 133

INTRODUCTION

Large scale climate phenomena such as El Niño-Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO) can create bottom-up effects in marine food webs that alter prey availability for top predators (Grosbois & Thompson 2005, Sydeman et al. 2006). Species like seabirds, which forage over hundreds to thousands of square kilometres, are frequently influenced by these indirect effects

We revisited burrows in subsequent years to recapture marked birds and band previously unmarked adults. Burrows were checked daily or every second day, as weather permitted, until the original banded bird was recaptured or both members of the breeding pair were caught. The burrow checks occurred over a nine-day period on Rock Islets and over a three-day period on Cleland Island. We also checked any new burrows and burrows that had previously been empty in the study area, and we banded adults found. Only data from the first bird encountered of any breeding pair were used in the survival analyses to ensure the independence of data from each burrow. The total number of study birds includes birds banded in the first year, as well as the first birds encountered in new and previously empty burrows in the second and third years of the study.

On Rock Islets, 23 burrows disappeared during storms during the winter of 2006/07. We therefore expanded our Rock Islet study area in 2007 and excavated 85 new burrows to replace those that had been lost and in anticipation of future losses; data from the destroyed burrows were not used in the analyses.

TABLE 1

Reduced m-array showing when and how many Leach's Storm Petrels were recaptured for the first time after release on Cleland Island and Rock Islets, British Columbia, 2006–2010

Year released	# released	# recaptured for first time after release				
		2007	2008	2009	2010	Total
Cleland Island (n = 436)						
2006	0	0	0	0	0	0
2007	400		301	59	4	364
2008	337			265	50	315
2009	324				257	257
Rock Islets (n = 546)						
2006	282[a]	213	35	6	0	254
2007	370		289	49	7	345
2008	324			262	44	306
2009	317				260	260

[a] 305 birds were banded in this year, but 23 were excluded from the analyses because their burrows were washed away in storms during the first winter post-banding (see Methods for full explanation).

Survival analysis

We estimated annual apparent survival of Leach's Storm Petrels between 2006 and 2010 using the Cormack-Jolly-Seber (CJS) model. We calculated annual apparent survival (q) after accounting for the resighting probability (p), i.e., the probability of encountering an individual if it was alive, using the program MARK (White & Burnham 1999). We fitted a global transient CJS model (Pradel et al. 1997, Sanz-Aguilar et al. 2010) that allowed (1) survival in the first year to be lower than in subsequent years (to control for disturbance and capture effects), (2) survival at the two islands to differ, and (3) survival to vary across years. We allowed the resighting probability to vary with island and year, and we assessed the fit of the global model using the median c-hat procedure implemented in MARK.

Next, we used the global transient CJS model and a two-step approach to determine the best model structure for the resighting probability and to model annual apparent survival. The candidate model set examining variation in resighting probability included a model that allowed resighting probability to be lower in 2007 (following the storms that led to the loss of some burrows) than in other years, as well as models where resighting probability varied with island and year (n = 6 models). The candidate model set examining variation in survival included 11 models. Since we found some evidence of overdispersion in the data (see Results), we used Quasi-Akaike's Information Criterion (QAICc) to rank competing models in the two candidate sets (Burnham & Anderson 2002).

RESULTS

Our capture-mark-recapture data set included a total of 982 birds (546 from Rock Islets and 436 from Cleland Island) and 2271 recapture events. We recaptured birds, on average, two times over the five years (range 0–4, Table 1). The global transient CJS model was an adequate fit to the data (median c-hat = 2.71). We nevertheless controlled for the slight overdispersion in our data in the two candidate model sets (Anderson et al. 1994).

Resighting probability was best modelled as a constant (0.81 ± 0.01, 0.78–0.84). This model received 2.4 times the support of models in which the resighting probability was lower in 2007 than in other years, or lower on Rock Islet than Cleland Island (Table 2).

There was some model uncertainty in the candidate model set examining variation in annual apparent survival, as three models received strong support (Table 3). The top model indicated that

TABLE 2

Model results for the candidate set examining variation in the resighting probability of Leach's Storm Petrels on Rock Islet and Cleland Island between 2007–2010. Apparent survival (q) in all models varies with island in the first year after capture and with island and year thereafter (i/i*t). Resighting probability (p) may vary with island (i), year (t), or differ in 2007.

Model	QAICc	QAICc	AICc Weights	Model Likelihood	Num. Par	QDeviance
q (i/i*t) p (.)	1289.74	0.00	0.437	1.000	8	31.74
q (i/i*t) p (2007)	1291.51	1.77	0.180	0.413	9	31.49
q (i/i*t) p (i)	1291.58	1.84	0.174	0.398	9	31.57
q (i/i*t) p (t)	1292.28	2.54	0.123	0.282	10	30.25
q (i/i*t) p (t+i)	1294.28	4.54	0.045	0.103	11	30.23
q (i/i*t) p (t*i)	1294.47	4.73	0.041	0.094	12	28.40

Storm Petrels eat a range of small fishes, crustaceans, jellyfish, and cephalopods (Pollet et al. 2019a), and their diet varies spatially and

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