Using mixed methods to understand sensitive wildlife poisoning behaviours in northern Cambodia

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SUPPLEMENTARY MATERIAL 2 Additional details on other forms of pesticide misuses and hunting.

Hunting

168 respondents (36%) stated that they hunted wildlife in the past year. The most common method of hunting was using traps (56% of 168 hunters), followed by slingshots (12%). Twenty-four (1%) hunters used nets and 23 (1%) used dogs. Finally, four hunters stated that they used cross bows, and three hunters stated that they used guns to hunt, but this may refer to the homemade air guns commonly found. Most hunters used a single method, but 44 (26%) reported using a combination of methods. Younger respondents were more likely to hunt (effect = -0.04, $z = -4.19$, $p < 0.01$, Supplementary Table 3), but no effect was found for wealth or other variables.

Agricultural pesticide usage

Pesticides were reported as used in all villages except one. Overall, 15% of households surveyed stated in response to a direct question that they had used pesticides in the past year, but this varied by village between 0 and 47% (median 8%). Interviews with village chiefs and FGD data suggest that usage varies from year to year and usually occurs in response to observations of pests on crops intended for commercial sale, but not on rice grown for home consumption. According to informants, irregularly occurring 'worm' (ដង្កូវ) outbreaks are a major driver of usage, but this did not occur in the year of our study. These 'worms' are in fact a kind of caterpillar which occurs seasonally. Pesticides are also mixed with water in the wet rice paddy to kill crabs which may then be consumed.

Twenty-one different pesticide products were identified by respondents as used for these purposes. Farmers typically report learning how to use pesticides from sellers at local markets when seeking advice on pest management, or from agricultural middlemen. We found no relation between respondent age and pesticide use, but wealthier households were more likely to use pesticides (effect size = 0.25, $z = 2.06$, $p = 0.04$, Supplementary Table 3). 'Termite poisons' are also used to prevent termite damage by soaking the roots of cassava or cashew crops before planting.

Rice field poisoning

In addition to waterhole poisoning, several other practices make use of poisons or pesticides to kill wildlife. Firstly, following a traditional method, poison produced from tree bark is placed in a water source to stun fish. This is a common method but is not believed to be harmful to wildlife due to the weak effect of the poison. Secondly, poisons are sprayed on fruit trees to kill birds, but this was only reported in one village. Third, granular-form pesticides are mixed or boiled with rice and scattered in the rice field to kill birds that eat the rice crop. Poisoning at rice fields was thought by respondents across all types of questioning to affect only doves, parakeets, and sparrows. This was reported in six villages, and we

included this practice in our UCT questionnaire. The proportion of respondents allocated the treatment and control cards in this round did not differ significantly from 1:1 ($\chi^2 = 2.1$, df = 1, p = 0.15). The UCT results indicated that the proportion of households engaging in rice-field poisoning across 10 villages was not significantly different from zero with no design effect (p = 0.42, Supplementary Table 1). However, 4 respondents (1.7%) gave a maximal response for rice-field poisoning and when questioned directly, 10 respondents (2.2%) admitted to poisoning rice fields in the past year,

SUPPLEMENTARY TABLE 1 Summary of prevalence estimates for different behaviours using the Unmatched Count Technique, a method used to estimate prevalence of sensitive behaviours. This includes the results for the practice round which focused on fruit eating, and direct questioning estimates for poisoning practices. A significant design effect indicates sensitivity of the practice.

Behaviour	**Practice: fruit eating**	**Poisoning in rice field**	**Poisoning at waterholes**
Size of treatment group (total = 462)	221	241	254
Estimate % ± SE (p)	32% ± 14 (0.02)	-10% ± 12 (0.40)	-40% ± 12 (<0.001)
Design effect (p value)	0.67	0.42	**<0.01**
No. of maximal responses in treatment group (%)	22 (10.0 %)	4 (1.7 %)	6 (2.4 %)
Positive responses to direct question	NA	10 (2.2%)	6 (1.3%)

SUPPLEMENTARY TABLE 2 Poisoned wildlife observed by informants, showing the number of informants who have observed the species poisoned.

Wildlife Species	**IUCN Redlist status**	**No. of Reports**
"Egrets"		13
"Doves"		11
"Parakeet"		9
"Civets"		5
"Doves"		3
Red junglefowl *Gallus gallus*	Least concern	3
Black-winged kite *Elanus caeruleus*		3
Green imperial pigeon *Ducula aenea*	Least concern	3
Sarus crane *Antigone antigone*	Vulnerable	2
"Sparrows"		2
Chinese francolin *Francolinus pintadeanus*	Least concern	3
Giant ibis *Thaumatibis gigantea*	Critically endangered	2
Wild boar *Sus scrofa*	Least concern	1
"Monkeys"		1
"Cobras"		1
Lesser Mouse deer *Tragulus kanchil*	Least concern	1
"Storks"		1
Green peafowl *Pavo muticus*	Endangered	1
Lesser adjutant *Leptoptilos javanicus*	Vulnerable	1
"Eagles"		1
"Snakes"		1
"Drongo"		1

SUPPLEMENTARY TABLE 3 Fixed effect coefficients from linear mixed models. Effect size estimates are given relative to the intercept. Bolded variables have effect sizes larger than two times the standard error, or for generalised models have a p-value less than 0.05.

Model	Descriptive norms Linear mixed model					Injunctive norms Linear mixed model					Combined norms Linear mixed model				
Variable/Coefficient	Estimate	Std. Error	T-value	95% C.I. lower bound	95% C.I. upper bound	Estimate	Std. Error	T-value	95% C.I. lower bound	95% C.I. upper bound	Estimate	Std. Error	T-value	95% C.I. lower bound	95% C.I. upper bound
Intercept	3.878	0.335	11.57	3.223	4.508	4.612	0.320	14.41	3.995	5.229	8.478	0.514	16.49	7.477	9.479
Age (Years / SD)	-0.052	0.081	-0.649	-0.210	0.103	**-0.231**	**0.077**	**-2.978**	**-0.380**	**-0.079**	**-0.283**	**0.125**	**-2.261**	**-0.527**	**-0.039**
Agricultural Pesticide use	0.093	0.202	0.461	-0.300	0.481	**-0.258**	**0.194**	**-1.330**	**-0.641**	**0.109**	-0.175	0.313	-0.560	-0.784	0.433
Residence time (years / SD)	-0.042	0.082	-0.509	-0.199	0.118	-0.010	0.079	-0.123	-0.165	0.139	-0.053	0.127	-0.420	-0.300	0.193
Native Intervention village	0.136	0.162	0.836	-0.153	0.424	**-0.484**	**0.151**	**-3.199**	**-0.766**	**-0.205**	**-0.346**	**0.231**	**-1.500**	**-0.796**	**0.103**
VMN member	-0.164	0.176	-0.933	-0.496	0.184	-0.016	0.168	-0.092	-0.339	0.314	-0.169	0.272	-0.620	-0.698	0.361
Wealth score	**0.150**	**0.060**	**2.526**	**0.039**	**0.270**	-0.035	0.057	-0.621	-0.145	0.076	**0.121**	**0.092**	**1.310**	**-0.059**	**0.300**
Protected area (Kulen Promtep)	**-1.129**	**0.167**	**-6.752**	**-1.433**	**-0.828**	**-0.756**	**0.157**	**-4.822**	**-1.051**	**-0.470**	**-1.891**	**0.242**	**-7.819**	**-2.362**	**-1.420**

Model	Attitudes Linear mixed model					Pesticide usage Generalised linear mixed model				Hunting Generalised linear mixed model			
Variable/Coefficient	Estimate	Std. Error	T-value	95% C.I. lower bound	95% C.I. upper bound	Estimate	Std. Error	z-value	P-value	Estimate	Std. Error	z-value	P-value
Intercept	4.083	0.381	10.71	3.401	4.837	-2.673	0.865	-3.091	0.002	0.758	0.484	1.566	0.117
Age (Years / SD)	**-0.121**	**0.088**	**-1.379**	**-0.317**	**0.036**	0.322	0.168	1.924	0.054	**-0.522**	**0.128**	**-4.068**	**<0.001**
Agricultural Pesticide use	**0.394**	**0.222**	**1.773**	**-0.048**	**0.782**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Residence time (years / SD)	0.052	0.090	0.581	-0.084	0.251	-0.218	0.177	-1.234	0.217	0.176	0.126	1.397	0.1624
Native Intervention village	**-0.294**	**0.229**	**-1.284**	**-0.619**	**-0.009**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
VMN member	-0.010	0.191	-0.052	-0.397	0.322	**-1.132**	**0.477**	**-2.372**	**0.018**	-0.367	0.264	-1.392	0.164
Wealth score	**-0.216**	**0.065**	**-3.335**	**-0.337**	**-0.093**	0.250	0.138	1.816	0.069	0.057	0.088	0.654	0.513
Protected area (Kulen Promtep)	-0.114	0.227	-0.502	-0.433	0.206	**-1.400**	**0.658**	**-2.127**	**0.033**	-0.322	0.218	-1.478	0.139

SUPPLEMENTARY TABLE 4 Fixed effect coefficients from Cumulative Linked logistic mixed models for perceived behavioural control. Bold indicates an effect size greater than the two times standard error, or a p-value below 0.05.

MODEL:	PERCEIVED BEHAVIOURAL CONTROL 1: EFFECTIVE CUMULATIVE LINKED (LOGIT) MIXED MODEL				PERCEIVED BEHAVIOURAL CONTROL 2: EASY CUMULATIVE LINKED (LOGIT) MIXED MODEL			
VARIABLES/COEFFICIENTS	ESTIMATE	STD. ERROR	Z VALUE	P VALUE	ESTIMATE	STD. ERROR	Z VALUE	P VALUE
Age (Years / SD)	-0.166	0.109	-1.524	0.128	**-0.289**	**0.108**	**-2.674**	**0.008**
Agricultural Pesticide use	**0.609**	**0.281**	**2.170**	**0.030**	**0.817**	**0.253**	**3.233**	**0.001**
Residence time (Years / SD)	0.013	0.112	0.116	0.908	-0.141	0.111	-1.262	0.207
VMN member	0.091	0.247	0.366	0.714	**0.519**	**0.231**	**2.244**	**0.025**
Wealth score	-0.025	0.081	-0.306	0.760	0.113	0.080	1.402	0.161
Protected Area (Kulen Promtep)	**1.634**	**0.501**	**3.258**	**0.001**	-0.130	0.211	-0.617	0.537
Class membership: 1|2	**-1.299**	**0.569**	**-2.284**	**0.022**	-0.510	0.438	-1.164	0.244
Class membership: 2|3	-0.722	0.564	-1.279	0.201	0.136	0.437	0.312	0.755
Class membership: 3|4	-0.224	0.563	-0.397	0.691	0.801	0.439	1.824	0.068
Class membership: 4|5	**1.158**	**0.567**	**2.041**	**0.041**	**1.537**	**0.448**	**3.433**	**0.001**

SUPPLEMENTARY TABLE 5 Random effect coefficients for models of attitudes, perceived norms, and perceived behavioural control. Bold indicates a value greater than two times the standard error or deviation. S.D. = standard deviation, S.E. = standard error.

MODEL:	COMBINED NORMS LINEAR MIXED EFFECT MODEL		DESCRIPTIVE NORMS LINEAR MIXED EFFECT MODEL		INJUNCTIVE NORMS LINEAR MIXED EFFECT MODEL		ATTITUDES LINEAR MIXED EFFECT MODEL		PERCEIVED BEHAVIOURAL CONTROL 1: EFFECTIVE CUMULATIVE LINKED (LOGIT) MIXED MODEL		PERCEIVED BEHAVIOURAL CONTROL 2: EASY CUMULATIVE LINKED (LOGIT) MIXED MODEL	
VARIABLES/COEFFICIENTS	VALUE	S.D.	VALUE	S.D.	VALUE	S.D.	VALUE	S.D.	VALUE	S.E.	VALUE	S.E.
Village 1	0.000	0.000	-0.001	0.084	-0.014	0.068	0.114	0.152	**-0.575**	**0.061**	**-0.055**	**0.009**
Village 2	0.000	0.000	0.014	0.087	0.020	0.069	0.283	0.169	0.092	0.092	**0.025**	**0.009**
Village 3	0.000	0.000	-0.008	0.087	0.009	0.069	0.040	0.169	-0.087	0.081	0.0002	0.010
Village 4	0.000	0.000	0.054	0.084	0.0003	0.068	0.017	0.153	**1.191**	**0.076**	**0.041**	**0.010**
Village 5	0.000	0.000	-0.037	0.087	0.038	0.069	-0.164	0.171	-0.062	0.068	**0.021**	**0.009**
Village 6	0.000	0.000	-0.046	0.086	-0.009	0.068	-0.058	0.160	**-1.252**	**0.070**	**-0.062**	**0.010**
Village 7	0.000	0.000	0.038	0.084	0.011	0.068	0.097	0.152	**-0.400**	**0.051**	**-0.034**	**0.009**
Village 8	0.000	0.000	-0.033	0.089	0.0002	0.070	-0.128	0.181	**0.572**	**0.054**	**0.031**	**0.010**
Village 9	0.000	0.000	0.017	0.087	-0.035	0.069	-0.192	0.167	**0.593**	**0.060**	**0.037**	**0.010**
Village 10	0.000	0.000	0.003	0.087	-0.020	0.069	-0.010	0.166	-0.112	0.075	-0.002	0.010