Supplement 1. Figures

Supplement Figure 1. Map of Ngorongoro and Serengeti Districts

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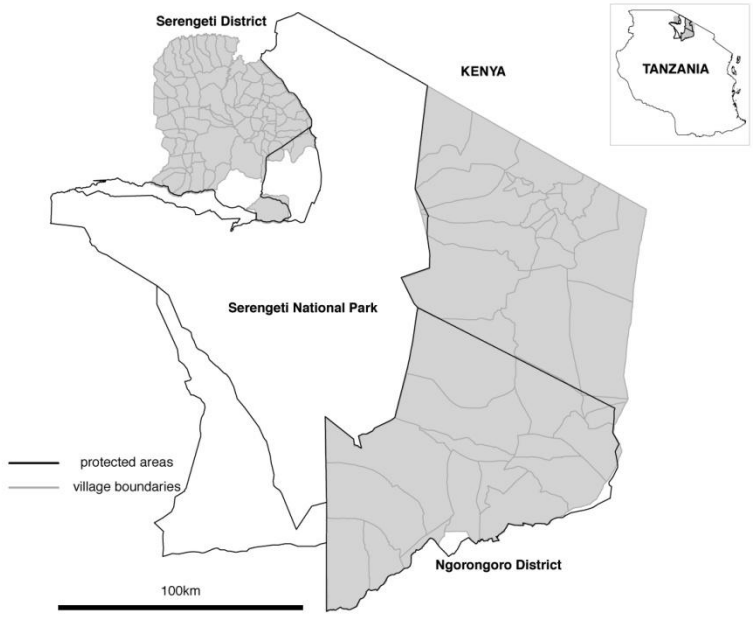
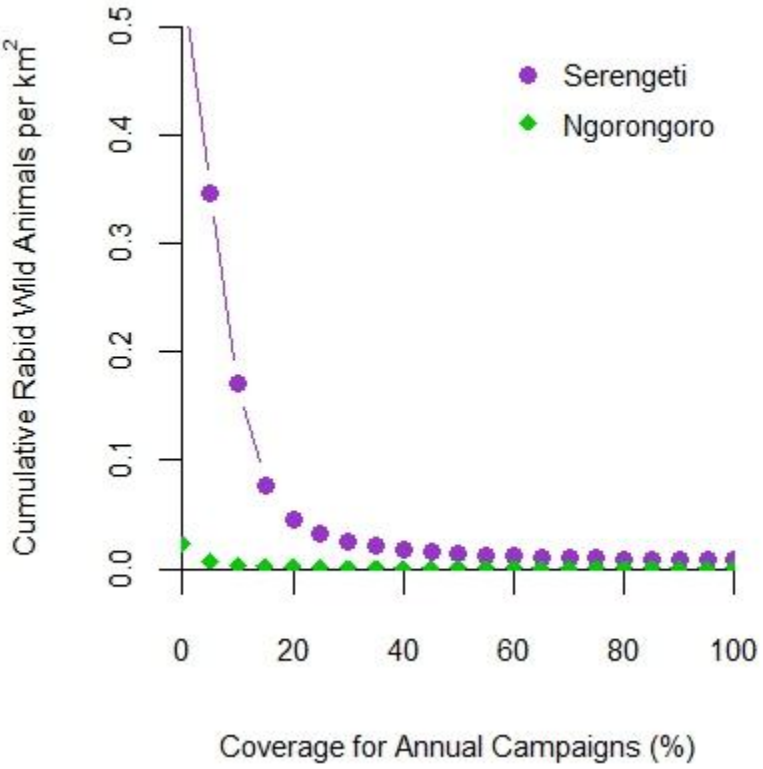
Supplement Figure 6. Sensitivity of strategy choice to cost and availability of post-exposure prophylaxis (PEP)

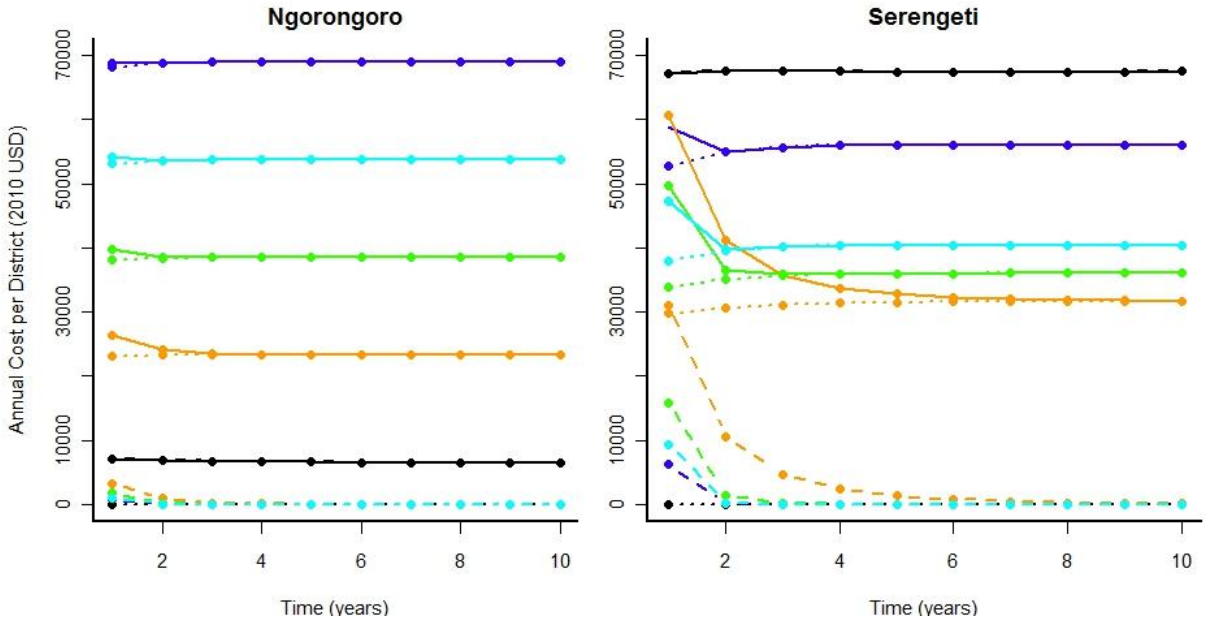
Supplement Figure 1. Map of Ngorongoro and Serengeti Districts. Black lines correspond to the boundaries of protected areas, and gray lines correspond to the administrative boundaries of villages in the two districts.



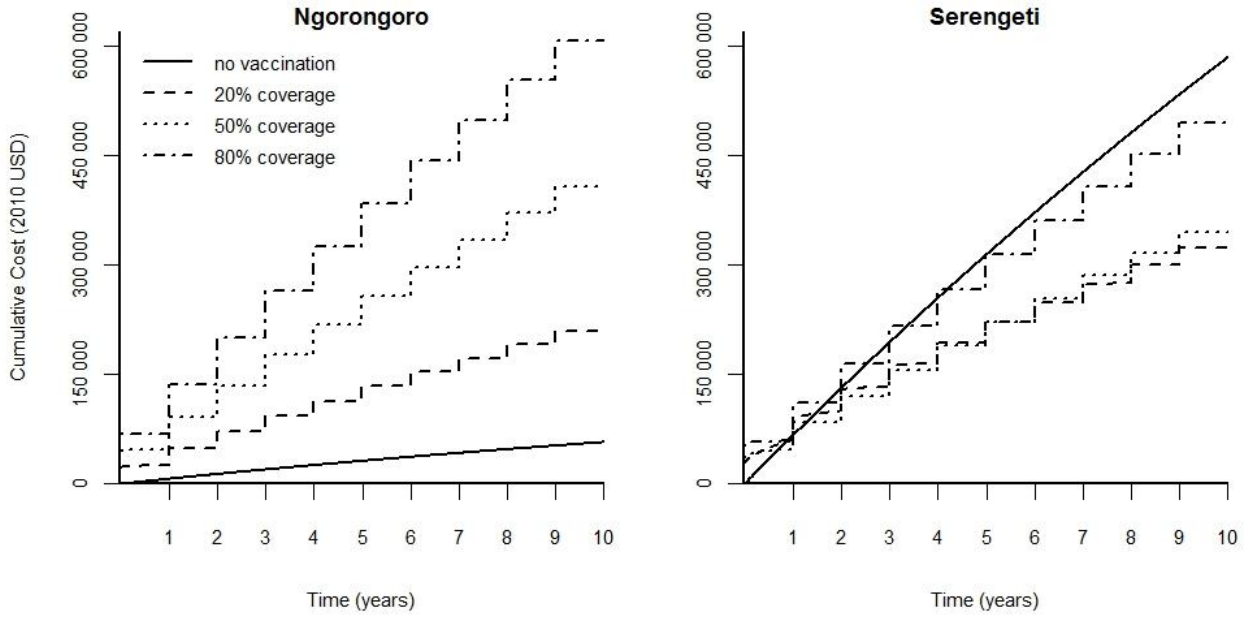
Supplement Figure 2. Rabies cases in wildlife. Cases are cumulative over ten years and undiscounted.



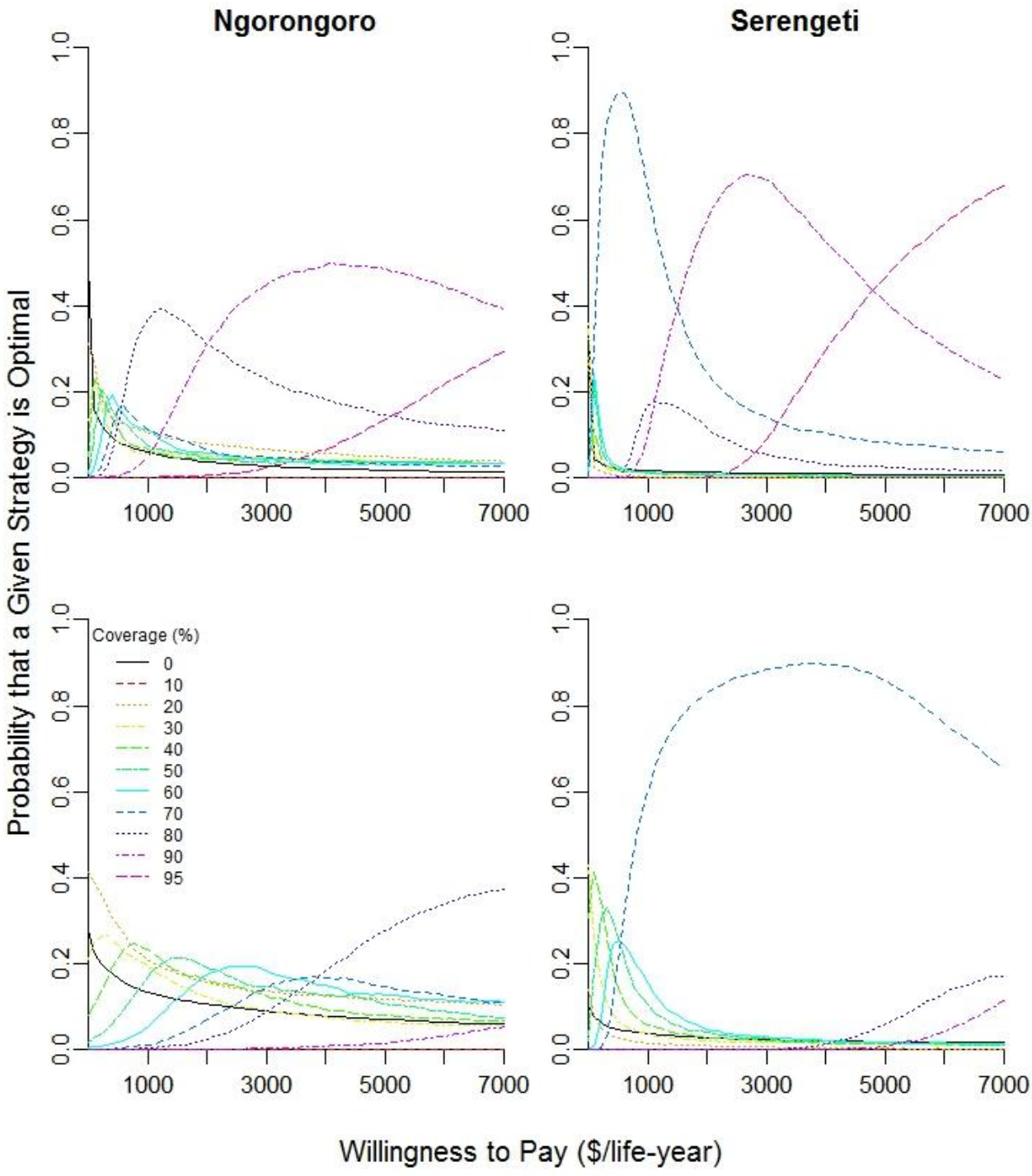
Supplement Figure 3. Annual costs per district of rabies prevention at various levels of coverage. Costs are annual and undiscounted. Dashed lines indicate post-exposure prophylaxis costs; dotted lines, canine vaccination costs; solid lines, total costs. Black indicates 0% vaccination coverage; orange, 20% coverage; green, 40% coverage; turquoise, 60% coverage; blue, 80% coverage.



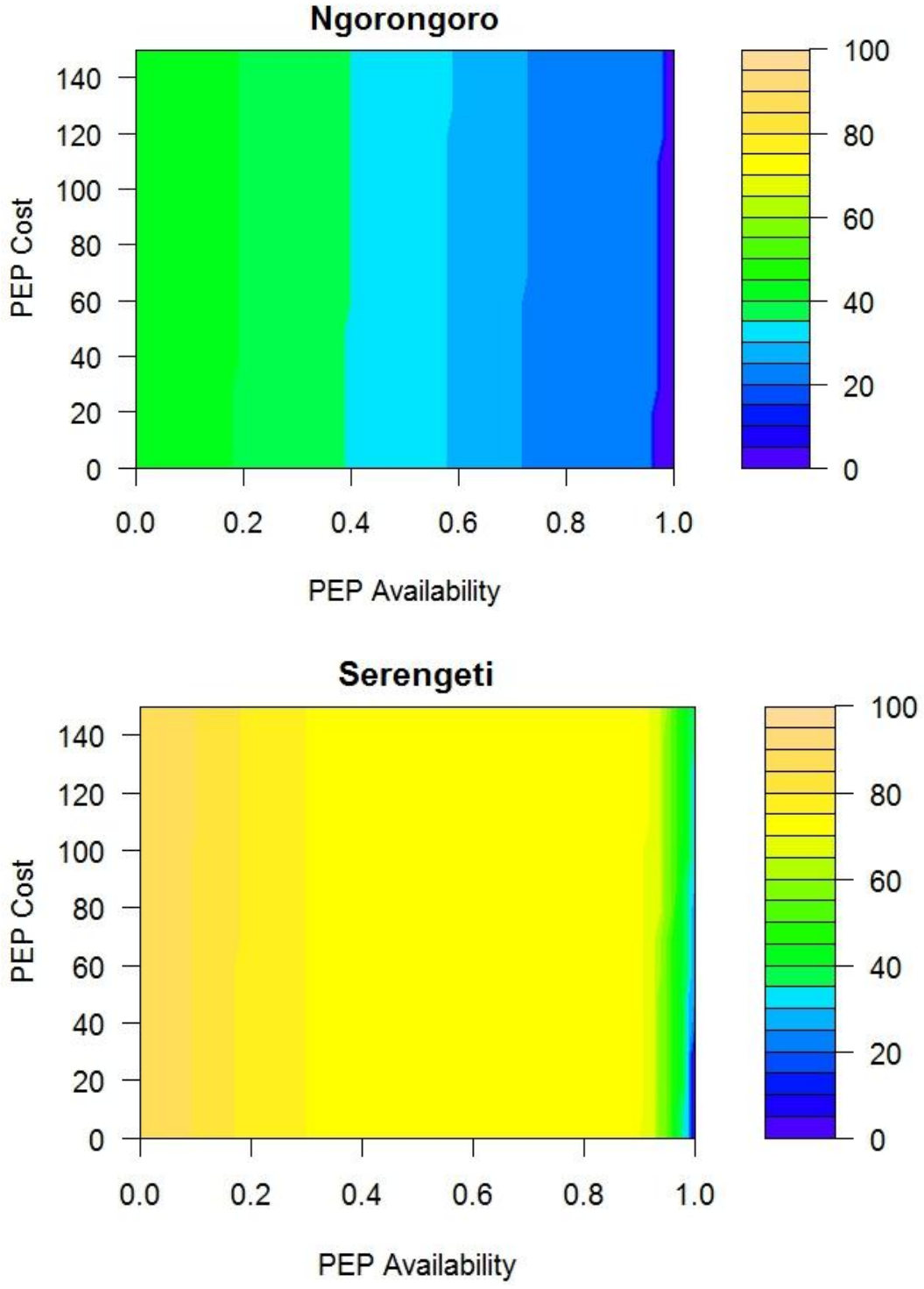
Supplement Figure 4. Timeline of cost. The monetary expenditure over time of no vaccination is compared with 20%, 40%, 60%, and 80% canine vaccination coverage. Costs are discounted and cumulative. In Ngorongoro District, vaccination is always more expensive than post-exposure prophylaxis (PEP) alone. In Serengeti District, even relatively high coverage (80%) breaks even with PEP-only strategy by end of the first year.



Supplement Figure 5. Sensitivity of strategy choice to post-exposure prophylaxis (PEP) availability. Curves represent the probability that a strategy will provide most net benefit for a given willingness-to-pay threshold, subject to PEP availability (top, available for 30% of rabid bite victims; below, for 90% of victims).



Supplement Figure 6. Sensitivity of strategy choice to cost and availability of post-exposure prophylaxis (PEP). The color of a region indicates the optimal strategy (*i.e.*, the canine vaccination coverage level that provides the largest net benefit) for a given combination of PEP cost and availability. The color scale corresponds to increasing levels of vaccination coverage from zero to 95% in increments of 5%. The willingness-to-pay threshold is set to $1430/life-year.



Supplement 2. Tables

Supplement Table 1: Transmission Model Equations

Supplement Table 2: Parameters for Transmission Model, Cost, and Decision Model

Supplement Table 3: Model Sensitivity to Variation in Wildlife Density

Supplement Table 4: Estimates of Rabies Epidemiological Parameters

Supplement Table 5: Costs, Benefits, and ICERs for Control Strategies When Canine Removal Is Not Practiced

Supplement Table 6: Comparative Cost of Revaccination

Supplement Table 1: Transmission Model Equations

$dS_d/dt = b_d*(S_d + V_d) - \mu_d*S_d - \gamma_d*S_d*N_d - \beta_{11}*I_d*S_d - \beta_{12}*I_w*S_d$ **$- (\nu*N_d - V_d)$**

$dE_d/dt = \beta_{11}*I_d* S_d + \beta_{12}*I_w* S_d - \mu_d*E_d - \gamma*E_d*N_d - \sigma*E_d$

$dI_d/dt = \sigma*E_d - \mu_d *I_d - \gamma*I_d*N_d - \alpha*I_d$

$dV_d/dt =$ **$(\nu*N_d - V_d)$** $- \mu_d *V_d - \gamma*V_d*N_d$

$dS_w/dt = (b_w-\mu_w)* S_w - \gamma_w*S_w*N_w - \beta_{22}*I_w*S_w - \beta_{21}*I_d*S_w$

$dE_w/dt = \beta_{22}*I_w*S_w + \beta_{21}*I_d*S_w - \mu_w*E_w - \gamma*E_w*N_w - \sigma*E_w$

$dI_w/dt = \sigma*E_w - \mu_w*I_w - \gamma*I_w*N_w - \alpha*I_w$

$N_d = S_d + E_d + I_d + V_d$

$N_w = S_w + E_w + I_w$

Blue portions are active only during vaccination campaigns.

Supplement Table 2: Parameters for Transmission Model, Cost, and Decision Model

Parameter	Description	Estimate	Distribution	Reference
Transmission Model Parameters				
b_d	Birth rate (domestic dogs)	1.72/year	normal (1.72, 0.11)	(18)
μ_d	Death rate (adult dogs)	.45/year	normal (0.45, 0.02)	(18)
b_w, μ_w	Birth/death rate (wildlife)	same as for dogs	same as for dogs	
$K_{d,N}$	Carrying capacity (Ngorongoro, dogs)	1.5		(18)
$K_{d,S}$	Carrying capacity (Serengeti, dogs)	10		(18)
$K_{w,N}$	Carrying capacity (Ngorongoro, wildlife)	4.5		Field data
$K_{w,S}$	Carrying capacity (Serengeti, wildlife)	3.0		Field data
γ	Death from carrying capacity limits	$(b\text{-}\mu)$/K		
$1/\sigma$	Incubation period of rabies	22.3 days	normal (22.3, 1.28)	(18)
$1/\alpha$	Infectious period of rabies	3.1 days	normal (3.10, 0.13)	(18)
v	Vaccination coverage	varies	0 – 1	
$\beta_{11,N}$	Dog to dog transmission (Ngorongoro)	0.20	tnorm[1] (0.20, 0.020)	(10)
$\beta_{12,N}$	Wildlife to dog transmission (Ngorongoro)	0.11	tnorm[1] (0.11, 0.035)	(10)
$\beta_{21,N}$	Dog to wildlife transmission (Ngorongoro)	0.01	tnorm[1] (0.01, 0.002)	(10)
$\beta_{22,N}$	Wildlife to wildlife transmission (Ngorongoro)	0.03	tnorm[1] (0.03, 0.009)	(10)
$\beta_{11,S}$	Dog to dog transmission (Serengeti)	0.03	tnorm[1] (0.03, 0.001)	(10)
$\beta_{12,S}$	Wildlife to dog transmission (Serengeti)	0.03	tnorm[1] (0.03, 0.004)	(10)
$\beta_{21,S}$	Dog to wildlife transmission (Serengeti)	0.01	tnorm[1] (0.01, 0.001)	(10)
$\beta_{22,S}$	Wildlife to wildlife transmission (Serengeti)	0.02	tnorm[1] (0.02, 0.006)	(10)
Cost Parameters				
	Dog vaccination, Ngorongoro, per dog	$4.07	uniform (3.41 – 4.77)	(19)
	Dog vaccination, Serengeti, per dog	$2.05	uniform (1.00 – 3.19)	(19)
	PEP[2] administration, per regimen	$111.29		(25)
	Life-year cost per human case	31.426		(2)
Decision Tree Parameters				
P1	Number of humans bitten by a single rabid dog	.51		Field data
P2	That a bite victim of a rabid dog goes to the hospital (.76) and receives PEP[2] (.86)	.65		(25)
P3	That a bite victim of a rabid dog who does not seek PEP[2] will contract rabies	.19		(25)
	PEP[2] cost per bite (P1*P2*$111.29)	$36.89		
	Human rabies health burden per bite (P1*(1-P2)*P3*31.426 life-years)	1.07 life-years		

Estimates were used for the base-case analysis, and the full distribution was sampled for the uncertainty analysis.

[1] Truncated normal distribution
[2] Post-exposure prophylaxis

Supplement Table 3: Model Sensitivity to Variation in Wildlife Density

Vaccination Coverage (%)		$K_w = 3$	$K_w = 4.5$	$K_w = 6$
30	Life-years saved per km^2	0.113	0.113	0.113
60		0.116	0.116	0.116
90		0.117	0.117	0.117
30	Cost per km^2	$19.51	$19.51	$19.51
60		$33.68	$33.68	$33.68
90		$52.11	$52.11	$52.11

Health and economic outcomes associated with varying wildlife density are listed for Ngorongoro. K_w indicates the carrying capacity of wild carnivores (per km^2). For central-point implementation, $K_w = 4.5$ carnivores per km^2. Health and economic outcomes are cumulative over ten years and discounted at 3% annually.

Supplement Table 4: Estimates of Rabies Epidemiological Parameters

	Description		Ngorongoro District		Serengeti District	
	1° Infection	2° Infection	w/o removal	w/ removal	w/o removal	w/removal
k_{11}	dog	dog	1.16 (0.85 – 1.54)	0.92 (0.75 – 1.11)	1.09 (0.98 – 1.21)	1.01 (0.94 – 1.07)
k_{21}	dog	other	0.13 (0.05 – 0.27)	0.12 (0.07 – 0.19)	0.09 (0.06 – 0.13)	0.09 (0.07 – 0.11)
k_{12}	other	dog	0.49 (0.23 – 0.84)	0.48 (0.23 – 0.86)	0.95 (0.71 – 1.21)	0.95 (0.71 – 1.20)
k_{22}	other	other	0.39 (0.20 – 0.67)	0.39 (0.19 – 0.67)	0.23 (0.13 – 0.35)	0.23 (0.12 – 0.35)
R_0	basic reproduction number		1.24	1.02	1.18	1.11

The parameter k_{ij} indicates the number of animals of type i that a single rabid animal of type j is likely to infect. Values are reported both for the scenario in which rabid dogs are killed or restrained ("w/ removal") and for that in which they are not ("w/o removal"). The 95% confidence interval is given in parentheses. We previously reported estimates of transmission parameters for the scenario without rabid canine removal (10).

Supplement Table 5: Costs, Benefits, and ICERs for Control Strategies When Canine Removal Is Not Practiced

	Ngorongoro District			Serengeti District		
Vaccination Coverage (%)	Total Cost ($/km^2)	Life-years saved	ICER[1] ($/life-year)	Total Cost ($/km^2)	Life-years saved	ICER[1] ($/life-year)
0	*61.87*	*0.000*	*dominated*	*240.02*	*0.000*	*dominated*
5	*64.65*	*0.182*	*dominated*	*246.09*	*1.440*	*dominated*
10	*58.32*	*0.381*	*dominated*	*198.05*	*2.929*	*dominated*
15	*51.44*	*0.596*	*dominated*	*151.45*	*4.376*	*dominated*
20	*44.12*	*0.824*	*dominated*	*115.72*	*5.499*	*dominated*
25	*37.87*	*1.063*	*dominated*	*97.34*	*6.111*	*dominated*
30	*31.25*	*1.316*	*dominated*	*90.09*	*6.393*	*dominated*
35	*25.09*	*1.556*	*dominated*	*87.59*	*6.539*	*dominated*
40	22.69	1.683	minimum cost	86.87	6.628	minimum cost
45	23.27	1.722	14.84	87.28	6.688	6.76
50	24.65	1.738	86.63	88.10	6.732	18.67
55	26.21	1.748	163.26	89.17	6.766	31.99
60	27.86	1.754	243.12	90.69	6.792	58.15
65	29.56	1.760	332.10	92.01	6.813	62.33
70	31.33	1.764	435.01	93.66	6.830	96.20
75	33.07	1.767	532.34	107.51	6.844	972.03
80	34.88	1.770	666.88	121.37	6.856	1158.79
85	36.67	1.772	787.46	134.40	6.867	1284.46
90	41.80	1.774	2654.69	146.93	6.875	1439.37
95	52.11	1.776	6201.99	178.88	6.883	4247.69

Costs are in 2010 USD, and both costs and life-years saved are cumulative over ten years and discounted to present-value terms with a 3% discount rate. Dominated strategies, which are italicized, are those which are more expensive and which provide less benefit than another strategy or combination of strategies.

[1] Incremental Cost-Effectiveness Ratio

Supplement Table 6: Comparative Cost of Revaccination

	Ngorongoro		Serengeti	
	standard	no repeat vaccination	standard	no repeat vaccination
30%	$19.32	$16.24	$86.97	$72.97
60%	$33.61	$28.24	$104.31	$87.57
90%	$52.07	$43.75	$176.86	$148.48

The estimated cost per km^2 of a vaccination campaign is listed for scenarios where dogs are vaccinated every year regardless of vaccine history compared with scenarios where dogs are never revaccinated. Costs are in 2010 USD, discounted, and cumulative over ten years.