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Pacific Conservation Biology

Supplementary Material

The status and conservation needs of the Micronesian Megapode (*Megapodius laperouse laperouse*) across the Mariana archipelago

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SUPPLEMENTARY MATERIALS

Supplementary Material 1. Total land area and forested area, and number of transects and stations sampled during point-transect and playback surveys by island surveyed in in the Northern Mariana Islands in 2008 (Aguiguan), 2009 (Saipan) and 2010 (all remaining islands). Tinian and Uracus are not included because different methods were used to conducted presence/absence surveys them.

			Point-Transect		Playback	
Island	**Total Area (ha)**	**Forested Area[a] (ha)**	**Transects**	**Stations**	**Transects**	**Stations**
Aguiguan	700	340	6	74	11	110
Saipan	12,200	256	11	82	11	82
Anatahan	3,395	168[a]	-	-	6	21
Sarigan	452	179	6	41	6	41
Guguan	423	170	5	32	5	32
Alamagan	1,297	485	10	72	10	72
Pagan	4,772	1,971	13	144	13	144
Agrihan	4,388	168	9	93	9	97
Asuncion	784	316	4	38	4	38
Maug	211	40	2	14	2	14
Total	28,622	4,093	66	590	77	651

[a] Estimated forested area that was surveyed

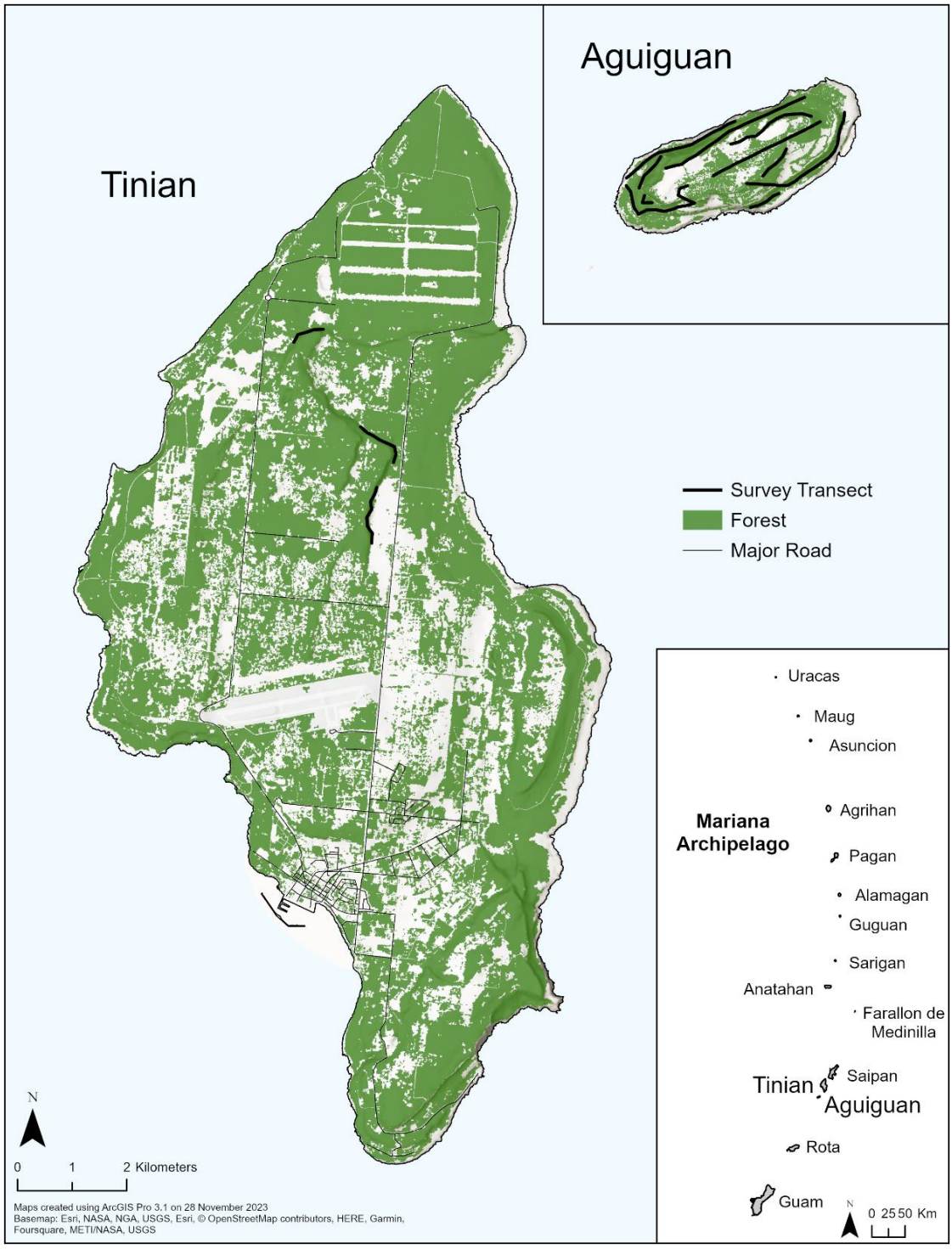
Supplementary Material 2. Point-transect sampling model selection results for the megapode data. Models are half-normal (H-norm) and hazard-rate (H-rate) key detection functions, and adjustment terms are cosine (Cos) hazard polynomial (H-poly) and simple polynomial series expansion of one order [S-poly(1)]. All covariate terms were continuous (con) except Time and Year were also treated as factor (fac) variables. K is the number of estimated parameters, L is the estimate of the log-likelihood, AIC_c is the 2nd-order Akaike's Information Criterion corrected for small sample sizes, ΔAIC_c is the difference among the AIC_c values, and w_i is the Akaike model weight that the likelihood that model is the best model (of the 11 models evaluated).

Model[a]	k	L	AIC_c	ΔAIC_c	w_i
H-rate S-poly(1) Year(fac)	6	-328.27	669.73	0.00	0.9981
H-rate S-poly(1) Gust	7	-333.35	682.31	12.58	0.0019
H-rate S-poly(1)	3	-346.18	698.68	28.95	<0.0000
H-rate S-poly(1) Detectability	5	-344.55	699.94	30.21	<0.0000
H-rate Key	2	-348.27	700.70	30.97	<0.0000
H-rate S-poly(1) Wind	6	-344.36	701.90	32.17	<0.0000
H-rate S-poly(1) Time(con)	4	-346.96	702.48	32.75	<0.0000
H-rate S-poly(1) Rain	4	-347.62	703.80	34.07	<0.0000
H-norm Key	1	-351.05	704.15	34.42	<0.0000
H-rate S-poly(1) Habitat	6	-346.35	705.89	36.16	<0.0000
H-rate S-poly(1) Detection Type	6	-346.95	707.08	37.35	<0.0000

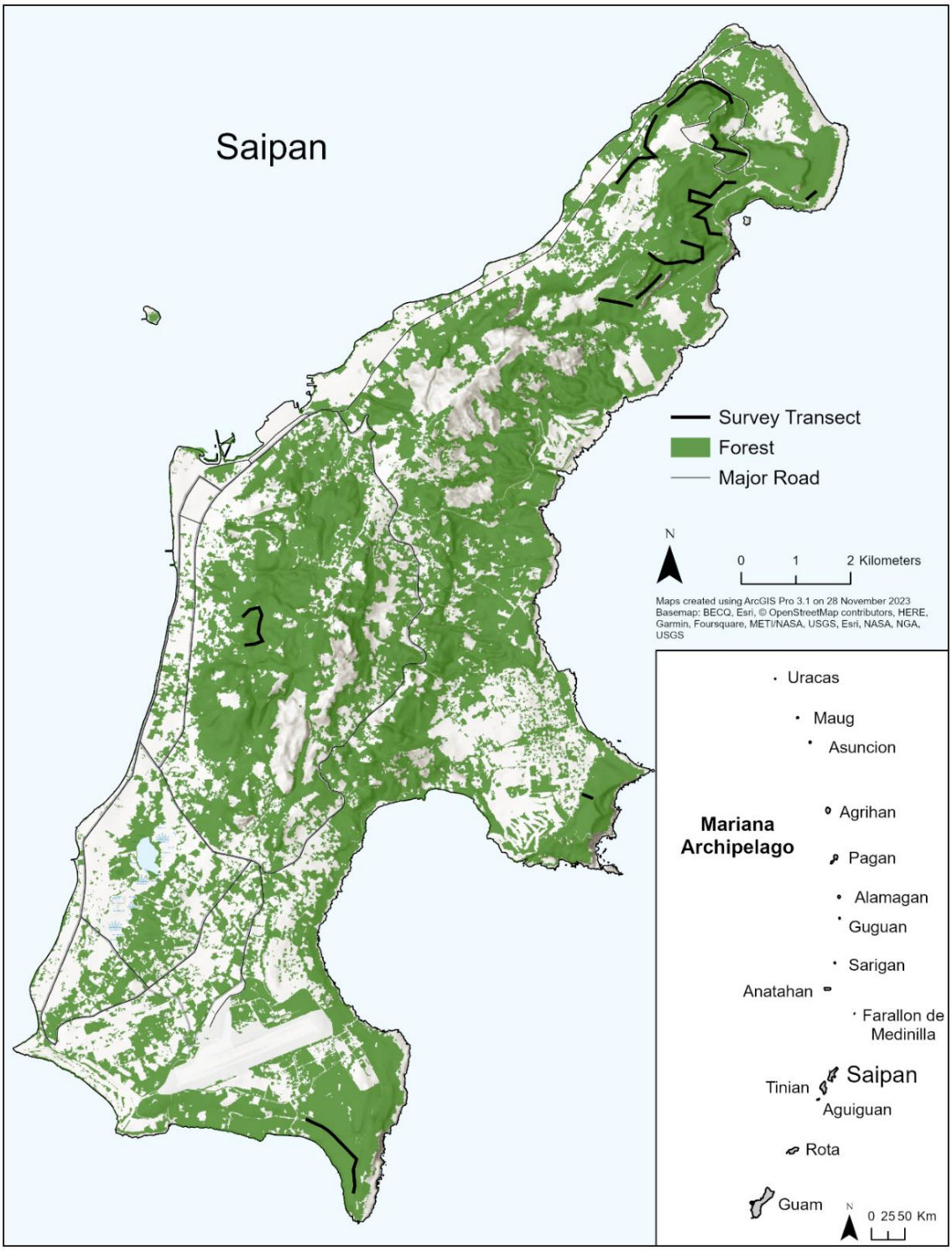
[a] The H-norm Cos and H-rate Cos models were best fit by the key model, and parameters in the H-norm H-poly model were highly correlated. The H-rate S-poly(1) model with covariates representing Cloud, Observer and Year(con) failed to converge.

Supplementary Material 3. Selection of models describing the relation of megapode occurrence to site habitat covariates. See Methods section for an explanation of site covariates indicated in parentheses following the occupancy symbol "ψ". Shaded models are those identified as the confidence set used in model averaging. The term "global" in model ψ(global)p(.) refers to the inclusion of all habitat variables. Column k is the number of model parameters; L is the -2*log likelihood; ΔAIC_c is the relative difference in AIC_c values from the model with the smallest value; w is the AIC_c model weight; ĉ is the estimated average over-dispersion parameter; and X^2 p-value is the probability of observing a X^2 greater than or equal to the test statistic based upon 999 parametric bootstraps. Model fit is considered adequate or good when X^2 p-value ≥ 0.05. Minimum AIC and AIC_c values for model ψ(.)p(.) was 218.7 and 219.1, respectively.

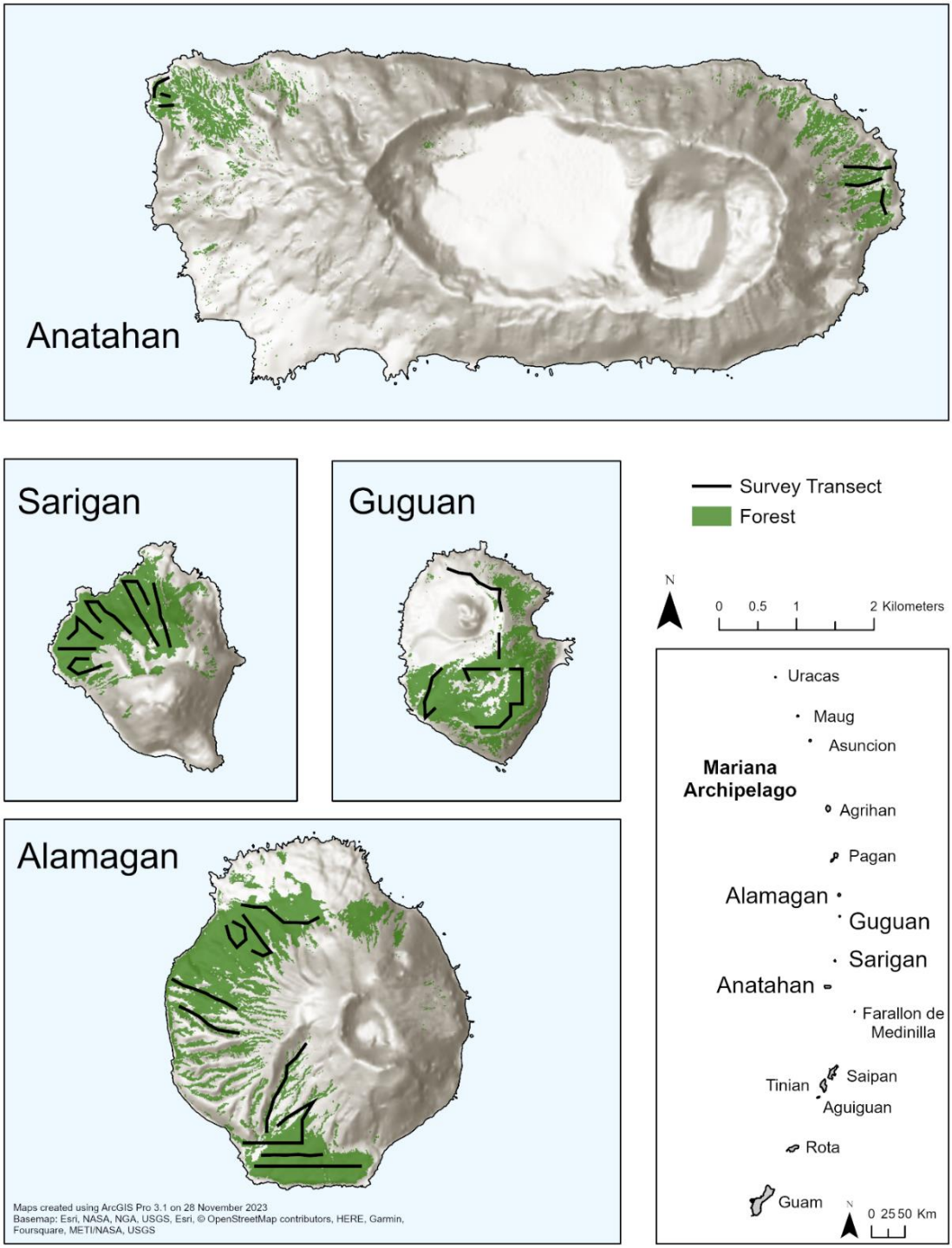
Model	k	L	ΔAICc	w	ĉ	X^2 p-value
ψ(.),p(.)	2	214.74	0.0	0.26	1.84	0.091
ψ(understory)p(.)	2	215.18	0.4	0.21	1.92	0.107
ψ(understory, elevation)p(.)	3	213.93	1.6	0.12	1.51	0.130
ψ(elevation)p(.)	2	216.39	1.6	0.11	1.49	0.152
ψ(exposure)p(.)	3	214.68	2.3	0.08	2.08	0.087
ψ(habitat)p(.)	3	214.73	2.4	0.08	1.79	0.105
ψ(distance)p(.)	2	217.96	3.2	0.05	1.46	0.130
ψ(elevation, exposure)p(.)	4	213.61	3.8	0.04	1.66	0.109
ψ(understory, exposure)p(.)	4	214.68	4.9	0.02	1.77	0.098
ψ(habitat, understory)p(.)	4	214.72	4.9	0.02	1.77	0.118
ψ(habitat, exposure)p(.)	5	214.54	7.5	0.01	1.96	0.091
ψ(global)p(.)	8	212.91	15.3	0.00	0.46	0.997



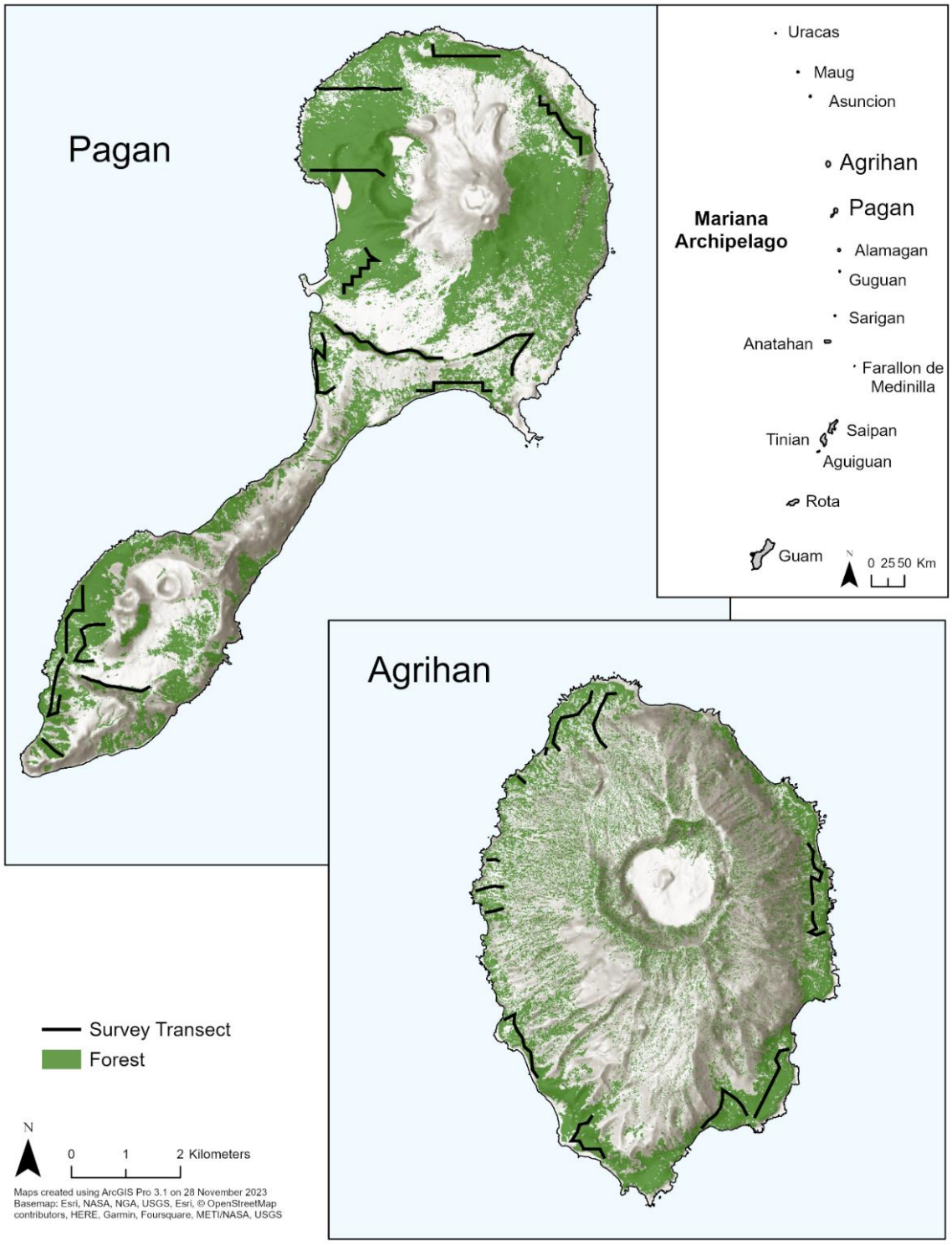
Supplementary Material 4a. Map of forested habitat cover and Micronesian Megapode survey areas on Tinian and Aguiguan in the Mariana Archipelago. Surveys were conducted between 13 and 18 August 2008 on Tinian and between 13 and 20 July 2009 on Aguiguan.



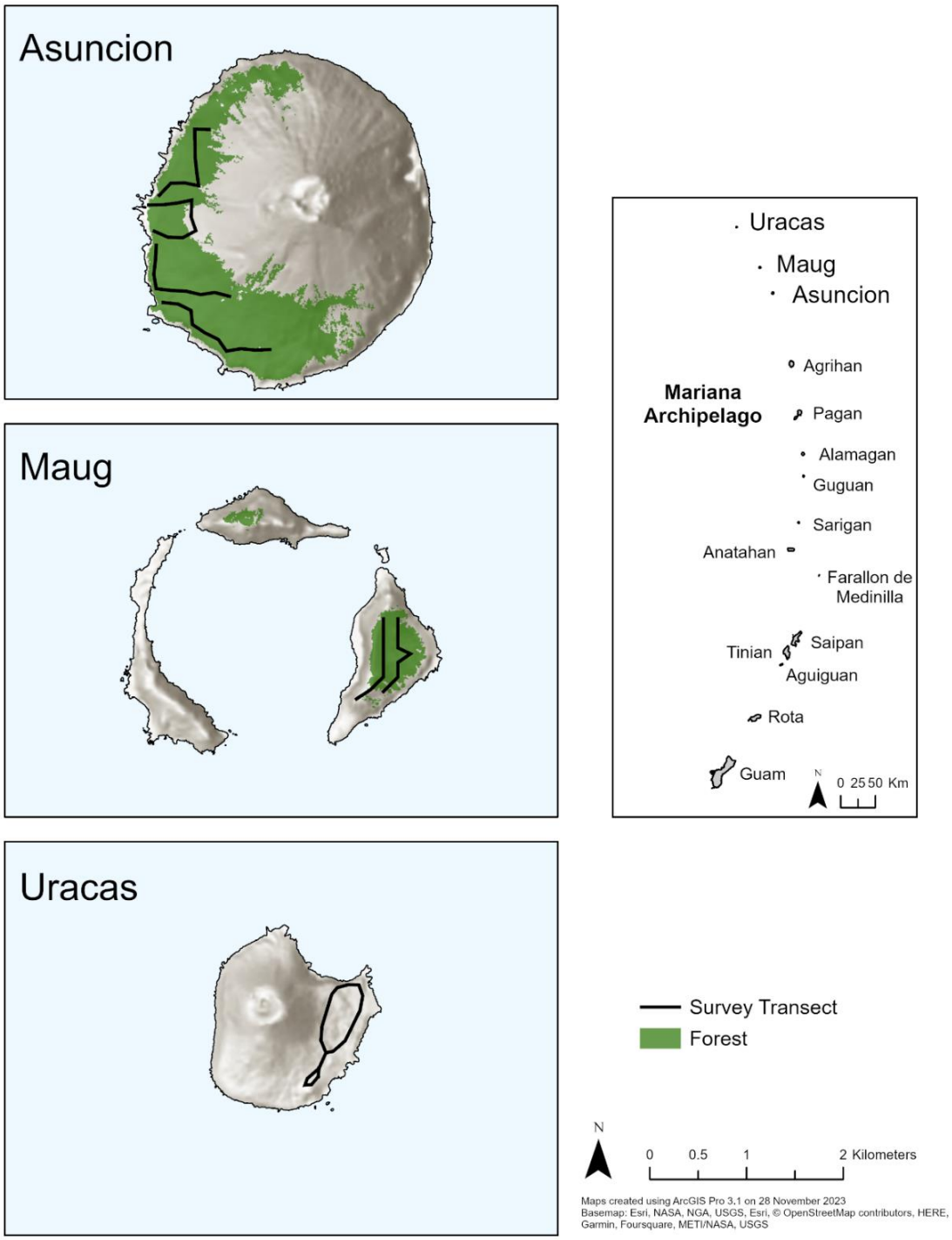
Supplementary Material 4b. Map of forested habitat cover and Micronesian Megapode survey areas on Saipan in the Mariana Archipelago where surveys were conducted between 29 January and 3 February 2010.



Supplementary Material 4c. Map of forested habitat cover and Micronesian Megapode survey areas on Anatahan, Sarigan, Guguan, and Alamagan in the Mariana Archipelago. Surveys were conducted between 18 May and 7 July 2010 on all islands except Anatahan, where they were completed between 7 and 9 December 2010.



Supplementary Material 4d. Map of forested habitat cover and Micronesian Megapode survey areas on Pagan and Agrihan in the Mariana Archipelago, where surveys were conducted between 18 May and 7 July 2010.



Supplementary Material 4e. Map of forested habitat cover and Micronesian Megapode survey areas on Asuncion, Maug and Uracas in the Mariana Archipelago, where surveys were conducted between 18 May and 7 July 2010.

Supplementary Material 5. Selection of models describing the relation of Micronesian Megapode occurrence to site and sampling covariates. Results for islands with high or low human presence are shown separately (panels *a* and *b*, respectively). Covariates are indicated in parentheses following the occupancy symbol "ψ" and detection probability symbol "*p*". Site covariates "veg", "understory", "canhgt", "cancov", and "time", refer to vegetation type, understory closure/openness, canopy height, and canopy cover, respectively. The sampling covariate "time" indicates the time of day (morning or afternoon) at which the observation was made. The term "global" refers to a model that includes all covariates. Column *k* is the number of model parameters; *L* is the -2*log likelihood; ΔAICc is the relative difference in AICc values from the model with the smallest value; *w* is the AICc model weight; ĉ is the estimated average over-dispersion parameter; and X^2 p-value is the probability of observing a X^2 greater than or equal to the test statistic based upon 999 parametric bootstraps. Where the global model has a ĉ < 1, calculation of QAICc is not necessary and ranking is performed on AICc. Shaded rows are top-ranked models for which occupancy estimates are provided in Table 4.

Panel *a*. Model results for islands with high human presence.

Model	*k*	*L*	ΔAICc	*w*	Ĉ	X^2 p-value
ψ(understory)*p*(.)	3	565.68	0.0	0.43	1.18	0.337
ψ(understory)*p*(time)	4	564.72	1.1	0.25	1.20	0.356
ψ(understory,veg)*p*(.)	6	562.19	2.7	0.11	1.15	0.337
ψ(veg)*p*(.)	5	564.49	2.9	0.10	0.92	0.465
ψ(understory,veg)*p*(time)	7	561.23	3.9	0.06	1.08	0.396
ψ(veg)*p*(time)	6	563.53	4.1	0.06	0.96	0.455
ψ(.)*p*(.)	2	577.93	10.2	0.00	1.16	0.366
ψ(.)*p*(time)	3	576.99	11.3	0.00	1.10	0.366
ψ(understory,canhgt)*p*(.)	4	1320.58	757.0	0.00	0.66	0.158
ψ(understory,canhgt)*p*(time)	5	1319.97	758.4	0.00	0.90	0.248
ψ(understory,cancov,canhgt)*p*(.)	5	1320.57	759.0	0.00	0.94	0.218
ψ(understory,cancov,canhgt)*p*(time)	6	1319.96	760.5	0.00	0.92	0.228
ψ(understory,cancov)*p*(.)	4	1326.33	762.7	0.00	1.18	0.287
ψ(canhgt)*p*(.)	3	1328.78	763.1	0.00	0.83	0.238
ψ(understory,cancov)*p*(time)	5	1325.72	764.2	0.00	0.84	0.257
ψ(canhgt)*p*(time)	4	1328.17	764.5	0.00	1.04	0.297
ψ(cancov,canhgt)*p*(.)	4	1328.22	764.6	0.00	0.88	0.257
ψ(global)*p*(.)	8	1320.22	765.0	0.00	0.71	0.178
ψ(cancov,canhgt)*p*(time)	5	1327.61	766.1	0.00	1.22	0.356
ψ(canhgt,veg)*p*(.)	6	1325.82	766.3	0.00	0.99	0.267
ψ(global)*p*(time)	9	1319.61	766.5	0.00	0.82	0.188
ψ(understory,cancov,veg)*p*(.)	7	1325.04	767.7	0.00	0.89	0.287
ψ(canhgt,veg)*p*(time)	7	1325.21	767.8	0.00	0.99	0.267
ψ(cancov,canhgt,veg)*p*(.)	7	1325.63	768.3	0.00	0.82	0.257
ψ(understory,cancov,veg)*p*(time)	8	1324.43	769.2	0.00	0.87	0.257
ψ(cancov,canhgt,veg)*p*(time)	8	1325.02	769.8	0.00	0.72	0.248
ψ(cancov,veg)*p*(.)	6	1334.49	775.0	0.00	0.85	0.347

Panel *a*. Model results for islands with high human presence.

Model	*k*	*L*	ΔAICc	*w*	$\hat{C}$	X^2 p-value
ψ(cancov,veg)*p*(time)	7	1333.89	776.5	0.00	0.72	0.347
ψ(cancov)*p*(.)	3	1346.64	781.0	0.00	0.80	0.406
ψ(cancov)*p*(time)	4	1346.04	782.4	0.00	0.86	0.465

Panel *b*. Model results for islands with low human presence.

Model	*k*	*L*	ΔAICc	*w*	$\hat{C}$	X^2 p-value
ψ(understory)*p*(.)	3	398.65	0.0	0.76	1.95	0.050
ψ(.)*p*(.)	2	398.65	3.1	0.16	1.90	0.059
ψ(canhgt)*p*(.)	3	398.65	6.7	0.03	1.89	0.079
ψ(understory,cancov)*p*(.)	4	398.65	8.2	0.01	1.90	0.069
ψ(cancov,veg)*p*(.)	4	398.65	8.3	0.01	1.89	0.069
ψ(understory,cancov,canhgt)*p*(time)	6	390.84	8.5	0.01	1.89	0.059
ψ(canhgt)*p*(time)	4	390.84	9.1	0.01	1.85	0.069
ψ(veg)*p*(time)	4	390.84	10.1	0.00	1.84	0.059
ψ(global)*p*(time)	7	390.84	10.7	0.00	1.90	0.069
ψ(cancov)*p*(.)	3	398.65	12.3	0.00	1.84	0.069
ψ(cancov)*p*(time)	4	390.84	14.4	0.00	1.80	0.099
ψ(veg)*p*(.)	3	398.65	16.5	0.00	1.81	0.099
ψ(understory,canhgt)*p*(.)	4	398.65	18.9	0.00	1.80	0.099
ψ(cancov,canhgt)*p*(.)	4	398.65	19.0	0.00	1.80	0.089
ψ(understory,canhgt)*p*(time)	5	390.84	21.3	0.00	1.77	0.069
ψ(understory,cancov,veg)*p*(time)	6	390.84	21.4	0.00	1.78	0.059
ψ(global)*p*(.)	6	398.65	22.2	0.00	1.81	0.040
ψ(understory,cancov,canhgt)*p*(.)	5	398.65	24.4	0.00	1.78	0.069
ψ(understory)*p*(time)	4	390.84	26.3	0.00	1.71	0.079
ψ(understory,cancov,veg)*p*(.)	5	398.65	27.9	0.00	1.75	0.129
ψ(canhgt,veg)*p*(time)	4	390.84	29.6	0.00	1.69	0.139
ψ(.)*p*(time)	3	390.84	30.4	0.00	1.67	0.119
ψ(cancov,veg)*p*(time)	5	390.84	41.6	0.00	1.62	0.109
ψ(understory,veg)*p*(time)	5	390.84	41.6	0.00	1.62	0.109
ψ(understory,cancov)*p*(time)	5	390.84	41.6	0.00	1.62	0.089
ψ(cancov,canhgt)*p*(time)	5	390.84	48.0	0.00	1.58	0.178
ψ(cancov,canhgt,veg)*p*(time)	6	390.84	54.1	0.00	1.55	0.129

Supplementary Material 6. Summary of Micronesian megapode occupancy (ψ) estimates and 95% confidence limits (lower and upper) for existing combinations of site covariate values. Estimates are presented only for islands with high human presence (occupancy for islands with low human presence is 1.0; that is, 100%). Results are shown only for the top-ranked subset of models as indicated by shading in Table 3. Results are sorted by ascending occupancy estimate within each model. Habitat variable "Understory" is ranked from 1 (closed/dense) to 5 (open/sparse) and "Vegetation" categories are coconut forest (CF) ironwood forest (IRON) secondary forest (including tangantangan forest; SF) and native forest (NF).

Panel *a*. Occupancy estimates for islands with high human presence.

Model	Ψ	95%CI lower	95%CI upper	Site Covariates	
ψ(understory)p(.)				Understory	
	0.04	0.01	0.13	5	
	0.08	0.04	0.17	4	
	0.14	0.09	0.21	3	
	0.23	0.18	0.30	2	
	0.36	0.26	0.48	1	
ψ(understory)p(time)				Understory	
	0.04	0.01	0.13	5	
	0.08	0.04	0.17	4	
	0.14	0.09	0.21	3	
	0.23	0.18	0.30	2	
	0.36	0.26	0.48	1	
ψ(understory,vegetation)p(.)				Understory	Vegetation
	0.05	0.01	0.16	5	CF
	0.06	0.01	0.23	5	IRON
	0.07	0.03	0.17	4	CF
	0.09	0.03	0.24	4	IRON
	0.10	0.04	0.20	3	CF
	0.12	0.04	0.28	3	IRON
	0.12	0.01	0.57	3	SF
	0.13	0.06	0.28	2	CF
	0.16	0.05	0.38	4	NF
	0.16	0.06	0.38	2	IRON
	0.18	0.06	0.43	1	CF
	0.21	0.11	0.36	3	NF
	0.22	0.03	0.73	1	SF
	0.28	0.20	0.37	2	NF
	0.36	0.25	0.48	1	NF
ψ(vegetation)p(.)					Vegetation
	0.10	0.04	0.20		CF
	0.12	0.05	0.29		IRON
	0.17	0.02	0.64		SF

Panel *a*. Occupancy estimates for islands with high human presence.

Model	Ψ	95%CI lower	95%CI upper	Site Covariates	
	0.30	0.23	0.39		NF
ψ(understory,vegetation)p(time)				Understory	Vegetation
	0.05	0.01	0.16	5	CF
	0.06	0.01	0.23	5	IRON
	0.07	0.03	0.17	4	CF
	0.09	0.03	0.24	4	IRON
	0.09	0.04	0.20	3	CF
	0.12	0.04	0.28	3	IRON
	0.12	0.01	0.57	3	SF
	0.13	0.06	0.28	2	CF
	0.16	0.05	0.38	4	NF
	0.16	0.06	0.38	2	IRON
	0.18	0.06	0.43	1	CF
	0.21	0.11	0.36	3	NF
	0.22	0.03	0.73	1	SF
	0.28	0.20	0.37	2	NF
	0.36	0.25	0.48	1	NF

Panel *b*. Occupancy estimates for Aguiguan

Model	ψ	95%CI lower	95%CI upper	Understory	Elevation
ψ(.)p(.)	0.69	0.45	0.86	-	-
ψ(understory)p(.)	0.58	0.35	0.78	1	
	0.65	0.23	0.92	2	
	0.72	0.14	0.98	3	
	0.78	0.08	0.99	4	
	0.83	0.04	1.00	5	
ψ(understory, elevation)p(.)	0.54	0.04	0.97	2	40
	0.57	0.07	0.96	2	50
	0.60	0.10	0.95	2	60
	0.62	0.02	0.99	3	40
	0.62	0.15	0.94	2	70
	0.65	0.22	0.93	2	80
	0.66	0.01	1.00	4	30
	0.68	0.20	0.95	2	90
	0.69	0.01	1.00	4	40
	0.70	0.09	0.98	3	70
	0.70	0.16	0.97	2	100
	0.72	0.13	0.98	3	80
	0.73	0.14	0.98	1	140
	0.75	0.11	0.99	2	120
	0.77	0.10	0.99	2	130
	0.78	0.09	0.99	1	160
	0.79	0.08	0.99	2	140
	0.80	0.07	1.00	4	90

Panel *b*. Occupancy estimates for Aguiguan

Model	ψ	95%CI lower	95%CI upper	Understory	Elevation
	0.84	0.04	1.00	3	140
	0.93	0.01	1.00	5	160
ψ(elevation)p(.)	0.35	0.09	0.74		30
	0.38	0.14	0.70		40
	0.41	0.20	0.66		50
	0.44	0.28	0.61		60
	0.47	0.38	0.56		70
	0.50	0.49	0.51		80
	0.53	0.45	0.60		90
	0.55	0.40	0.70		100
	0.61	0.31	0.85		120
	0.64	0.27	0.90		130
	0.67	0.23	0.93		140
	0.72	0.16	0.97		160

Supplementary Material 7. Detection probability (DP), in percent, of detecting one Micronesian Megapode from a population of *n* birds randomly distributed across the known range of the species on Uracas, CNMI, and the minimum number of survey visits (*Nmin*) to obtain 95% and 99% DP.

Population (n)	DP (%)	*Nmin*	
		DP = 95%	DP = 99%
20	99%	0.7	1.1
18	98%	0.8	1.2
16	97%	0.9	1.3
14	95%	1.0	1.5
12	92%	1.2	1.8
10	88%	1.4	2.1
8	82%	1.7	2.7
6	72%	2.3	3.6
4	58%	3.5	5.4
2	35%	7.0	10.7
1	19%	13.9	21.4