

LETTERS

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Avian flu threatens Neotropical birds

A highly pathogenic avian influenza virus (HPAIV) that spread through the Holarctic region in 2022, affecting millions of birds (1), has reached South America. The disease threatens marine and terrestrial birds, including endangered species. Real-time information gathering and steps to prevent the spread of disease will be required to mitigate this outbreak.

Along the Peruvian coastline alone, HPAIV killed more than 22,000 wild birds in just 4 weeks in 2022, mainly Peruvian pelicans (*Pelecanus thagus*) and Peruvian boobies (*Sula variegata*) (2), both of which are categorized as Endangered in Peru (3). The extant Peruvian population of pelicans in coastal protected areas is around 124,000 (4). The virus has also killed Near Threatened Guanay cormorants (*Leucocarbo bougainvilliorum*) (2, 3). Beyond their conservation status and intrinsic value, these species are of economic interest. The guano produced by the Peruvian pelican, the Peruvian booby, and the Guanay cormorant is used as fertilizer and constitutes one of the most valuable economic resources in Peru (5).

HPAIV is spreading across the continent. By December 2022, the virus had been found in birds in Ecuador, Colombia, Venezuela, and Chile (6). In addition to marine birds, the virus could threaten scavengers, as it has in other regions of the world (7), including the emblematic Andean condor (*Vultur gryphus*) (8). Viral transmission could occur if those scavengers consume infected carcasses while traveling from the Andean region to the coastline (9).

We urge Peruvian and other South American authorities and conservation managers to take steps to track and mitigate the spread of this disease. Up-to-date information about the wild bird species affected and the number of birds remaining in the region will be necessary to understand the extent of HPAIV's effects. Managers should perform active and passive epidemiological surveillance and reduce the availability of infected carcasses in the environment to prevent transmission to marine birds, obligate scavenger species, and humans. Given the difficulty of controlling emerging pathogens, reducing anthropogenic threats such as



An outbreak of highly pathogenic avian flu threatens the Peruvian pelican (*Pelecanus thagus*) population.

environmental pollution, resource overexploitation, and habitat loss should also be an urgent priority. Minimizing other risks will give bird populations a better chance against emerging pathogens. Finally, we recommend continuing these efforts even if this flu event passes; the epidemiological behavior of this virus indicates that recurrent outbreaks are likely (10).

Víctor Gamarra-Toledo^{1,2*}, Pablo I. Plaza², Roberto Gutiérrez^{1,3}, Paola Luyo³, Lizbeth Hernani³, Fernando Angulo⁴, Sergio A. Lambertucci²
¹Museo de Historia Natural, Universidad Nacional de San Agustín de Arequipa, Arequipa, Peru.
²Grupo de Investigaciones en Biología de la Conservación, Instituto de Investigaciones en Biodiversidad y Medio ambiente (Consejo Nacional de Investigaciones Científicas y Técnicas–Universidad Nacional del Comahue), Bariloche, Argentina.
³Servicio Nacional de Áreas Naturales Protegidas por el Estado, Lima, Peru.
⁴Centro de Ornitología y Biodiversidad, Lima, Peru.
 *Corresponding author.
 Email: vgamarrrat@unsa.edu.pe

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Atmospheric goals for sustainable development

Atmospheric chemistry and composition underlie the existential threats of climate change and ozone depletion (1), and poor air quality represents the greatest environmental health issue in the modern world (2). However, the only targets and indicators related to atmospheric health and clean air in the United Nations Sustainable Development Goals (SDGs) focus on reducing fine particulate pollution levels and the associated mortality rates (3, 4). By creating targets for a broad range of specific pollutants, the SDGs could facilitate more effective actions, monitoring, and funding.

The SDGs consider air quality only in terms of the mass density of particulate matter of 2.5 μm or less (PM_{2.5}). However, PM_{2.5} is not a single pollutant but rather a measurement that contains many different compounds, including sulfate, black carbon, metals, and organic compounds of all particle sizes below 2.5 μm . Measuring PM_{2.5} does not provide specific information about the concentrations of the components that make up PM_{2.5}, nor does it account for the impact of other air pollutants known to be harmful, such as ozone and nitrogen dioxide.

Given that we still cannot fully explain the cause of the statistical link between PM_{2.5} and adverse health outcomes (5, 6), this measurement alone does not provide adequate information. The SDGs would be more valuable if they also included targets to reduce deaths from specific pollutants. Particle number concentration and chemical composition may be more important than fine particulate matter mass density for health outcomes (7, 8). Moreover, instead of tracking excess mortality alone, targets should include nonfatal health impacts, as well as impacts on ecosystems and agriculture.

Metrics for reduction of other atmospheric pollutants could be added to future developments of the SDGs. For example, in SDG 10 (Reduced Inequalities), reducing pollutants could contribute to access to clean air to breathe, a major contributor to health inequalities (9). Targets that address stratospheric ozone chemistry could be added to SDG 15 (Life on Land), given that life is only possible because of a healthy atmosphere, including the ozone layer (10). Inclusion of targets for tropospheric ozone would increase the pressure to control atmospheric pollution holistically, which—if ozone levels were successfully reduced—would also increase agricultural yields (SDG 2, Zero Hunger) (11). SDG 13 (Climate Action) could improve transparency by providing explicit targets for the peak concentrations of all major climate forcers, including greenhouse gases and particulates, which would help to track our progress in meeting global climate change commitments.

Updating the SDGs to incorporate atmospheric targets would improve data, policies, and incentives. Better regional policies on air pollution control and monitoring would also be supported in accordance with the broader guidance. In addition, a more holistic strategy would provide incentives for funders to support scientists researching pollutants that are not categorized as PM_{2.5}.

Melita Keywood^{1*}, Clare Paton-Walsh², Mark Lawrence³, Christian George⁴, Paola Formenti⁵, Robyn Schofield⁶, Helen Cleugh^{1,7}, Nathan Borgford-Parnell⁸, Anthony Capon⁹

¹Commonwealth Scientific and Industrial Research Organisation Environment, Melbourne, Australia. ²University of Wollongong, Centre Atmospheric Chemistry, Wollongong, Australia. ³Research Institute for Sustainability, Potsdam, Germany. ⁴University of Lyon, Université Claude Bernard Lyon 1, Centre National de la Recherche Scientifique (CNRS), Lyon, France. ⁵Laboratoire Interuniversitaire des Systèmes Atmosphériques, Université Paris Cité Paris and Université Paris Est Creteil, CNRS, Paris, France. ⁶School of Geography, Earth, and Atmospheric Sciences, University of Melbourne, Melbourne, Australia. ⁷Australian National University, Canberra, Australia. ⁸United

Nations Environment Programme, Climate & Clean Air Coalition, Paris, France. ⁹Monash University, Monash Sustainable Development Institute, Melbourne, VIC, Australia.

*Corresponding author.

Email: melita.keywood@csiro.au

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COMPETING INTERESTS

M.K. is the president of the International Commission for Atmospheric Chemistry and Global Pollution. C.P.-W. is co-chair of the International Global Atmospheric Chemistry Project. M.L. is co-chair of the German National Science Platform for Sustainability in the Agenda 2030. R.S. is president of the Australian Council of Environmental Deans and Directors and a board member of the Australian Community Climate and Earth System Simulator–National Research Infrastructure. H.C. is the vice chair of the World Climate Research Program Joint Scientific Committee.

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Evidence required for ethical social science

The history of science is littered with violations of the human rights of research participants (1, 2). One response has been regulation. In the United States, the Belmont Report lays out ethical principles for human subjects research (3), which form the foundation of modern-day institutional review boards. According to the Belmont Report, ethics committees and investigators need to determine whether the benefits of the research outweigh the costs and whether the costs unevenly burden particular groups. However, the assumptions underlying such assessments can be flawed (4, 5). Without evidence about the causal effects of social science research on participant welfare, researchers risk causing unexpected harms or missing unexpected benefits.

Randomized experiments can provide data to replace assumptions about the potential benefits and costs of research on study participants. By randomly assigning some people to participate in a study and others not to participate, researchers can estimate the causal effects of participation on welfare (6). Researchers can also randomly assign and compare multiple

versions of a protocol to learn about the marginal costs and benefits to participants, or they could randomize the sequence of a study component and participant welfare questions (7). Finally, researchers can add participant welfare questions to the end of an existing experimental study to understand the costs and benefits of a treatment. In each case, the experiments should be designed to assess whether costs and benefits are distributed equally among different subsets of participants.

Research ethics has come a long way since the Belmont Report, but researchers who work with human subjects still lack the causal evidence to make fully informed ethical choices. Researchers know they can do better, as calls for ethics appendices or ethics sections in pre-registrations illustrate (8, 9). To facilitate the adoption of these strategies, funders could require more transparency on the ethics of the work they support. The experimental designs we propose can be embedded into ongoing research efforts, adding little expense. Researchers can also coordinate efforts by using open access forums to post study instruments, data, and results, and when appropriate can implement harmonized experiments to build generalizable evidence across cases (10). Randomized experiments that assess the effects of participating in research can augment existing practices and build credible evidence to inform future risk-benefit calculations and improve ethical decision making.

Rebecca Littman¹, Rebecca Wolfe^{2*}, Graeme Blair³, Sarah Ryan⁴

¹Department of Psychology, University of Illinois–Chicago, Chicago, IL, USA. ²Harris School of Public Policy, University of Chicago, Chicago, IL, USA. ³Department of Political Science, University of California Los Angeles, Los Angeles, CA, USA. ⁴Department of Psychology, University of California Berkeley, Berkeley, CA, USA.

*Corresponding author.

Email: rebeccawolfe@uchicago.edu

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