

Assessing the design and power of capture-recapture studies to estimate demographic parameters for the Endangered Oceania humpback whale population

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Table S1. Estimates of male superpopulation size (N_S), apparent survival (Φ) and population growth rate (λ) from the λ -POPAN model fitted to the Oceania male genotype capture-recapture dataset from Constantine et al (2012). The model parameters are shown on the left and are population growth rate (λ), apparent survival (Φ), and capture probability (p) and follow this notation: (.) denotes the model parameter is time-invariant, (t) denotes the model parameter varies with capture occasion and (0.95) denotes the model parameter is fixed at 0.95. Where the model did not return variance estimates due to non-convergence or boundary estimates, CIs are marked as NA. Model fit is shown by Δ AIC. It should be noted that the sparseness of the data (as highlighted by Constantine et al. 2012) and short time span of the 1999-2005 surveys meant these data can be problematic for capture-recapture modelling.

Model	Δ AIC	N_S	95% CL	λ	95% CL	Φ	95% CL
$\lambda(.)p(t)\Phi(0.95)$	0.00	1257	1005, 1573	0.99	0.86,1.11	0.95	fixed
$\lambda(.)p(t),\Phi=1=\lambda$	0.35	1122	918, 1370	1.00	fixed	1	fixed
$\lambda(.)p(t)\Phi(.)$	4.28	1153	NA	1.02	NA	1	NA
$\lambda(.)p(.)\Phi(0.95)$	112.31	1342	1088,1657	1.02	0.97, 1.02	0.95	fixed
$\lambda(.)p(.)\Phi(.)$	113.37	1457	1154,1840	1.01	0.97, 1.02	0.88	0.74, 1.00

Table S2. Estimates of male superpopulation size (N_s), apparent survival (Φ) and population growth rate (λ) from the λ -POPAN model fitted to the New Caledonian male genotype mark-recapture dataset from Constantine et al (2012). The model parameters are shown on the left and are population growth rate (λ), apparent survival (Φ), and capture probability (p) and follow this notation: (.) denotes the model parameter is time-invariant, (t) denotes the model parameter varies with capture occasion and (0.95) denotes the model parameter is fixed at 0.95. In some models sample size is used as a proxy for survey effort and years with similar survey effort are constrained to have the same capture probability, as shown by '=', for example, 1999=2002=2004 indicates these three years are constrained to have the same capture probability. Where the model did not return variance estimates due to non-convergence or boundary estimates, CIs are marked as NA. Model fit is shown by Δ AIC.

	Δ AIC	N_s	95% CL	λ	95% CL	Φ	95% CL
$\lambda(.)p(1999=2002=2004, 2001=2003=2005,2000), \Phi(.)$	0.00	529	406, 690	1.02	0.94, 1.09	0.78	0.62, 0.93
$\lambda(.)p(1999=2002=2004,t), \Phi(0.95)$	1.16	531	401, 704	1.12	1.00, 1.24	0.95	fixed
$\lambda(.)p(1999=2002=2004, 2001=2003=2005,2000), \Phi(0.95)$	2.25	495	383, 639	1.03	0.96, 1.11	0.95	fixed
$\lambda(.)p(1999=2002,t)\Phi(0.95)$	3.06	523	390, 702	1.11	0.95, 1.26	0.95	fixed
$\lambda(.)p(t)\Phi(0.95)$	4.80	538	389, 743	1.13	0.94, 1.32	0.95	fixed
$\lambda(.)p(1999=2002,t)\Phi(.)$	7.08	508	NA	1.12	NA	1.00	NA
$\lambda(.)p(1999=2002=2004,t), \Phi(0.95)$	19.94	953	NA	1.18	NA	1.00	NA
$\lambda(.)p(.)\Phi(0.95)$	40.77	536	411, 698	1.09	1.02, 1.16	0.95	fixed
$\lambda(.)p(.)\Phi(.)$	40.86	560	429, 730	1.09	1.02, 1.16	0.83	0.67, 0.99
$\lambda(.)p(t)\Phi(.)$	354.38	205	193, 219	1.07	0.85, 1.28	1	NA

Table S3. Estimates of male superpopulation size (N_s), apparent survival (Φ) and population growth rate (λ) from the λ -POPAN model fitted to the Tongan male genotype mark-recapture dataset from Constantine et al (2012). The model parameters are shown on the left and are population growth rate (λ), apparent survival (Φ), and capture probability (p) and follow this notation: (.) denotes the model parameter is time-invariant, (t) denotes the model parameter varies with capture occasion and (0.95) denotes the model parameter is fixed at 0.95. In some models sample size is used as a proxy for survey effort and years with similar survey effort are constrained to have the same capture probability, as shown by '=', for example, 1999=2002=2004 indicates these three years are constrained to have the same capture probability. Where the model did not return variance estimates due to non-convergence or boundary estimates, CIs are marked as NA. Model fit is shown by Δ AIC.

	Δ AIC	N_s	95% CL	λ	95% CL	Φ	95% CL
$\lambda(.)p(2000=2005, 2001=2002=2003)\Phi(.95)$	0	1549	852, 2815	0.98	0.89,1.08	0.95	fixed
$\lambda(.)p(2001=2002, 2000=2005, 2003)\Phi(0.95)$	1.05	1130	793, 1609	0.95	0.85,1.05	0.95	fixed
$\lambda(.)p(2000=2005, 2001=2002=2003)\Phi(.)$	1.93	1466	699, 3074	0.99	0.89,1.09	0.98	0.79, 1.00
$\lambda(.)p(t)\Phi(0.95)$	3.92	1702	NA	0.95	NA	0.95	fixed
$\lambda(.)p(2001=2002,t)\Phi(0.95)$	7.91	817	413, 1616	0.95	0.61,1.29	0.95	fixed
$\lambda(.)p(.)\Phi(.)$	19.82	1519	745, 3099	0.96	0.88,1.04	0.96	0.77, 1.00
$\lambda(.)p(.)\Phi(0.95)$	22.08	890	594, 1332	0.95	0.88,1.02	0.95	fixed