Domestic animal disease control programs to protect wildlife

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How domestic animal diseases threaten wildlife

**DIRECT IMPACTS**

- Domestic animals (e.g. Rabies, CDV, FeLV)
- Wildlife populations
- Trophic cascades (e.g. Rinderpest)

**INDIRECT IMPACTS**

- Impacts on livestock production and livelihoods (e.g. MCF, FMD)
- Conflict driving forms of land use incompatible with wildlife (e.g. MCF, FMD)

Trophic cascades lead to changes in wildlife populations, which can have indirect impacts on livestock and land use forms.
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<thead>
<tr>
<th>Threatened Host</th>
<th>Pathogen</th>
<th>Original Host</th>
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<tbody>
<tr>
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Successive rabies outbreaks in the late 1980s and early 1990s led to local extinction of the population in 1992.

Isolates characterised as canid strain Africa 1b.

Single strain of rabies virus circulating in the Serengeti.
Identifying domestic animals as reservoirs of disease: Rabies in the Serengeti

Is the virus maintained in independent cycles of infection in wildlife?

Or are dogs the only maintenance host for rabies in the Serengeti?
Contact tracing studies

Rabid animals are recognisable
Transmission events are memorable

Hampson et al. (2008) PLoS Biology 7: (3). e53
Cases in wildlife linked with outbreaks in dogs

Short chains of transmission in wildlife

Domestic dog
Livestock
Other carnivores

1997

Highest root probability

1996

2004

2003

2004

hyena

2003

genet

aardwolf

1999

1996

bat-eared fox

1998

bat-eared foxes

domestic cat

1997

If wildlife do maintain rabies independently of dogs, mass rabies vaccination of domestic dogs should result in elimination of disease.
People make considerable efforts to bring dogs for vaccination
Most dogs in rural Tanzania are accessible for parenteral vaccination through central-point campaigns.

On average each rabid dog infects 1.2 others. Low value of $R_0$ suggests that elimination should be feasible (bringing $R_0 < 1$)

$$P_{crit} = 1 - 1/R_0$$

No outbreaks where vaccination coverage > 70%

Hampson et al. (2008) PLoS Biology 7: (3). e53
Dog vaccination can result in significant decline in animal-bite injuries and demand for expensive human post-exposure vaccine

Cleaveland et al., 2003, Vaccine 21: 1965-1973
Dog vaccination has resulted in elimination of rabies from Ngorongoro District with no cases recorded since 2006

No evidence for persistence of rabies in wildlife in the Serengeti National Park
A combination strategy of central-point + community-based animal health workers was most cost effective and achieved >80% coverage.

Rabies has now disappeared from this area. A single variant of rabies circulates in the Serengeti and is maintained only in domestic dogs.

Mass dog vaccination is epidemiologically, logistically and economically feasible.

Elimination of canine rabies is a plausible objective.
Eradication of rinderpest

Rinderpest virus has been wiped out, scientists say

By Pallab Ghosh
Science correspondent, BBC News

Scientists working for the UN say that they have eradicated a virus which can be deadly to cattle.

If confirmed, rinderpest would become only the second viral disease - after smallpox - to have been eliminated by humans.

Rinderpest was once prevalent in the Middle East, Africa and Asia.

The UN’s Food and Agriculture Organization (FAO) has said that it will now suspend its efforts to track and eliminate the virus.
Ecosystem-wide impacts arising from cattle vaccination against rinderpest

Removal of rinderpest => 5-fold increase in wildebeest
Wildlife NOT reservoirs of infection

![Graph showing % with antibodies over years for Wildebeest and Buffalo]
Removal of rinderpest: trophic cascades

Wildebeest impacts on grass biomass => fire reduction

Reduced fire => regeneration of woodland

Shifted the Serengeti from a net carbon source to a carbon sink

Holdo et al. (2009) PLoS Biology, 7:e1000210
Rinderpest removal: effect on predators

Increase in lion and hyaenas (‘bottom-up’ regulation)

Declines in wild dogs and cheetahs (‘top-down’ regulation through competition/killing)

 Gamma herpesvirus infection (AlHV-1) transmitted from wildebeest to cattle.
- Causes a fatal disease in cattle, but wildebeest are asymptomatic carriers.
- High levels of virus excretion in wildebeest calves up to 3 mths of age
- Increasing levels of conflict with Maasai herds

Malignant Catarrhal Fever
Associated with wildebeest calving season

*Emoyian oo engati*

“Disease of wildebeest”
Increased intensity and duration of grazing in highlands

Expansion of wildebeest migration

Increased avoidance of short-grass plains in wet season by Maasai

Increased intensity and duration of grazing in highlands

Negative environmental impacts on highland reserves

↑free felling
↑erosion
overgrazing

↑ in unpalatable grasses e.g. *Eleusine, Pennisetum* spp

↓ access to high-quality forage
↓ access to salt

↑ in tick-borne disease e.g. ECF, Ormilo

↑ in directly transmitted diseases e.g. FMD, CBPP

↑ cattle mortality
↓ cattle fecundity

Reduced herd size

"POVERTY SPIRAL"

↑ need to sell animal to raise / earn cash income
↓ livestock : human ratio

Increase in the human population
Poverty and malnutrition in Masailand

- >50% of children malnourished or undernourished in Ngorongoro District
- Growing number of families living in acute poverty
- Poor livestock production and food security => major shifts in land-use away from livestock towards cultivation
Conversion of rangelands

- In Kenya, mechanised cultivation associated with significant declines in wildlife

Serneels, Said, and Lambin (2001)
Survival of rangelands and traditional pastoralism important for maintaining integrity of savannah ecosystems

Vaccination of cattle against MCF would help ensure the sustainability of wildlife-livestock systems in east Africa
MCF vaccination trials: mucosal barrier immunisation strategy

Haig et al. (2008) Vaccine 26:4461-4468

Protection associated with high titres of neutralising antibody in nasal secretions and blood plasma

Protection associated with reduced establishment of virus in the blood
MCF field vaccination trial

- Two-dose i.m. regimen to stimulate mucosal antibody
- Challenge cattle by herding close to wildebeest calves
- Assess impact on livelihoods and land-use in the ecosystem
- Buffalo maintain SAT serotypes of FMDV
- FMD has major impacts on pastoral livelihoods and national livestock economies
- Trade-offs between livestock production and wildlife-based land-use options
- How can we best control FMD adjacent to wildlife protected areas?
Concluding comments

• The role of veterinarians in wildlife health issues is diverse and expanding

• Disease control programmes in domestic animals have the potential for major direct and indirect benefits for species conservation and protected area management.

• Healthy livestock populations can contribute to the integrity and survival of many ecosystems
Collaborators

Glasgow University
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Moredun Research Institute
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Nottingham University
David Haig

Veterinary Laboratories Agency
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Washington State University
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Sokoine University of Agriculture
Rudovick Kazwala, Enos Kamani

Tanazania Wildlife Research Institute
Julius Keyyu, Robert Fyumagwa, Richard Hoare

Ministry of Livestock Development and Fisheries
Mmeta Yongolo, Chanasa Ngeleja, Emmanuel Swai, Deogratius Mshanga

Tanzania National Parks
Titus Mlengeya, Morris Kilewo
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• BBSRC - DfID Combating Infectious Diseases of Livestock for International Development
• Bill and Melinda Gates Foundation
• Google.org
• Intervet
• Tusk Trust
• WSPA
• Disney Conservation Fund
• Frankfurt Zoological Society
• Lincoln Park Zoo
Thank You!

To all of you who purchased Nobivac® Rabies in the past year – and who therefore donated free vaccine to the Ahya Serengeti project – we are honoured to pass on this brief message.

*Thank you, thank you, thank you.*

*Your donation of rabies vaccine has helped to save the lives of our dogs, our wildlife, and most importantly of all – our children.*

*As recently as 2003, bite injuries and rabies cases were at record levels – almost 80 per 1000 households. Last year, by contrast, there were no cases at all.*

“*And in one further, extraordinary development, the African wild dog has been sighted once again within the National Park. This vanishingly rare animal was thought to have become locally extinct some fifteen years ago, due to rabies.*

“The Ahya Serengeti project must go on, or disease will surely return. But with your generous and remarkable help, we are certain to succeed. God bless you all.”

Magzi Kaare, Project Leader

*Intervet*

The future of vaccination