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The Social Costs of Keystone Species Collapse: Evidence From The Decline of Vultures in India

Based on BFI Working Paper 2022-165, "The Social Costs of Keystone Species Collapse: Evidence From The Decline of Vultures in India," by Eyal G. Frank, University of Chicago; and Anant Sudarshan, University of Warwick

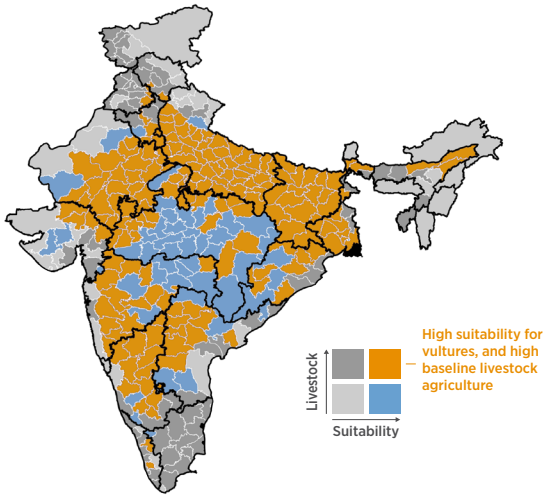
Human death rates increased by more than 4% in vulture-suitable districts after these birds nearly went extinct; additionally, evidence points to an increase in feral dog populations and rabies, along with diminished water quality in affected regions.

Over the last century, species extinction around the world has occurred at rates about one hundred times higher than previous mass extinctions, leading scientists to label the current human-driven phenomenon as the sixth mass extinction in the planet's history. While biodiversity loss is arguably costly, and efforts are made to restore and protect endangered species, we know precious little about the effects of lost species on human well-being. Likewise, policymakers often fly blind when considering mitigation efforts, especially when such extinction events occur unpredictably.

Economic theory has long recognized the conceptual and practical difficulties involved in carrying out a forward-looking cost-benefit analysis in the presence of uncertainty, irreversibility, and catastrophic tail risks, and those factors figure prominently when considering the cost of species extinction. Studying marginal changes, for example, does not capture the effects of catastrophic collapse; also, data limitations of, say, species populations, often constrain causal evidence; and the number of potentially endangered species is large, forcing researchers to target both evaluation and conservation efforts.

For this paper, the question at hand is the effect of a rapid decline in the population of vultures in India caused by the introduction of a veterinary medicine, diclofenac, that was passed to vultures via carrion, with deadly consequences. Please see the working paper for more details, but the authors combine techniques from economics and ecology to address the research challenges described above, including a difference-in-differences strategy to compare districts with habitats highly suitable for vultures to those that are unsuitable, both before and after the onset of diclofenac use.

Figure 1 • Spatial Distribution of Diclofenac-Affected-Vulture Ranges & Livestock Agriculture



Note: Districts in India, at their stable 1981 geographic borders, classified as high or low exposure to diclofenac-vulture-collapse, and as high or low baseline livestock agriculture. See working paper for more details.

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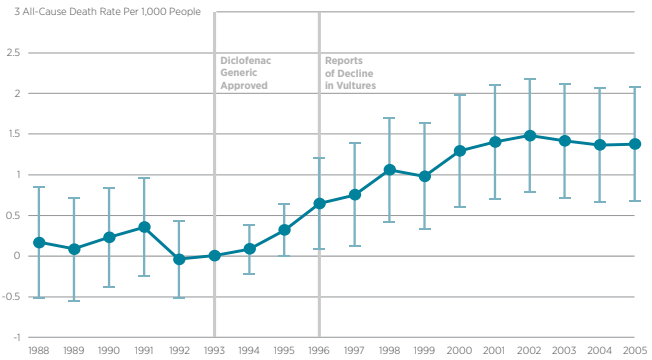
Figure 2 • All-Cause Death Rates



Note: Difference-in-Differences estimation results from Equation (1). Comparing the high to low suitability vulture districts. Sample includes all districts (combining urban and rural areas) with balanced data from 1988 to 2005. Regression includes district and zonal council-by-year fixed effects. Observations are population-weighted. Standard errors are clustered at the district level.

Before describing the authors' findings, a brief note about vultures' crucial role in India's biosphere. Vultures have long provided critical environmental sanitation services by quickly dispatching of carcasses in India, which was home to over 500 million livestock animals in 2019, the most in the world. However, beginning in the second half of the 1990s, and over the course of just a few years, the number of Indian vultures in the wild fell by over 95% following the introduction of diclofenac. Once numbering in the tens of millions, this decline is the fastest of a bird species in recorded history, and the largest in magnitude since the extinction of the passenger pigeon in the United States. As vultures died out, the scavenging services they provided disappeared too, and carrion were left in the open for long periods, likely leading to an increase in the population of rats and feral dogs, in the incidence of rabies, and in the transmission of pathogens and diseases such as anthrax to other scavengers, as well as to increased water pollution from carcass dumping and surface runoff.

What are the human health-related effects of this rapid, unexpected decline in a keystone species (considered to be those that help hold the ecosystem together)? The authors find the following:

- Districts affected by the disappearance of vultures saw an increase in human all-cause death rates of at least 4.2%, averaged over 2000 to 2005.
- Elevated mortality is largest in populated areas where carcass dumps occur on the outskirts of town.
- Increased dog populations occur in high-vulture suitability districts, and a sharp increase in sales of rabies vaccines occurs following the veterinary use of diclofenac.
- Water quality deteriorates in districts affected by the disappearance of vultures, after their collapse.

As the authors describe, vultures are not the most beloved of creatures and, consequently, likely do not attract attention when it comes to species decline. Yet, as this research reveals, vultures perform a valuable service that profoundly impacts human health (and also provides other economic and cultural benefits described in the paper).

Bottom line: the restoration of vultures could lead to large increases in human welfare in India and suggest a critical need to protect vultures in other settings, such as parts of Africa, where the birds still exist and feed partly on livestock carrion. Further, this research argues for thoroughly evaluating the role of all keystone species and their impact on human well-being and, in doing so, prospectively evaluating policies with potential negative species effects.

READ THE WORKING PAPER

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