APPENDIX C. Additional tables and figures.

TABLE C1. Bird- or habitat-specific, point-level variables used in state process models.

Variable	Category	Description	Species	Mean	Range
salt_pct	Map	Percentage of 100 m radius landscape that is "regularly flooded", or approximately saltmarsh.	BTGR, CLRA, LEBI, MAWR, SESP, XXRA	25.5	[0, 98.3]
brack_pct	Map	Percentage of 100 m radius landscape that is "irregularly flooded", or approximately brackish marsh.	BTGR, CLRA, COYE, KIRA, LEBI, MAWR, RWBL, SESP, XXRA	14.5	[0, 91.9]
fresh_pct	Map	Percentage of 100 m radius landscape that is freshwater marsh.	COYE, KIRA, XXRA	6.5	[0, 56.9]
swamp_pct	Map	Percentage of 100 m radius landscape that is tidal swamp.	YTWA	20.2	[0, 100]
fresh_ed	Map	Edge density of freshwater marsh class, within 200 m radius.	YTWA	20.6	[0, 156.3]
swamp_ed	Map	Edge density of tidal swamp class, within 200 m radius.	DOWO, HOWA, NOPA, PIWO, PROW, RBWO, REVI, SUTA, YBCU, YTWA	34.4	[0, 178.5]
water_ed	Map	Edge density of water class, within 200 m radius.	BTGR, CLRA, COYE, LEBI, MAWR, RWBL, SESP	0.009	[0, 0.021]
ba_sum_live	Field	Total basal area in m^2 of living trees, averaged over *circles.*	BTGR, COYE, DOWO, HOWA, KIRA, LEBI, NOPA, PIWO, PROW, RBWO, REVI, RWBL, SUTA, YBCU, YTWA	0.98	[0, 9.47]
ba_sum_snag	Field	Total basal area in m^2 of standing dead trees, averaged over *circles.*	BTGR, COYE, DOWO, HOWA, LEBI, NOPA, PIWO, PROW, RBWO, REVI, RWBL, SUTA, YBCU	0.06	[0, 0.74]
ba_med_live	Field	Median basal area in cm^2 of living trees, over all *circles.*	DOWO, HOWA, KIRA, NOPA, PIWO, PROW, RBWO, REVI, SUTA, YBCU, YTWA	19.9	[0, 56.9]
ba_med_snag	Field	Median basal area in cm^2 of dead trees, over all *circles.*	DOWO, PIWO, RBWO, REVI, SUTA, YBCU	14.3	[0, 292.6]
denscl_circ	Field	Percentage of density cloth that	BTGR, CLRA, COYE,	40.8	[11.0,

		was obscured, averaged over all observations within *circles*.	HOWA, KIRA, LEBI, MAWR, NOPA, PROW, RWBL, SESP, XXRA		81.8]
denscl_tb	Field	Percentage of density cloth that was obscured, averaged over all observations within the *topbank*.	BTGR, CLRA, COYE, KIRA, LEBI, MAWR, RWBL, SESP, XXRA	69.0	[9.5, 100.0]
densio	Field	Canopy density, as a percentage, averaged over all observations within *circles*.	BTGR, COYE, DOWO, HOWA, KIRA, NOPA, PIWO, PROW, RBWO, REVI, RWBL, SUTA, XXRA, YBCU, YTWA	20.3	[0, 91]
sparalte	Field	Average of maximum cover values within *circles*, of *Spartina alterniflora*.	CLRA, MAWR, SESP, XXRA	2.0	[0, 4.7]
juncroem	Field	Average of maximum cover values within *circles*, of *Juncus roemerianus*.	CLRA, MAWR, SESP	0.76	[0, 5]
sparcyno	Field	Average of maximum cover values within *circles*, of *Sparalte cynosuroides*.	COYE, KIRA, MAWR, XXRA	0.43	[0, 5]
zizamili	Field	Average of maximum cover values within *circles*, of *Zizania miliacea*.	KIRA, XXRA	0.8	[0, 5]
can_spp	Field	Total number of species observed in *canopy* strata of *circles*.	DOWO, HOWA, NOPA, PIWO, PROW, RBWO, REVI, SUTA, YBCU	1.5	[0, 8]
upp_spp	Field	Total number of species observed in *upper understory* strata of *circles*.	DOWO, HOWA, NOPA, PIWO, PROW, RBWO, REVI, SUTA, YBCU	1.8	[0, 9]
low_spp	Field	Total number of species observed in *lower understory* strata of *circles*.	DOWO, HOWA, NOPA, PIWO, PROW, RBWO, REVI, SUTA, YBCU	2.1	[0, 11]

Notes: All variables are continuous. For each predictor, codes are shown for species having that predictor in the initial set of candidate state process covariates.

TABLE C2. Best covariates, for considered species.

Species	Component	Variable Name	$\overline{s}$	Type
Least Bittern	p	*tide*	0.90	Visit
	ψ	*slamm_2*	0.97	Map
		swamp	0.96	Map
		water_ed	0.79	Map
		ba_sum_snag	0.58	Field

		salinity	0.54	Field
		dist_for	0.53	Map
King Rail	*p*	*noise*	0.59	Visit
	ψ	*slamm_2*	0.80	Map
		swamp	0.75	Map
		comm_2	0.66	Field
		denscl_tb	0.57	Field
Clapper Rail	*p*	*noise*	0.29	Visit
	ψ	*sparalte*	1.00	Field
		brack	0.95	Map
		comm_2	0.80	Field
Clapper / King Rail	*p*	*tide*	0.96	Visit
	ψ	*slamm_2*	0.99	Map
		denscl_tb	0.88	Field
		zizamili	0.87	Field
		max_strat	0.86	Field
		comm_2	0.75	Field
		dist_for	0.58	Map
		denscl_circ	0.55	Field
Yellow-billed Cuckoo	*p*	*julian*	1.00	Daily
	ψ	*upp_spp*	0.99	Field
		comm_2	0.89	Field
		ba_med_live	0.64	Field
		ba_sum_snag	0.60	Field
		salinity	0.57	Field
		brack	0.56	Map
		fresh	0.51	Map
Red-bellied Woodpecker	*p*	*julian*	0.97	Daily
	ψ	*low_spp*	0.99	Field
		dist_upl	0.81	Map
		salinity	0.68	Field
		ba_med_snag	0.67	Field
		chan_width	0.60	Field
		rel_elev	0.55	Map
		brack	0.53	Map
Downy Woodpecker	*p*	*julian*	0.82	Daily
	ψ	*densio*	0.98	Field
		ba_med_live	0.71	Field
		brack	0.53	Map
Pileated Woodpecker	*p*	*wind*	0.84	Visit
	ψ	*low_spp*	0.99	Field
		dist_dev	0.98	Map
		brack	0.63	Map
		fresh	0.53	Map
Red-eyed Vireo	*p*	*wind*	0.96	Visit
	ψ	*ba_sum_live*	1.00	Field
		quad_spp	0.98	Field
		brack	0.51	Map

Marsh Wren	*p*	*precip*	0.23	Daily
	ψ	*sparalte*	1.00	Field
		dist_upl	0.97	Map
		ht_mean	0.90	Field
		water_pct	0.65	Map
		denscl_circ	0.61	Field
		rel_elev	0.58	Field
Prothonotary Warbler	*p*	*julian*	0.73	Daily
	ψ	*ba_sum_live*	1.00	Field
		salt	0.62	Map
		brack	0.51	Map
Common Yellowthroat	*p*	*previous*	0.77	Daily
	ψ	*comm_2*	1.00	Field
		water_pct	1.00	Map
		fresh_pland	0.99	Map
		dist_for	0.97	Map
		region_sd	0.54	Field
Hooded Warbler	*p*	*precip*	0.49	Daily
	ψ	*densio*	0.83	Field
		ht_mean	0.73	Field
		salt	0.70	Map
		shr_spp	0.58	Field
		brack	0.51	Map
Northern Parula	*p*	*noise*	1.00	Visit
	ψ	*slamm_1*	1.00	Map
		comm_2	0.85	Field
		dist_upl	0.79	Map
		brack	0.71	Map
		ba_sum_snag	0.60	Field
		gro_spp	0.53	Field
Yellow-throated Warbler	*p*	*julian*	0.70	Daily
	ψ	*max_strat*	1.00	Field
		fresh_ed	0.81	Map
		dist_upl	0.77	Map
		total_len	0.70	Field
		dist_for	0.51	Map
Seaside Sparrow	*p*	*noise*	0.98	Visit
	ψ	*sparalte*	1.00	Field
		dist_for	0.97	Map
		rel_elev	0.89	Field
		denscl_circ	0.83	Field
Summer Tanager	*p*	*julian*	0.71	Daily
	ψ	*max_strat*	0.97	Field
		ba_sum_snag	0.82	Field
		dist_for	0.60	Map
		brack	0.56	Map
		dist_dev	0.52	Map
Red-winged Blackbird	*p*	*noise*	0.87	Visit
	ψ	*denscl_circ*	0.98	Field

		slamm_2	0.97	Map
		slamm_1	0.95	Map
		dist_dev	0.60	Map
		fresh	0.53	Map
Boat-tailed Grackle	*p*	*julian*	0.48	Daily
	ψ	*slamm_1*	1.00	Map
		comm_2	0.87	Field
		dist_for	0.57	Map
		slamm_2	0.54	Map
		region_sd	0.53	Field

Notes: For the state process model (*ψ),* predictors are shown which occurred in more than half the iterations over three MCMC chains, in the second round of variable selection using the refined (uncorrelated) set of predictors. That is, the posterior mean for the associated indicator variable $\bar{s} > 0.5$. For the detection process model (*p*), the best predictor is given even if $\bar{s} < 0.5$.

TABLE C3. Best occupancy models, from each round of model selection (*Full* set, *Map*-only, and SLAMM *Class*) for species with at least one model with a cross-validation Positive Predictive Value (PPV) greater than 0.70.

Species	**Set**	***p* Terms**	***ψ* Terms**	**Type**	***K***	$\bar{D}$	**DIC$_v$**	**AUC**	**PPV**	**NPV**	**cut**
Red-eyed Vireo	*F*	Int*(+)*, *wind(-)*	Int*(-)*, *ba_sum_live(+)*, *quad_spp(+)*	Fld	5	96.11	105.8	0.97	0.71	0.98	0.40
	M	Int*(+)*, *wind(-)*	Int*(-)*, *slamm_1(+)*, *dist_for(+)*, *brack*	...	6	104.38	142.6	0.92	0.54	0.97	0.21
	C	Int*(+)*, *wind(-)*	Int*(-)*, *swamp(+)*, *fresh(+)*	...	5	102.04	134.8	0.91	0.55	0.97	0.45
Marsh Wren	*F*	Int*(+)*, *prcp*	*sparalte(+)*, *dist_upl(+)*	Mix	5	131.60	136.7	0.96	0.92	0.94	0.70
	M	Int*(+)*, *prev(-)*	*slamm_1(-)*, *dist_upl(+)*, *chan_width(-)*	...	6	129.54	137.6	0.87	0.78	0.82	0.48
	C	Int*(+)*, *prev(-)*	Int*(-)*, *salt(+)*, *brack(+)*	...	5	130.12	143.0	0.89	0.83	0.88	0.61
Seaside	*F*	Int*(+)*,	Int*(-)*,	Mix	7	116.72	132.0	0.95	0.77	0.95	0.51

Sparrow		*noise(-)*	*sparalte(+), dist_for(+), rel_elev(+), denscl_circ(-)*								
	M	Int*(+), noise(-)*	Int*(-), slamm_1(-), dist_for(+)*	...	5	114.07	138.1	0.94	0.77	0.94	0.41
	C	Int*(+), noise(-)*	Int*(-), brack(+), salt(+)*	...	5	120.25	164.1	0.89	0.65	0.91	0.43
Northern Parula	*F*	Int*(+), noise(-)*	*slamm_1(+), comm_2(-)*	Mix	5	93.21	98.47	0.92	0.76	0.92	0.30
	M	Int*(+), noise(-)*	*slamm_1(+)*	...	4	94.37	105.5	0.94	0.77	0.94	0.53
	C	Int*(+), noise(-)*	Int*(-), swamp(+), fresh(+)*	...	5	94.71	106.2	0.94	0.80	0.94	0.46
Red-bellied Woodpecker	*F*	Int*(+), julian(+)*	*low_spp(+)*	Fld	4	142.57	163.5	0.92	0.70	0.94	0.43
	M	Int*(+), julian(+)*	*slamm_1(+)*	...	4	143.30	166.8	0.92	0.72	0.94	0.41
	C	Int*(+), julian(+)*	Int*(-), swamp(+), fresh(+)*	...	5	144.69	173.8	0.92	0.70	0.94	0.41
Clapper Rail	*F*	Int*(+), noise*	*sparalte(+), brack(+), comm_2(+)*	Mix	6	233.30	258.2	0.87	0.76	0.82	0.66
	M	Int*(+)*	Int*(+), slamm_1(-)*	...	3	242.27	256.6	0.84	0.73	0.80	0.68
	C	Int*(+), noise(-)*	Int*(-), brack(+), salt(+)*	...	5	231.40	251.0	0.86	0.74	0.83	0.65
Boat-tailed Grackle	*F*	Int*(+), julian(+)*	Int*(+), slamm_1(-), comm_2(+), dist_for(-), slamm_2(+)*	Mix	7	256.59	275.6	0.85	0.77	0.78	0.63
	M	*arm(F+, T+)*	Int*(+), slamm_1(-), slamm_2(+), dist_for(-)*	...	7	260.37	288.0	0.83	0.74	0.72	0.60
	C	*arm(F+, T+)*	Int*(-), brack(+), fresh(+), salt(+)*	...	7	265.21	304.7	0.81	0.72	0.73	0.63
Red-winged Blackbird	*F*	Int*(+), noise(+)*	Int*(+), denscl_circ(+), slamm_2(+), slamm_1(-), dist_dev(-), fresh*	Mix	8	246.65	276.4	0.83	0.82	0.70	0.64
	M	Int*(+), noise(+)*	Int*(+), slamm_2(+), slamm_1(-), dist_upl(-), chan_width(+)*	...	7	245.98	276.6	0.84	0.83	0.75	0.62
	C	Int*(+),*	Int*(+), brack(+),*	...	5	250.63	306.4	0.78	0.78	0.70	0.52

		noise(+)	*fresh*								

Notes: Species are ordered by AUC of their best-scoring models. The predictor set is shown in the Set column as *F* = *Full* set, *M* = *Map*, *C* = *Class*. For *Full Set* models, the Type column indicates whether the ψ terms were Field- ("Fld") or Map-derived, or a mix of both. *K* is the number of model parameters, $\bar{D}$ the mean deviance, AUC the median AUC value from the cross-validation procedure (note these are probably inflated for rare species), PPV and NPV the median positive and negative predictive value; the cut column shows the median threshold for determining presence over the 50 iterations of cross-validation. Parenthetical indicators of effect direction are shown when the 90% credible interval (CrI) for that model term did not include zero. "Int" represents the intercept for a model component, and is only shown when its 90% CrI did not cross zero.

TABLE C4. Best occupancy models, from each round of model selection (*Full* set, *Map*-only, and SLAMM *Class*) for species with at least one model with a cross-validation Positive Predictive Value (PPV) less than 0.70.

Species	**Set**	***p* Terms**	**ψ Terms**	**Type**	***K***	$\bar{D}$	**DIC$_v$**	**AUC**	**PPV**	**NPV**	**cut**
Yellow-throated Warbler	*F*	Int*(+), julian(-)*	*max_strat(+), fresh_ed(+)*	Mix	5	166.35	202.4	0.89	0.65	0.94	0.44
	M	Int*(+), julian(-)*	*swamp_ed(+), dist_upl(-)*		5	170.41	199.3	0.90	0.62	0.92	0.29
	C	Int*(+), julian(-)*	Int*(-), swamp(+), fresh(+)*		5	167.36	218.9	0.85	0.60	0.92	0.38
Common Yellowthroat	*F*	Int*(+), prev(+)*	*comm_2(+), water_pct(+), fresh_pland(+), dist_for(-), region_sd(-)*	Fld	8	177.49	197.4	0.88	0.63	0.92	0.45
	M	Int*(+), prev(+)*	*chan_width(+), fresh_pland(+),*	...	7	180.63	205.4	0.89	0.63	0.92	0.37

			dist_for(-), brack(+)								
	C	Int*(+), prev(+)*	Int*(-), brack(+), fresh(+), swamp*	...	6	173.26	257.3	0.74	0.45	0.85	0.23
Clapper / King Rail	*F*	Int*(+), tide(H-)*	*slamm_2(+), denscl_tb(+), zizamili(-), max_strat(-)*	Mix	8	152.35	172.1	0.91	0.56	0.95	0.34
	M	Int*(+), tide(H-)*	*slamm_1(-), slamm_2(+)*	...	6	152.47	175.3	0.90	0.60	0.94	0.26
	C	Int*(+), tide(H-)*	Int*(-), salt, brack(+), fresh(+)*	...	7	153.35	185.4	0.89	0.58	0.95	0.22
Hooded Warbler	*F*	*prcp*	Int*(-), densio(+), ht_mean(-), salt, shr_spp*	Fld	7	34.82	55.71	0.98	0.58	1.0	0.24
	M	*prcp*	Int*(-), slamm_1(+)*	...	4	35.93	63.59	0.95	0.33	1.0	0.17
	C	*prcp*	Int*(-), swamp(+)*	...	4	35.23	60.4	0.90	0.15	1.0	0.11
Yellow-billed Cuckoo	*F*	Int*(-), julian(+)*	Int*(-), upp_spp(+), comm_2(-), ba_med.live(+), ba_sum_snag*	Fld	7	111.12	129.2	0.93	0.46	0.98	0.15
	M	Int*(-), julian(+)*	Int*(-), slamm_1(+), brack(-), dist_dev(+)*	...	6	109.77	153.1	0.92	0.44	0.98	0.17
	C	Int*(-), julian(+)*	Int*(-), swamp(+)*	...	4	113.58	176.5	0.85	0.31	0.97	0.10
Pileated Woodpecker	*F*	Int*(-), wind(-)*	*low_spp(+), dist_dev(-), brack, fresh*	Mix	7	179.23	196.0	0.87	0.42	0.95	0.34
	M	Int*(-), wind(-)*	*slamm_1(+), dist_dev(-), brack(-)*	...	6	180.36	202.5	0.87	0.41	0.95	0.31
	C	*wind(-)*	Int*(-), swamp(+), fresh(+)*	...	5	168.36	217.4	0.83	0.42	0.95	0.28
Prothonotary Warbler	*F*	Int*(-), julian(+)*	Int*(-), ba_sum_live(+)*	Fld	4	72.71	93.7	0.93	0.35	0.98	0.11
	M	Int*(-), julian(+)*	Int*(-), slamm_1(+), dist_dev(+), brack, dist_for*	...	7	74.81	99.1	0.95	0.40	0.99	0.15
	C	*julian(+)*	Int*(-), swamp(+)*	...	4	71.44	131.2	0.90	0.26	0.98	0.13
Summer Tanager	*F*	Int*(-), julian(+)*	Int*(-), max_strat(+), ba_sum_snag(+), dist_for(-)*	Mix	6	131.40	159.0	0.90	0.36	0.97	0.19
	M	Int*(-),*	*slamm_1(+),*	...	6	142.95	183.7	0.86	0.29	0.96	0.17

		wind(-)	*dist_upl(-), brack(-)*								
	C	Int*(-), julian(+)*	Int*(-), swamp(+), fresh(+)*	...	5	136.01	196.1	0.83	0.30	0.96	0.15
Least Bittern	*F*	*tide(M-)*	Int*(-), slamm_2(+), swamp(-), water_ed(+)*	Map	5	116.50	158.0	0.88	0.36	0.97	0.16
	M	*same as above*	*same model as above*	...	…	…	…	…	…	…	...
	C	*tide(M-)*	Int*(-), salt, brack(+), fresh(+)*	...	7	120.33	176.4	0.83	0.34	0.96	0.10
King Rail	*F*	Int*(-), noise(+)*	*slamm_2(+), swamp(-)*	Map	4	97.83	161.0	0.82	0.22	0.98	0.11
	M	Int*(-), noise(+)*	*salt(-), swamp(-)*	...	5	82.23	129.2	0.89	0.29	1.0	0.14
	C	Int*(-), noise(+)*	Int*(-), brack(+), fresh(+), swamp*	...	6	86.55	145.8	0.87	0.27	0.98	0.13
Downy Woodpecker	*F*	Int*(-), julian(+)*	Int*(-), densio(+)*	Fld	4	87.65	107.3	0.88	0.21	0.98	0.14
	M	Int*(-), julian(+)*	Int*(-), slamm_1(+)*	...	4	78.78	116.5	0.88	0.21	0.98	0.08
	C	Int*(-), julian(+)*	Int*(-), fresh, swamp(+)*	...	5	86.86	128.1	0.84	0.20	0.98	0.06

Notes: Columns and notation are as in Table C3. Here, however, species are ordered by median PPV and not median AUC.

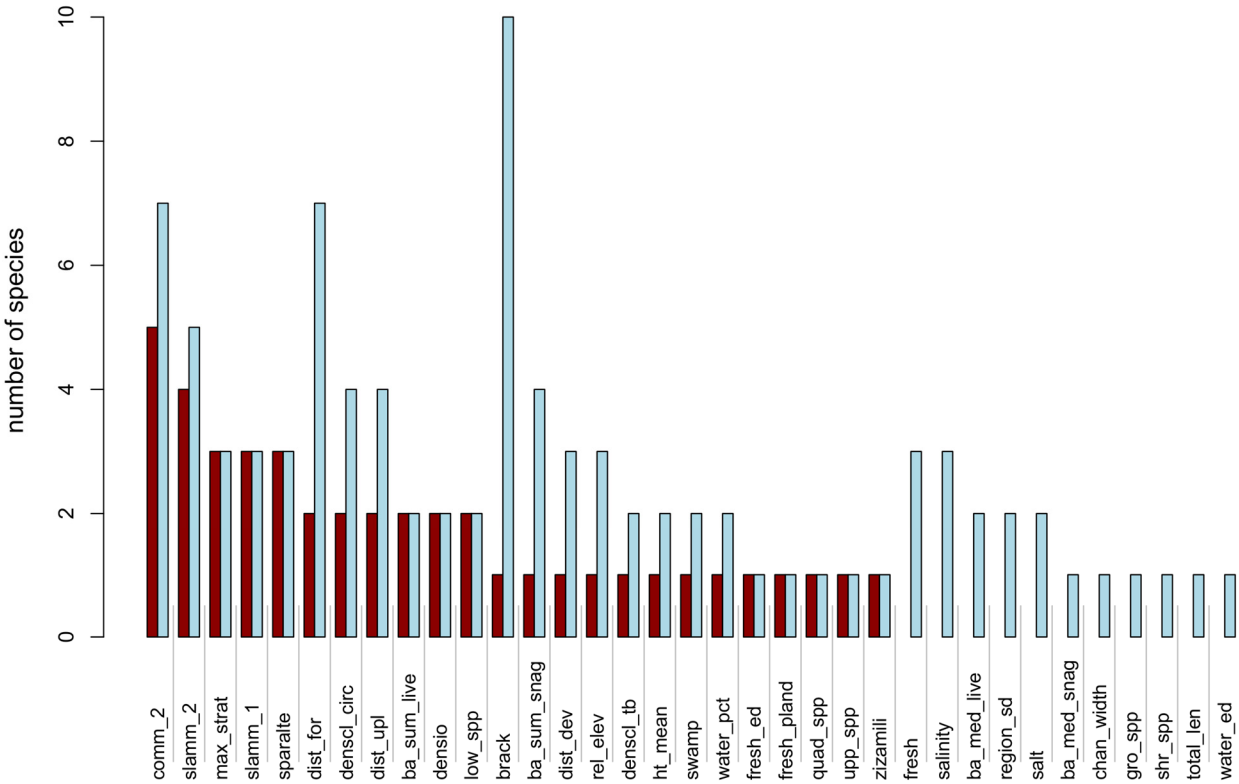

FIG. C1. Histograms of variable selection results in Table 5, at two different cutoff values of the Kuo-Mallick indicator variable s. Red bars show the total number of species for which each predictor was important at the $s \geq 0.8$ level; blue bars show the totals at the $s \geq 0.5$ level.