Modeling Inter-epidemic Persistence of Rift Valley Fever in Kruger Park's African Buffalo

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Rift Valley fever virus (RVF) is an emerging zoonotic disease that cycles between wildlife, livestock, and people in Africa, causing significant loss. RVF is most often identified in ruminants, both free-living and domestic. It is spread primarily by mosquitoes and, since several mosquito species are competent vectors of RVF, emergence in Europe and North America is a risk. Weather is often considered to be a significant driver of RVF outbreaks via large increases in mosquito populations. Current literature has focused on correlating large epidemics of RVF with El Nino and other weather events. However, little attention has been given to the underlying mechanisms driving the epidemics, such as transmission from mosquitoes to wildlife and the persistence of the virus between wet seasons.

RVF is endemic to Southern Africa, having been first identified in the region in 1951. In Southern Africa, focal or large-scale epidemics occur in a variable temporal cycle of between 7 and 11 years. It is unclear how RVF virus persists during the inter-epidemic periods, but there are two potential nonexclusive explanations for RVF virus persistence: 1) RVF is maintained in the vector population, or 2) RVF circulates undetected in some wildlife reservoir population.

We design and analyze a mathematical model for the dynamics of RVF to address the role of free-living African buffalo (Syncerus caffer) in Kruger National Park in the persistence of RVF. We use data from mosquito trapping and long-term buffalo studies to parameterize and inform the model. We find that a combination of vertical transmission and circulation in an alternate reservoir is the most likely explanation of persistence of RVF in Kruger National Park. This implies that exploration of vertical transmission rates and mosquito dynamics as well as transmission in alternate hosts is needed in order to understand RVF dynamics.