

Appendix 3. Abundance models.

The following tables give more information about the top model chosen for each species (Table A3.1) and the model selection process (Table A3.2).

Table A3.1. Top abundance models for each species. The top submodel for the observation process (detection) and the state process (abundance) was chosen using a model selection approach. All three possible state submodels included vegetation class (Class) as a predictor. Alternative state submodels included either a random effect of point (1|Point, to account for treating point-years as the sampling unit) or a restricted spatial regression component (RSR, with a 1000 m threshold, to account for spatial autocorrelation in counts). The estimated probability of detection p is given, or three estimates are given for those species which included observer in the observation submodel. Posterior predictive (Bayesian) P -values indicate goodness-of-fit, with values closest to 0.5 indicating the best fit. Species were classified based on their relative abundance in the five vegetation classes as early successional, forest, or other.

Common Name	Top state submodel	Top observation submodel	Estimated detection probability	Posterior predictive P -value	Vegetation class signature
American Goldfinch	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\text{Observer})$	0.12, 0.23, 0.21	0.22	Early successional
American Redstart	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.14	0.5	Other
American Robin	$\lambda(\text{Class})$	$p(\cdot)$	0.085	0.016	Forest
Baltimore Oriole	$\lambda(\text{Class}+\text{RSR})$	$p(\text{Observer})$	0.21, 0.093, 0.11	0.18	Forest
Bell's Vireo	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.22	0.64	Early successional
Black-capped Chickadee	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.15	0.29	Forest
Blue Jay	$\lambda(\text{Class})$	$p(\text{Observer})$	0.21, 0.084, 0.11	0.28	Forest
Brown Thrasher	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.12	0.44	Other
Brown-headed Cowbird	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\text{Observer})$	0.069, 0.16, 0.17	0.019	Other
Cedar Waxwing	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.16	0.35	Other
Chipping Sparrow	$\lambda(\text{Class})$	$p(\cdot)$	0.29	0.24	Other
Common Grackle	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\text{Observer})$	0.12, 0.074, 0.089	0.063	Other
Common Yellowthroat	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.16	0.51	Early successional
Downy Woodpecker	$\lambda(\text{Class})$	$p(\cdot)$	0.091	0.62	Forest
Eastern Bluebird	$\lambda(\text{Class})$	$p(\cdot)$	0.13	0.32	Other
Eastern Kingbird	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.12	0.19	Early successional
Eastern Wood-Pewee	$\lambda(\text{Class})$	$p(\text{Observer})$	0.33, 0.17, 0.2	0.48	Forest

European Starling	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.15	0.23	Other
Field Sparrow	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.15	0.51	Early successional
Gray Catbird	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.099	0.23	Other
Great Crested Flycatcher	$\lambda(\text{Class})$	$p(\cdot)$	0.26	0.42	Forest
Hairy Woodpecker	$\lambda(\text{Class})$	$p(\cdot)$	0.07	0.42	Forest
House Wren	$\lambda(\text{Class})$	$p(\text{Observer})$	0.29, 0.26, 0.22	0.82	Forest
Indigo Bunting	$\lambda(\text{Class})$	$p(\text{Observer})$	0.11, 0.36, 0.35	0.24	Other
Lark Sparrow	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.12	0.34	Early successional
Mourning Dove	$\lambda(\text{Class})$	$p(\cdot)$	0.24	0.96	Other
Northern Cardinal	$\lambda(\text{Class})$	$p(\text{Observer})$	0.26, 0.15, 0.068	0.53	Forest
Northern Flicker	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\text{Observer})$	0.057, 0.11, 0.093	0.20	Other
Orchard Oriole	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.19	0.56	Early successional
Ovenbird	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.23	0.64	Forest
Red-bellied Woodpecker	$\lambda(\text{Class})$	$p(\text{Observer})$	0.097, 0.35, 0.34	0.38	Forest
Red-eyed Vireo	$\lambda(\text{Class})$	$p(\cdot)$	0.22	0.45	Forest
Red-headed Woodpecker	$\lambda(\text{Class}+\text{RSR})$	$p(\text{Observer})$	0.16, 0.096, 0.14	0.84	Forest
Red-winged Blackbird	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\cdot)$	0.25	0.45	Early successional
Rose-breasted Grosbeak	$\lambda(\text{Class}+\text{RSR})$	$p(\text{Observer})$	0.22, 0.16, 0.14	0.78	Forest
Rufous-sided Towhee	$\lambda(\text{Class})$	$p(\text{Observer})$	0.24, 0.12, 0.18	0.27	Forest
Scarlet Tanager	$\lambda(\text{Class})$	$p(\cdot)$	0.25	0.19	Other
Song Sparrow	$\lambda(\text{Class})$	$p(\cdot)$	0.12	0.27	Early successional
Warbling Vireo	$\lambda(\text{Class}+\text{RSR})$	$p(\cdot)$	0.14	0.53	Forest
White-breasted Nuthatch	$\lambda(\text{Class})$	$p(\cdot)$	0.18	0.51	Forest
Wild Turkey	$\lambda(\text{Class})$	$p(\text{Observer})$	0.035, 0.31, 0.51	0.82	Other
Willow Flycatcher	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\text{Observer})$	0.28, 0.079, 0.092	0.72	Early successional
Wood Thrush	$\lambda(\text{Class})$	$p(\cdot)$	0.18	0.21	Forest
Yellow Warbler	$\lambda(\text{Class}+(1 \text{Point}))$	$p(\text{Observer})$	0.3, 0.15, 0.19	0.48	Early successional
Yellow-billed Cuckoo	$\lambda(\text{Class})$	$p(\text{Observer})$	0.058, 0.51, 0.19	0.56	Other
Yellow-throated Vireo	$\lambda(\text{Class})$	$p(\cdot)$	0.18	0.32	Other

Table A3.2. Model selection results for state submodels using the R package *ubms*. Species names are given in Table A1.1. Each species was analyzed separately. ELPD is the expected log pointwise predictive density and refers to the expected predictive accuracy of the model. Δ ELPD is the difference in ELPD between the given model and the model with the lowest ELPD. SE of Δ ELPD is the standard error of that difference. For the species with no ELPD given, only one model could be fitted, so no model selection was performed. See Table A3.1 for explanation of the state submodels. Only models which could be successfully fitted are included in this table. In some cases, indicated with footnotes, the model with the highest ELPD had a low posterior predictive p-value, in which case that model was not used and the model with the next highest ELPD was considered instead. In those cases, additional model selection comparisons were made (not shown) to assess the Δ ELPD and SE of Δ ELPD for those model sets.

Species	State submodel	ELPD	N. Param.	Δ ELPD	SE of Δ ELPD	Weight
AMGO [‡]	Class+RSR1000	-511.8	18.1	0.0	0.00	0.55
	Class+(1 point)	-515.0	64.7	-3.2	7.63	0.45
	Class	-531.8	10.5	-20.0	9.34	0.00
AMRE	Class+(1 point)	-190.4	35.6	0.0	0.00	0.79
	Class+RSR1000	-212.2	13.9	-21.9	12.64	0.21
	Class	-235.3	8.5	-45.0	13.98	0.00
AMRO	Class	-553.4	6.1	0.0	0.00	0.57
	Class+RSR1000	-553.8	12.7	-0.3	2.49	0.43
BAOR	Class+RSR1000	-859.7	25.8	0.0	0.00	0.33
	Class	-880.5	8.9	-20.8	7.11	0.06
BCCH	Class+(1 point)	-390.8	52.5	0.0	0.00	0.94
	Class	-402.2	7.5	-11.4	5.41	0.06
BEVI	Class+(1 point)	-354.4	52.2	0.0	0.00	0.89
	Class+RSR1000	-389.3	20.7	-34.9	11.88	0.11
	Class	-409.5	7.0	-55.1	15.75	0.00
BHCO	Class+(1 point)	-627.7	74.5	0.0	0.00	0.49
	Class+RSR1000	-629.8	23.8	-2.1	9.02	0.51
	Class	-655.7	12.0	-28.0	12.07	0.00
BLJA	Class	-567.1	8.4	0.0	0.00	0.55
	Class+RSR1000	-567.8	14.4	-0.8	3.38	0.45
BRTH	Class+(1 point)	-433.2	47.6	0.0	0.00	0.89
	Class+RSR1000	-447.7	16.5	-14.5	7.26	0.11
	Class	-455.4	7.8	-22.2	6.99	0.00
CEDW [†]	Class+(1 point)	-219.9	48.1	0.0	0.00	0.73
	Class	-250.1	11.3	-30.2	18.90	0.27
CHSP	Class+RSR1000	-105.0	11.3	0.0	0.00	0.59
	Class	-105.9	7.4	-0.9	3.78	0.41

COGR	Class+(1 point)	-435.2	77.8	0.0	0.00	0.77
	Class	-477.5	14.7	-42.3	18.38	0.23
	Class+RSR1000	-479.4	27.5	-44.2	17.88	0.00
COYE	Class+(1 point)	-298.1	47.3	0.0	0.00	1.00
	Class	-325.1	7.1	-27.0	8.05	0.00
DOWO	Class	-263.7	3.9	0.0	0.00	0.92
	Class+RSR1000	-265.5	8.8	-1.8	2.11	0.08
EABL	Class	-	-	-	-	-
EAKI	Class+(1 point)	-499.6	54.7	0.0	0.00	1.00
	Class	-516.8	7.2	-17.2	5.66	0.00
EAWP	Class+RSR1000	-579.0	14.2	0.0	0.00	0.94
	Class	-583.6	8.0	-4.6	3.24	0.06
EUST [†]	Class+(1 point)	-231.7	67.7	0.0	0.00	0.65
	Class	-287.5	15.3	-55.9	48.00	0.35
FISP	Class+(1 point)	-401.3	55.2	0.0	0.00	1.00
	Class	-443.1	7.1	-41.8	8.63	0.00
GCFL	Class+RSR1000	-359.5	10.6	0.0	0.00	0.91
	Class	-364.7	5.6	-5.2	3.88	0.09
GRCA	Class+(1 point)	-373.1	49.0	0.0	0.00	0.87
	Class+RSR1000	-382.8	16.1	-9.7	5.80	0.13
	Class	-383.8	7.0	-10.7	4.99	0.00
HAWO	Class	-	-	-	-	-
HOWR	Class+RSR1000	-972.8	14.7	0.0	0.00	0.72
	Class	-975.3	7.6	-2.5	3.40	0.28
INBU	Class	-	-	-	-	-
LASP	Class+(1 point)	-177.4	36.2	0.0	0.00	1.00
	Class	-187.7	7.5	-10.2	5.03	0.00
MODO	Class	-836.5	5.0	0.0	0.00	0.59
	Class+RSR1000	-837.1	10.3	-0.5	2.39	0.41
NOCA	Class+RSR1000	-451.3	13.5	0.0	0.00	0.84
	Class	-461.7	8.4	-10.4	5.93	0.16
NOFL [†]	Class+(1 point)	-387.9	23.4	0.0	0.00	0.99
	Class	-389.1	7.9	-1.3	1.33	0.00
	Class+RSR1000	-390.8	12.5	-3.0	2.29	0.00
OROR	Class+(1 point)	-610.2	56.6	0.0	0.00	0.85
	Class+RSR1000	-627.9	15.4	-17.7	7.74	0.15
	Class	-645.4	7.4	-35.1	7.79	0.00
OVEN	Class+(1 point)	-192.0	40.3	0.0	0.00	0.56
	Class+RSR1000	-196.7	14.9	-4.7	7.94	0.44

	Class	-249.7	5.6	-57.8	9.72	0.00
RBGR	Class+RSR1000	-617.3	15.4	0.0	0.00	1.00
	Class	-633.7	7.2	-16.4	4.87	0.00
RBWO	Class	-238.3	8.0	0.0	0.00	0.63
	Class+RSR1000	-239.5	13.5	-1.2	3.32	0.37
REVI	Class	-	-	-	-	-
RHW0	Class+RSR1000	-535.4	12.0	0.0	0.00	1.00
	Class+(1 point)	-546.6	21.5	-11.2	3.77	0.00
	Class	-551.6	4.7	-16.4	4.38	0.00
RSTO	Class+RSR1000	-602.3	15.1	0.0	0.00	0.58
	Class	-602.8	8.0	-0.5	2.77	0.42
RWBL	Class+(1 point)	-346.9	64.3	0.0	0.00	0.97
	Class	-453.0	13.2	-106.2	20.36	0.03
SCTA	Class	-	-	-	-	-
SOSP	Class	-340.1	4.6	0.0	0.00	0.51
	Class+RSR1000	-340.2	9.5	0.0	2.35	0.49
WAVI	Class+RSR1000	-543.2	9.8	0.0	0.00	1.00
	Class	-551.6	5.6	-8.4	3.68	0.00
WBNU	Class	-	-	-	-	-
WIFL	Class+(1 point)	-277.8	42.2	0.0	0.00	0.87
	Class+RSR1000	-291.3	15.0	-13.4	6.60	0.13
	Class	-293.3	8.6	-15.5	5.92	0.00
WITU	Class	-113.5	6.4	0.0	0.00	1.00
	Class+RSR1000	-116.7	10.0	-3.2	1.24	0.00
WOTH	Class	-	-	-	-	-
YBCU	Class	-	-	-	-	-
YEWA	Class+(1 point)	-947.6	78.3	0.0	0.00	0.80
	Class+RSR1000	-976.3	31.4	-28.8	10.53	0.20
	Class	-1028.1	10.7	-80.5	12.85	0.00
YTVI	Class	-	-	-	-	-

† The SE of the difference in ELPDs was greater than our cutoff, so the model with the next lowest ELPD was chosen. That model, however, had a low goodness-of-fit score, so it was removed from contention and the random effect model was chosen instead.

‡ The model containing the restricted spatial regression had a low goodness-of-fit, so it was removed from contention and the model with the next lowest ELPD was chosen instead.