × ($age^2 + t$)	Status + $age^2 + t$	146	19,124.824	59.479
10	Status × (*a* + *t*)	Status + $age^2 + t$	158	19,099.986	59.552
11	Status × (age + *t*)	Status + $age^2 + t$	144	19,129.848	60.358
12	Status × *t*	Status + $age^2 + t$	142	19,134.858	61.226
13	Status + age^2	Status + $age^2 + t$	54	19,408.674	154.763
14	*i*	Status + $age^2 + t$	51	19,417.004	157.016
15	Status × *a*	Status + $age^2 + t$	68	19,384.214	157.580
16	Status	Status + $age^2 + t$	52	19,416.426	158.463
17	Status + age	Status + $age^2 + t$	53	19,415.386	159.449
18	Age	Status + $age^2 + t$	51	19,419.549	159.561
19	Age^2	Status + $age^2 + t$	52	19,418.692	160.729
20	Status × age	Status + $age^2 + t$	52	19,419.505	161.542
21	*a*	Status + $age^2 + t$	59	19,406.028	162.257
22	Status + *a*	Status + $age^2 + t$	60	19,405.252	163.510
23	Status × age^2	Status + $age^2 + t$	54	19,417.655	163.744
5:					
1	$Age^2 + t$	$Age^2 + t$	97	19,171.689	5.383
2	Status + $age^2 + t$	$Age^2 + t$	98	19,171.346	7.089
3	Age + *t*	$Age^2 + t$	96	19,177.177	8.824
4	Status + age + *t*	$Age^2 + t$	97	19,175.281	6.647
5	*t*	$Age^2 + t$	95	19,179.651	9.251
6	Status + *t*	$Age^2 + t$	96	19,179.116	10.763
7	*a* + *t*	$Age^2 + t$	103	19,168.715	14.707
8	Status + *a* + *t*	$Age^2 + t$	104	19,168.365	16.408
9	Status × ($age^2 + t$)	$Age^2 + t$	145	19,126.562	59.144
10	Status × (*a* + *t*)	$Age^2 + t$	157	19,101.802	59.289

Table A1 (*Continued*)

Step, model	Φ	*p*	No. estimated parameters	Deviance	ΔqAIC
11	Status × (age + *t*)	$Age^2 + t$	143	19,131.292	59.730
12	Status × *t*	$Age^2 + t$	141	19,136.420	60.717
13	Status + age^2	$Age^2 + t$	53	19,411.036	155.099
14	*i*	$Age^2 + t$	50	19,418.213	156.201
15	Status × *a*	$Age^2 + t$	67	19,386.422	157.788
16	Status	$Age^2 + t$	51	19,418.125	158.137
17	Age	$Age^2 + t$	50	19,420.597	158.584
18	Status + age	$Age^2 + t$	52	19,417.355	159.392
19	Age^2	$Age^2 + t$	51	19,419.823	159.835
20	Status × age	$Age^2 + t$	51	19,420.568	160.580
21	*a*	$Age^2 + t$	58	19,407.875	162.076
22	Status × age^2	$Age^2 + t$	53	19,418.894	162.957
23	Status + *a*	$Age^2 + t$	59	19,407.762	163.991

Note: For each model, the number of estimated parameters is shown, along with the deviance and the difference in quasi Akaike Information Criterion (ΔqAIC; calculated as [(deviance/overdispersion parameter $\hat{c}$) + 2 × number of parameters estimated]) between that model and the best-supported model in the main text, which had a qAIC of 19,362.634. In the model description, *i* indicates constant recapture or survival, status immigrant status (i.e., locally born versus immigrant), *t* time (i.e., year effects), *a* age as a class variable, and age/age^2 age as a covariate.

Table A2. Age-specific performance in 4,935 female great tits

Age	Recapture	Survival	Recruits	RV	$Recruits_{min}$	RV_{min}	Bias
1	.85	.48	.58	1.15	.49	.94	1.22
2	.81	.50	.63	1.18	.51	.93	1.27
3	.78	.49	.64	1.10	.50	.84	1.31
4	.75	.43	.61	.95	.46	.70	1.36
5	.72	.37	.55	.78	.40	.55	1.42
6	.69	.31	.47	.61	.32	.41	1.49
7	.66	.24	.38	.46	.25	.30	1.53
8	.63	.19	.28	.32	.18	.20	1.60
9	.60	.14	.20	.20	.12	.12	1.67

Note: Age-specific recapture and survival probability as estimated using model averaging of the best-supported models in table 1 in the main text, local recruit production as estimated by Bouwhuis et al. (2009) and when taking into account the decline in recapture probability with age ($recruits_{min}$) and the resulting reproductive values (RV and RV_{min}) in 4,935 female great tits. Also reported is the bias in the estimate of RV, calculated as the ratio between RV and RV_{min}.