APPENDIX S2 | Details for models, priors, MCMC sampling, and results for all parameters from mark-recapture models

RJMCMC selection of CJS model

The *multimark* CJS framework uses a probit link for capture probability and apparent annual survival. We used the default uninformative priors for all parameters (Table S2.1; McClintock 2015). Each model was fitted with three MCMC chains of 500,000 iterations each, including a 25,000-sample burn-in, thinned to every 250 samples. We used the same number of iterations for the RJMCMC as the final sample size for each model, i.e., three chains of 1,900 iterations each for a total of 5,700 samples.

Estimation of survival

We fitted the final CJS model with three parallel MCMC chains of 1,000,000 iterations each thinned to every 50 samples, including a 25,000-iteration burn-in, resulting in 58,500 samples.

Estimation of abundance

We used the default uninformative priors for all parameters (Table S2.2; McClintock 2015 for more details). We fitted the model with three parallel MCMC chains of 1,000,000 iterations each thinned to every 100 samples, including a 250,000-iteration burn-in, resulting in 22,500 samples.

Estimation of annual rate of change through multiple imputation

For each fixed value of ϕ, we fitted the model with three MCMC chains, each including an adaptation phase of 500 samples, burn-in of 10,000 samples, and 20,000 iterations thinned at 100-sample intervals, resulting in 600 samples. This was repeated over 250 samples of φ, resulting in 150,000 samples.

TABLE S2.1 Summaries of priors and results for parameters estimated by final CJS model in *multimark*: β_{ϕ} is probit-link apparent annual survival; $\beta_{p,0}$ is the probit-link intercept of annual capture probability p; $\beta_{p,e}$ is the probit-link slope of capture probability with standardized Beaufort- and season-adjusted effort index (see Methods); $\sigma^2_{p,z}$ is the variance of probit-link individual random effects in capture probability; α is probability of simultaneous left- and right-sided detections, given both types encountered; τ is the sum of the conditional probabilities of left- and right-sided encounters, respectively, given detection (we assumed equal probabilities for both sides); ψ is probability that a randomly selected capture history belongs to one of the unique individuals encountered at least once; p_t is capture probability for occasion t, and ϕ is apparent annual survival. See McClintock (2015) for more details on model parameterization. Additional estimated parameters not reported here are the latent state matrix (dead or alive) and the vector of individual random effects for capture probability.

Parameter	**Prior**	**Mean**	***SD***	**Mode**	P_5	P_{25}	P_{50}	P_{75}	P_{95}	***n***
$\beta_{p,0}$	(0, 1)	−1.256	0.154	−1.222	−1.52	−1.355	−1.249	−1.148	−1.015	11,577
$\beta_{p,e}$	(0, 1)	0.189	0.079	0.185	0.060	0.135	0.188	0.242	0.321	38,293
β_{ϕ}	(0, 1)	1.702	0.282	1.634	1.278	1.505	1.682	1.876	2.195	9,100
$\sigma^2_{p,z}$	Inv-γ(1,0.01)	0.230	0.188	0.023	0.01	0.083	0.195	0.330	0.582	12,487
α	Unif(0,1)	0.926	0.048	0.959	0.835	0.900	0.936	0.962	0.986	51,068
τ	Beta(1,1)	0.564	0.060	0.564	0.464	0.524	0.564	0.604	0.660	53,919
ψ	Beta(1,1)	0.915	0.030	0.923	0.863	0.896	0.917	0.936	0.959	48,365
p_2	N/A (derived)	0.155	0.027	0.145	0.114	0.135	0.152	0.171	0.204	17,297
p_3	N/A (derived)	0.099	0.022	0.096	0.066	0.083	0.097	0.113	0.138	44,732
p_4	N/A (derived)	0.125	0.022	0.120	0.092	0.110	0.123	0.139	0.163	24,466
p_5	N/A (derived)	0.085	0.023	0.080	0.050	0.068	0.082	0.099	0.127	52,296
p_6	N/A (derived)	0.121	0.021	0.116	0.088	0.106	0.119	0.134	0.158	26,548
p_7	N/A (derived)	0.101	0.022	0.098	0.068	0.086	0.100	0.115	0.139	43,013
p_8	N/A (derived)	0.168	0.032	0.158	0.121	0.146	0.165	0.187	0.225	16,335
p_9	N/A (derived)	0.117	0.021	0.111	0.084	0.102	0.115	0.130	0.154	29,258
p_{10}	N/A (derived)	0.170	0.033	0.160	0.123	0.147	0.167	0.190	0.229	16,301
p_{11}	N/A (derived)	0.210	0.049	0.201	0.139	0.175	0.205	0.239	0.299	17,139
ϕ	N/A (derived)	0.950	0.027	0.962	0.899	0.934	0.954	0.970	0.986	9,811

TABLE S2.2 Summaries of priors and results for parameters estimated by closed population model in *multimark*: $\beta_{p,0}$ is the logit-link intercept of annual capture probability p; $\beta_{p,e}$ is the logit-link slope of capture probability with standardized Beaufort- and season-adjusted effort index (see Methods); $\sigma_{p,z}$ is the standard deviation of logit-link individual random effects in capture probability; α is probability of simultaneous left- and right-sided detections, given both types encountered; τ is the sum of the conditional probabilities of left- and right-sided encounters, respectively, given detection (we assumed equal probabilities for both sides); ψ is probability that an individual in the data-augmented capture history matrix was encountered at least once; p_t is capture probability for occasion t; N_{nc} is noncalf abundance, including a correction factor of 1.052; N is total abundance, including a correction factor of 1.107. See McClintock (2015) for more details on model parameterization. Not reported here are the latent capture history matrix and the vector of individual random effects for capture probability.

Parameter	**Prior**	**Mean**	***SD***	**Mode**	**P_5**	**P_{25}**	**P_{50}**	**P_{75}**	**P_{95}**	***n***
$\beta_{p,0}$	(0, 1.75)	−1.774	0.695	−1.401	−3.108	−2.154	−1.643	−1.269	−0.876	3,961
$\beta_{p,\mathrm{e}}$	(0, 1.75)	0.759	0.219	0.76	0.406	0.609	0.756	0.902	1.126	22,279
$\sigma_{p,z}$	half-Cauchy(25)	0.848	0.493	0.319	0.11	0.459	0.819	1.187	1.711	3,481
α	Unif(0,1)	0.9	0.06	0.926	0.786	0.865	0.909	0.945	0.978	24,194
τ	Beta(1,1)	0.556	0.066	0.556	0.446	0.51	0.556	0.6	0.662	21,871
ψ	Beta(1,1)	0.972	0.026	0.994	0.921	0.96	0.979	0.991	0.998	21,586
p_9	N/A (derived)	0.104	0.042	0.089	0.045	0.073	0.099	0.13	0.18	7,610
p_{10}	N/A (derived)	0.21	0.07	0.19	0.1	0.159	0.207	0.257	0.329	5,289
p_{11}	N/A (derived)	0.303	0.1	0.305	0.145	0.229	0.3	0.37	0.474	5,338
N_{nc}	N/A (derived)	115	49	84	67	83	101	131	208	5,207
N	N/A (derived)	121	52	89	71	87	106	138	219	5,207

TABLE S2.3 Summaries of priors and results for parameters estimated by Pradel-lambda model: $\beta_{p,0}$ is the logit-link intercept for annual capture probability p; $\beta_{p,e}$ is the logit-link slope for capture probability with standardized Beaufort- and season-adjusted effort index (see Methods); $\sigma_{p,t}$ is the standard deviation of logit-link temporal random effects in capture probability, β_λ is the log-link intercept for population growth rate, and λ is population growth rate.

Parameter	**Prior**	**Mean**	***SD***	**Mode**	**P_5**	**P_{25}**	**P_{50}**	**P_{75}**	**P_{95}**	***n***
$\beta_{p,0}$	(0, 3.16)	−2.378	0.227	−2.38	−2.749	−2.53	−2.379	−2.228	−2.003	1,001
$\beta_{p,e}$	(0, 10)	0.402	0.133	0.399	0.187	0.316	0.401	0.487	0.617	44,705
$\sigma_{p,t}$	Unif(0,2)	0.187	0.146	0.037	0.015	0.076	0.157	0.263	0.463	12,1827
β_λ	(0, 10)	−0.009	0.03	−0.01	−0.057	−0.029	−0.009	0.011	0.04	38,731
p_1	NA (derived)	0.086	0.025	0.076	0.053	0.068	0.081	0.098	0.133	4,822
p_2	NA (derived)	0.104	0.025	0.099	0.067	0.087	0.102	0.119	0.149	1,704
p_3	NA (derived)	0.055	0.017	0.052	0.031	0.044	0.054	0.065	0.085	5,171
p_4	NA (derived)	0.084	0.021	0.079	0.054	0.069	0.082	0.096	0.122	2,041
p_5	NA (derived)	0.056	0.018	0.048	0.032	0.043	0.053	0.065	0.089	7,440
p_6	NA (derived)	0.076	0.019	0.071	0.049	0.063	0.075	0.088	0.11	1,912
p_7	NA (derived)	0.065	0.017	0.059	0.04	0.052	0.062	0.075	0.096	2,885
p_8	NA (derived)	0.127	0.029	0.12	0.086	0.107	0.124	0.144	0.18	938
p_9	NA (derived)	0.069	0.018	0.067	0.042	0.057	0.068	0.08	0.101	1,991
p_{10}	NA (derived)	0.126	0.029	0.117	0.085	0.106	0.123	0.142	0.177	803
p_{11}	NA (derived)	0.169	0.04	0.16	0.111	0.14	0.164	0.192	0.241	795
λ	NA (derived)	0.992	0.029	0.989	0.944	0.972	0.991	1.011	1.041	39,021