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## Evaluating wildlife markets for pandemic disease risk



The effects of zoonotic disease pandemics are so dire that strong preventive measures to reduce interactions between people and wildlife species have been proposed, including wildlife trade bans.<sup>1-4</sup> China's ban on the trade and consumption of wildlife following the emergence of COVID-19 is one such strong response.<sup>3</sup> But opposition to wildlife trade bans has come from diverse sectors with vested interests (eg, wildlife farm owners, wildlife traders, and European game industries), and others are concerned about the loss of income to local collectors and wildlife trade being pushed underground.<sup>5</sup>

Considering these pressures, more nuanced solutions, such as prohibitions of high disease-risk wildlife sales, rather than broad bans, could be necessary.<sup>3</sup> Furthermore, broad trade bans, where enacted, could weaken and be narrowed over time. A focus on high disease-risk wildlife sales will require capacities and tools to monitor markets, especially for public health and wildlife enforcement authorities, and policy makers, to help ensure appropriate safeguards and monitoring protocols are in place for informed regulation of the wildlife trade. Science-based tools are necessary to evaluate the risks associated with the consumption and interaction with commonly traded wildlife taxa for zoonotic disease risk based on the probability of hosting or serving as intermediate hosts for viruses that have the potential to cause a pandemic or more localised epidemics.<sup>6,7</sup> Bats, pangolins, primates, viverrids, mustelids, canids, felids, and rodents are known to be high-risk primary and intermediate hosts.<sup>6</sup> Crowding large numbers of animals in stressful conditions and transporting them through long trade chains can amplify viral loads and shedding.<sup>6</sup>

Although improvements in market hygiene and butchering practices could diminish risk to some extent,<sup>4</sup> in reality, if high disease-risk taxa are being traded, no matter how clean the cages and knives are, novel and highly pathogenic viruses can still spill over to humans in trade chains. And it only takes one jump to trigger the next pandemic or regional epidemic in today's socioecologically connected world. Moreover, putting stringent hygiene measures in place in low-income tropical regions where people still kill, trade,

and consume wildlife, or consider them as delicacies, is impractical in the near term or even midterm.

Instead, regulations of wildlife trade chains could offer substantial risk mitigation, but will require that markets and trade chains are assessed for zoonotic disease risk based on zoonotic risk potential, transmission or spillover risk, and the potential of disease spread based on the number and types of different high disease-risk wildlife taxa being sold and market conditions. For instance, many bats on sale in a town market will elevate the market risk, which, in turn, might be amplified in situations in which many live wildlife species are present and interacting with many vendors and buyers. The ecological importance of particular wildlife should also be considered in the risk weighting as the removal of particular keystone species, such as top predators from ecosystems that can exacerbate future pandemic risk.<sup>8</sup> We have introduced a tool to monitor wildlife trade venues in the Asia-Pacific region and assess them for potential zoonotic disease risk using these parameters.<sup>9</sup>

This type of field evaluation tool can be used by health and wildlife authorities to evaluate the risk profiles of different wildlife markets and trade chains, and adds to the arsenal of tools that have been proposed to assess wildlife taxa as hosts for viruses with spillover and pandemic risk.<sup>6,7</sup> Recommendations can then be made to policy makers to help guide discussion and decisions on wildlife trade regulations, including bans, or adaptive management as risk profiles change. Practical tools like these also provide opportunities for the public and non-governmental organisations to identify and report high-risk wildlife trade activity.

Zoonotic spillovers are predicted to become more frequent as humans become increasingly exposed to novel pathogens through the juggernaut of natural habitat destruction and increased interfaces with wildlife, and as the global commerce in wildlife continues to increase.<sup>10</sup> Ending, or at least minimising, highest risk activities informed through a One Health approach must be a response by the global community to reduce the risk of future zoonotic disease pandemics. The tool we have developed is available for free download<sup>9</sup> and can be used to evaluate zoonotic risk levels of markets that offer wildlife for sale in a standard and objective manner and contribute to this response.

We declare no competing interests.

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**\*Eric Wikramanayake, Dirk Pfeiffer, Ioannis Magouras, Anne Conan, Stefan Ziegler, Timothy C Bonebrake, K Yoganand, David Olson**  
**ericw@wwf.org.hk**

WWF Asia-Pacific Counter-Illegal Wildlife Trade Hub, WWF-Hong Kong, Kwai Chung, New Territories, Hong Kong Special Administrative Region, China (EW, DO); Centre for Applied One Health Research and Policy Advice, City University of Hong Kong, Kowloon, Hong Kong Special Administrative Region, China (DP, IM, AC); WWF-Germany, Frankfurt, Germany (SZ); School of Biological Sciences, University of Hong Kong, Hong Kong Special Administrative Region, China (TCB); WWF Greater Mekong, Saylor Village, Chanthabouly, Vientiane, Laos (KY)

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