Appendix 1. Model rankings for Pradel parameterization for residency and recruitment of hatch-year Roseate Terns during the 2014 and 2015 staging seasons at Cape Cod National Seashore, MA. We fit a series of models for each parameter, beginning with the detection probability (*p*) while we used the most general parameterization (fully year*region*week varying) for the other model parameters (Φ and *f*; Table A1.1). We repeated this model selection procedure using the best-supported models from previous steps to fit models for the remaining parameters (residency probability, Φ; Table A1.2 and recruitment rate, *f*; Table A1.3).

Table A1.1. Pradel survival and recruitment model rankings for *p*, detection probability. We constrained the time-varying detection probabilities such that our first two and final two detection probabilities were equal (e.g., $p1=p2$ and $p9=p10$). We modeled the most general parameterization (time * year * region) for the residency (Φ) and recruitment (*f*) parameters and used the best-supported model for detection probability (*p*) from this model selection process in subsequent model selection steps for each of the remaining parameters.

Model[†]	QAICc[‡]	ΔQAICc	w_i[§]	Likelihood[‖]	K[¶]	Deviance[#]
Φ(time * year * region)*p*(time * year + region)*f*(time * year * region)	7782.15	0	0.68	1	89	641.91
Φ(time * year * region)*p*(region)*f*(time * year * region)	7785.13	2.98	0.15	0.23	74	676.03
Φ(time * year * region)*p*(year * region)*f*(time * year * region)	7785.65	3.50	0.12	0.17	76	672.41
Φ(time * year * region)*p*(year + time + region)*f*(time * year * region)	7787.27	5.12	0.05	0.08	82	661.59
Φ(time * year * region)*p*(time * region)*f*(time * year * region)	7796.59	14.44	0	0	88	658.43
Φ(time * year * region)*p*(time * region + year)*f*(time * year * region)	7798.09	15.94	0	0	89	657.84
Φ(time * year * region)*p*(time * year * region)*f*(time * year * region)	7802.39	20.24	0	0	104	630.8
Φ(time * year * region)*p*(.)*f*(time * year * region)	7806.62	24.47	0	0	73	699.59
Φ(time * year * region)*p*(year * time)*f*(time * year * region)	7807.23	25.08	0	0	88	669.07
Φ(time * year * region)*p*(time)*f*(time * year * region)	7807.53	25.38	0	0	80	686.00
Φ(time * year * region)*p*($Time^2$)*f*(time * year * region)	7808.04	25.89	0	0	74	698.94
Φ(time * year * region)*p*(Time)*f*(time * year * region)	7808.62	26.47	0	0	74	699.51

Φ(time * year * region)*p*(year)*f*(time * year * region)	7811.73	29.58	0	0	74	702.62

[†]Model parameterization, where Φ is the residency parameter, *p* is the detection probability, and *f* is the recruitment rate parameter. Models tested included combinations of constant (.), week-varying (time), time trend (Time), quadratic time trend ($Time^2$), year-varying, and region-varying detection probabilities. We modeled the most general parameterization (time * year * region) for the residency (Φ) and recruitment (*f*) parameters.

[‡]Adjusted AICc values. A $\hat{c}$ value of 2.03 was applied to the dataset to correct for overdispersion of the data.

[§]QAICc model weight

[|]Model likelihood

[¶]Number of parameters included in the model

[#]Model deviance

Table A1.2. Pradel survival and recruitment model rankings for residency probability (Φ), using the best-supported model from our previous model selection procedure for detection probability (*p*; Table A1.1). We constrained the detection probability such that our first two and final two detection probabilities were equal (e.g., $p1=p2$ and $p9=p10$) so that all parameters would be identifiable. We modeled the most general parameterization (time * year * region) on the recruitment rate (*f*) parameter in all models in this step.

Model[†]	QAICc[‡]	ΔQAICc	w_i[§]	Likelihood[|]	K[¶]	Deviance[#]
$\Phi(\text{Time}^2)p(\text{time * year + region})f(\text{time * year * region})$	7729.22	0	0.81	1.00	55	659.25
$\Phi(\text{Time})p(\text{time * year + region})f(\text{time * year * region})$	7732.17	2.96	0.18	0.23	55	662.21
$\Phi(\text{time})p(\text{time * year + region})f(\text{time * year * region})$	7739.79	10.57	0	0.01	62	655.44
$\Phi(\text{time + year + region})p(\text{time * year + region})f(\text{time * year * region})$	7743.89	14.68	0	0	64	655.43
$\Phi(\text{time * region})p(\text{time * year + region})f(\text{time * year * region})$	7754.91	25.69	0	0	71	652.00
$\Phi(\text{time * year + region})p(\text{time * year + region})f(\text{time * year * region})$	7755.30	26.09	0	0	72	650.34
$\Phi(\text{time * region})p(\text{time * year + region})f(\text{time * year * region})$	7756.30	27.08	0	0	71	653.39
$\Phi(\text{time * region + year})p(\text{time * year + region})f(\text{time * year * region})$	7758.29	29.07	0	0	72	653.32
$\Phi(\text{time * year * region})p(\text{time * year + region})f(\text{time * year * region})$	7782.15	52.94	0	0	89	641.91
$\Phi(.)p(\text{time * year + region})f(\text{time * year * region})$	7801.05	71.84	0	0	54	733.14
$\Phi(\text{region})p(\text{time * year + region})f(\text{time * year * region})$	7802.37	73.16	0	0	55	732.41
$\Phi(\text{year})p(\text{time * year + region})f(\text{time * year * region})$	7802.40	73.19	0	0	55	732.44
$\Phi(\text{year * region})p(\text{time * year + region})f(\text{time * year * region})$	7805.51	76.29	0	0	57	731.44

[†]Model parameterization, where Φ is the residency probability, *p* is the detection probability, and *f* is recruitment rate. Models tested included combinations of constant (.), week-varying (time), time trend (Time), quadratic time trend ($Time^2$), year-varying, and region-varying Φ probabilities. We used the best model from the detection probability model selection procedure, fully time-by-year-by-region varying *p*, and we modeled the most general parameterization (time * year * region) on the recruitment rate (*f*) parameter in all models in this step.

[‡]Adjusted AICc values. A $\hat{c}$ value of 2.03 was applied to the dataset to correct for overdispersion of the data.

[§]QAICc model weight

[|]Model likelihood

[¶]Number of parameters included in the model

[#]Model deviance

Table A1.3. Pradel survival and recruitment model rankings for recruitment rate (*f*), using the best-supported model from our previous model selection procedure for detection probability (*p*; Table A1.1) and the two best-supported models for residency probability (Φ; Table A1.2). We constrained the detection probability such that our first two and final two detection probabilities were equal (e.g., $p1=p2$ and $p9=p10$) so that all parameters would be identifiable.

Model[†]	QAICc[‡]	ΔQAICc	w_i[§]	Likelihood[‖]	K[¶]	Deviance[#]
$\Phi(Time^2)p$(time * year + region)f(time + year + region)	7726.88	0	0.51	1.00	30	707.90
$\Phi(Time^2)p$(time * year + region)f(time * year * region)	7729.22	2.33	0.16	0.31	55	659.25
$\Phi(Time^2)p$(time * year + region)f(time * region + year)	7729.77	2.88	0.12	0.24	38	694.53
Φ(Time)p(time * year + region)f(time + year + region)	7729.94	3.06	0.11	0.22	30	710.95
Φ(Time)p(time * year + region)f(time * year * region)	7732.17	5.29	0.04	0.07	55	662.21
Φ(Time)p(time * year + region)f(time * region + year)	7732.47	5.59	0.03	0.06	38	697.23
$\Phi(Time^2)p$(time * year + region)f(time * region)	7733.78	6.89	0.02	0.03	37	700.57
$\Phi(Time^2)p$(time * year + region)f(time * year + region)	7736.04	9.15	0.01	0.01	38	700.80
Φ(Time)p(time * year + region)f(time * region)	7737.08	10.2	0	0.01	37	703.88
Φ(Time)p(time * year + region)f(time * year + region)	7739.13	12.25	0	0	38	703.89
$\Phi(Time^2)p$(time * year + region)f(Time)	7739.83	12.95	0	0	21	739.06
$\Phi(Time^2)p$(time * year + region)f(time)	7739.92	13.03	0	0	28	724.99
Φ(Time)p(time * year + region)f(time)	7742.31	15.43	0	0	28	727.38

Φ(Time)p(time * year + region)f(Time)	7742.74	15.86	0	0	21	741.97
Φ(Time^2)p(time * year + region)f(time * year)	7748.27	21.39	0	0	37	715.07
Φ(Time)p(time * year + region)f(time * year)	7751.02	24.13	0	0	37	717.82
Φ(Time^2)p(time * year + region)f(Time^2)	7774.61	47.73	0	0	21	773.84
Φ(Time)p(time * year + region)f(Time^2)	7777.51	50.62	0	0	21	776.73
Φ(Time)p(time * year + region)f(year * region)	7843.23	116.35	0	0	23	838.42
Φ(Time^2)p(time * year + region)f(year * region)	7845.96	119.08	0	0	23	841.15
Φ(Time)p(time * year + region)f(region)	7848.94	122.06	0	0	21	848.17
Φ(Time)p(time * year + region)f(.)	7850.15	123.27	0	0	20	851.40
Φ(Time^2)p(time * year + region)f(region)	7851.55	124.67	0	0	21	850.78
Φ(Time)p(time * year + region)f(year)	7852.12	125.24	0	0	21	851.35
Φ(Time^2)p(time * year + region)f(.)	7852.85	125.97	0	0	20	854.10
Φ(Time^2)p(time * year + region)f(year)	7854.71	127.82	0	0	21	853.93

[†]Model parameterization, where Φ is the residency probability, p is the detection probability, and f is recruitment rate. Models tested included combinations of constant (.), week-varying (time), time trend (Time), quadratic time trend (Time^2), year-varying, and region-varying Φ probabilities. We used the best model from the detection probability model selection procedure, fully time-by-year-by-region varying p, and we used the two best-supported model from the residency probability model selection procedure (Time- and Time^2-varying Φ) to fit models for f.

‡Adjusted AICc values. A $\hat{c}$ value of 2.03 was applied to the dataset to correct for overdispersion of the data.

§QAICc model weight

|Model likelihood

¶Number of parameters included in the model

#Model deviance