

Science Advances



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Comment on: Impending extinction crisis of the world's primates: Why primates matter? By Estrada A. et al. SCIENCE ADVANCES 18 JAN 2017 : E1600946
(<http://advances.sciencemag.org/content/3/1/e1600946>)

Yellow fever threatens Atlantic Forest primates

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(25 May 2017)

Emerging infectious diseases were cited as a cause of population decline of wild nonhuman primates (NHPs) by A. Estrada and collaborators in their review “Impending extinction crisis of the world’s primates” (Science Advances, 18 January, e1600946). Concurrent with the publication of this review, an epidemic of jungle yellow fever (YF) in the Atlantic Forest region of southeastern Brazil is affecting humans and NHPs alike, challenging health and wildlife conservation authorities and professionals. From December 2016 to 18 May 2017, YF has killed 264 people (42 additional deaths are under investigation) and caused, at least, 5,000 NHP deaths (1). Our field estimates sum many thousands of NHP deaths. Humans have access to an effective vaccine and about 85% of infected unvaccinated people are asymptomatic or develop a mild form of YF (2). Despite this resistance, there are 758 confirmed human cases and a further 622 cases under investigation, about 63% of them in regions of recommended vaccination prior to the current epidemic.

A disease of African origin, YF has spread to a portion of the Atlantic Forest that is outside the region of regular recommended vaccination (1) and encompasses most of the distribution of several NHPs, including the Vulnerable northern masked titi monkey (*Callicebus personatus*) and the Critically Endangered northern muriqui (*Brachyteles hypoxanthus*) and northern brown howler monkey (*Alouatta guariba guariba*) (3). Belonging to a genus highly sensitive to YF (4-7), the northern brown howler may reach the brink of extinction after this epizootic. Also particularly worrisome is the recent confirmation of human deaths of yellow fever in the municipality of Casimiro de Abreu in the state of Rio de Janeiro. Casimiro de Abreu is located in the center of the distribution of the Endangered golden lion tamarin (*Leontopithecus rosalia*), a charismatic species whose conservation status has improved thanks to decades of research and management efforts both in the

field and captivity and many million dollars invested in its recovery from near extinction. Lion tamarins appear to be highly sensitive to the Brazilian strains of the YF virus (8). Therefore, although no lion tamarins have died of the disease so far, the danger is real. Mortality among other taxa, even if not as extreme as that of howler monkeys, will compromise populations due to their isolation in already highly fragmented landscapes (5). This epizootic sadly demonstrates that even in areas like the Atlantic Forest where species and habitat protection is effective, unpredicted disease outbreaks like this (and, for example, Ebola in Central and West Africa) can be a major threat, exacerbated in areas of highly fragmented forest as in this region.

Worsening the situation, in many locations people afraid of the disease are harassing and killing NHPs, even in regions without current cases of YF. This misguided – and illegal – behavior further compromises NHP conservation, and backfires against public health by suppressing their critical role as sentinels of YF virus circulation. The obliteration of this free public health service in areas devoid of NHPs might be particularly missed by those people whose vaccination is not recommended.

Many questions remain unanswered about the factors that trigger and disperse YF, but it is certain that the vaccination of all inhabitants and visitors of risk areas would help to prevent human epidemics (2) and benefit NHPs by removing this source of people's fear and obviating our potential role in the spread of the virus. Therefore, vaccinating people is not only crucial for public health but also for biodiversity conservation.

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