BioScience, 2026, 76, biag099
https://doi.org/10.1093/biosci/biag099
KEY CHALLENGES

OXFORD

Key Challenges and future research, education, and policy questions in One Health

Mary Ann Ottinger[1,*], Geoffrey M. Henebry[2], Meghann Jarchow[3], Rodney Keenan[4], Anna Monfils[5], Katey Pelican[6], Pim Martens[7], Paige S. Warren[8], Paul Abram[9], Molly A. Albecker[1], Brian F. Allan[10], Todd W. Anderson[11], C. Jane Anderson[12], Erin Ashe[13], Edmundo Barrios[14], Olivier Beauchet[15,16,17], Sarah Bekessy[18], Sofia Belardinelli[19,20], Paul Bois[21,22], Antoine Boudreau LeBlanc[23,24,25], Alexander Braczkowski[26], Jane Ellen Buikstra[27], Yanni Cao[28], Mark Carr[29], Luis Fernando Chaves[30], Jana Collatz[31], Louise Cooley[32], Kevin Crooks[33], Kevin Curtin[34], Juan Martin Dabezies[35,36], Michele Dechoum[37], Prakash N. K. Deenapanray[38,39], Edward Emile DeMartini[40], Adam Dolezal[41], Martin Dovciak[42], Damjana Drobne[43], Maged Elkahky[14], Franz Essl[44], Mariline Fancelli[45], Colin Farrelly[46], Cadhla Firth[12], Cene Fišer[43], S. Luke Flory[47], Nicholas M. Fountain-Jones[48], Luigi Garaffa[19,49,50], Joseph K. Gaydos[51], Wayne M. Getz[52], Samuel Charles Gilvarg[53], Meredith Gore[36], Nicole Gottdenker[54], Vanina Guernier-Cambert[55], Rodrigo Hamede[56], Jordan Hampton[57], Annette M. Hübschle[58], Philip E. Hulme[59], Jacinta Humphrey[18], Brian Husband[60], Zehidul Hussain[61], Kate Hutson[62,63], Michael Jacob[64], Marshall P. Jones[65], Menna N.M.I. Jones[66], Matt Kammer-Kerwick[67], Nicole Kelp[68], Holly Kirk[69], Alexandra-Maria Klein[70], Xavier Gaston Hervé Koenig[38], Jonathan Kolby[12], Ore Koren[71], Camryn Ashley Kritzell[1], Ralph J. Larson[72], Marcus A. Lashley[73], Brian Leydet[42], Catherine Lindell[74,75], Shirley Luckhart[76], Seth B. Magle[77], Stefano Mammola[78], Angeliki F. Martinou[79], Richard Meyers[80], Pawel Michalak[81], Debra Miller[82], Maureen H. Murray[83], Kimberly Nielsen[13], Barbara F. Nowak[32], Christopher O'Bryan[84], Matthew O'Neal[85], Malgorzata O'Reilly[32], Julia Osterman[70,86,87], Anibal Pauchard[88], Deborah L. Paul[89], Jérôme Pelletier[90,91], Maria Pinto[45], Timothée Poisot[92], Parham Pourdavood[93], Petr Pyšek[94], Stephen A. Raverty[95,96], Kimberly Rivera[83], Katherine May Robertson[18], Helen Roy[97], Sadie J. Ryan[98], Chadi M. Saad-Roy[99], Jonathan Salerno[100], Lisa Schulte Moore[101,102], Andy Sheppard[103], Chloe Sher[104], Alistair M.S. Smith[105], Pamela Soltis[106], Cybill Staentzel[107], Patrick R. Stephens[108], Mingwei Su[109], Yunbo Zheng[109], Mekala Sundaram[110], Thilina Surasinghe[111], Fiona Tang[112], Alejandro Tena[113], Cody W. Thompson[114], Amy Toth[115], Richard Unsworth[116], Andrew L. Vander Yacht[53], Henriette van Heerden[117], James Verdier[118], Montserrat Vilà[119], Paolo Vineis[120], Emma Watkins[121], Rob Williams[13], Vivienne Williams[122], John Wilson[123], Barbara Wolfe[124], Cary Wu[125], Jianyong Wu[28], Kris Wyckhuys[14,126,127,128], Jane Younger[129] and Charles B. Fenster[130]

[1]Department of Biology and Biochemistry, University of Houston, Houston, TX, United States
[2]Michigan State University, Department of Geography, Environment, and Spatial Sciences, East Lansing, MI, United States
[3]University of South Dakota, Department of Sustainability and Environment, SD, United States
[4]University of Melbourne, School of Ecosystem and Forestry Sciences, Carlton, Victoria, Australia
[5]Central Michigan University, Department of Biology, Mount Pleasant, MI, United States
[6]University of Hawai'i System Health Sciences Institute, University of Hawaii, Honolulu, HI, United States
[7]Maastricht University, System Earth Science, Maastricht, The Netherlands
[8]Department of Environmental Conservation and College of Natural Sciences, University of Massachusetts, Amherst, MA, United States
[9]Agriculture and Agri-Food Canada, Agassiz Research and Development Centre, Agassiz, British Columbia, Canada
[10]Department of Entomology, University of Illinois, Urbana, IL, United States

Received: 3 June 2026. **Accepted:** 4 June 2026
© The Author(s) 2026. Published by Oxford University Press on behalf of the American Institute of Biological Sciences. All rights reserved. For commercial re-use, please contact reprints@oup.com for reprints and translation rights for reprints. All other permissions can be obtained through our RightsLink service via the Permissions link on the article page on our site-for further information please contact journals.permissions@oup.com

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

[11]San Diego State University, Department of Biology, San Diego, CA, United States
[12]Smithsonian's National Zoo and Conservation Biology Institute, Front Royal, VA, United States
[13]Oceans Initiative, Conservation Science, Seattle, WA, United States
[14]Food and Agriculture Organization, Rome, Italy
[15]Departments of Medicine and Geriatrics, University of Montreal, Montreal, Quebec, Canada
[16]Research Centre of the Geriatric University Institute of Montreal, Montreal, Quebec, Canada
[17]Department of Medicine, Division of Geriatric Medicine, Sir Mortimer B. Davis Jewish General Hospital and Lady Davis Institute for Medical Research, McGill University, Montreal, Quebec, Canada
[18]The University of Melbourne, School of Agriculture, Food and Ecosystem Sciences, Melbourne, Victoria, Australia
[19]University of Padova, Department of Biology, Padova, Italy
[20]Polytechnic of Milan, Department of Electronics, Information, and Bioengineering, Milan, Italy
[21]ICube Laboratory, University of Strasbourg, ENGEES, CNRS
[22]LTSER France Strasbourg and Michel Serres Institute, Strasbourg, France
[23]Faculté de Droit, Université Laval, Quebec, Canada
[24]Canada Excellence Research Chair One Urban Health, Montreal, Quebec, Canada
[25]Montreal Neurological Institute-Hospital, McGill University, Montreal, Quebec, Canada
[26]Griffith University, Brisbane, Queensland, Australia
[27]Center for Bioarchaeological Research, School of Human Evolution and Social Changes, Arizona State University, Tempe, AZ, United States
[28]Division of Environmental Health Sciences, College of Public Health, The Ohio State University, Columbus, OH, United States
[29]Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, CA, United States
[30]Indiana University Bloomington, Department of Geography, Bloomington, IN, United States
[31]Research Division Agroecology and Environment, Agroscope, Zurich, Switzerland
[32]University of Tasmania, Hobart, Tasmania, Australia
[33]Department of Fish, Wildlife, and Conservation Biology and the Center for Human-Carnivore Coexistence, Colorado State University, Fort Collins, CO, United States
[34]Department of Geography and the Environment, University of Alabama, Tuscaloosa, AL, United States
[35]Department of Agrarian Systems and Cultural Landscapes, University of the Republic, Uruguay
[36]Department of Geographical Sciences, University of Maryland, College Park, MD, United States
[37]Departamento de Ecologia e Zoologia, Universidade Federal de Santa Catarina, Santa Catarina, Brazil
[38]Université des Mascareignes, Sustainability and Climate Change Programme, Roches Brunes, Mauritius
[39]ELIA—Ecological Living In Action Ltd, La Gaulette, Mauritius
[40]Hawaii Institute of Marine Biology, SOEST, University of Hawaii, Kanoehe, HI, United States
[41]University of Illinois at Urbana-Champaign, Entomology, Urbana, IL, United States
[42]SUNY College of Environmental Science and Forestry, Department of Environmental Biology, Syracuse, NY, United States
[43]Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia
[44]Division of BioInvasions, Global Change & Macroecology, Department of Botany and Biodiversity Research, University of Vienna, Vienna, Austria
[45]Embrapa Mandioca e Fruticultura, Cruz das Almas, Brazil
[46]Department of Political Studies, Queen's University, Kingston, Ontario, Canada
[47]Invasion Science Institute, University of Florida, Gainesville, FL, United States
[48]Tasmanian School of Medicine, University of Tasmania, Hobart, Tasmania, Australia
[49]University of Paris 1 Panthéon-Sorbonne, Department of Philosophy, Paris, France
[50]University of Tours, Department of Medicine, Tours, France
[51]UC Davis One Health Institute, Orcas Island Office, Eastsound, WA, United States
[52]University of California, Berkeley, CA, United States
[53]SUNY College of Environmental Science and Forestry, Department of Sustainable Resources Management, Syracuse, NY, United States
[54]Department of Pathology, University of Georgia, Athens, GA, United States
[55]iEES-Paris, IRD, Paris, France
[56]School of Natural Sciences, University of Tasmania - Hobart, Hobart, Australia
[57]Murdoch University, School of Veterinary Medicine, Western Australia, Australia
[58]Global Risk Governance Progamme, Department of Public Law, Law Faculty, University of Cape Town, Cape Town, South Africa
[59]Centre for One Biosecurity Research, Analysis and Synthesis, Lincoln University, Christchurch, New Zealand
[60]University of Guelph, Department of Integrative Biology, Guelph, Ontario, Canada

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

[61]University of Maryland College Park, Department of Environmental Science and Technology, College Park, MD, United States
[62]Cawthron Institute, Nelson, New Zealand
[63]College of Science and Engineering, James Cook University, Townsville, Queensland, Australia
[64]Department of Psychiatry and Behavioral Sciences, University of California, San Francisco, CA, United States
[65]Smithsonian Institution, National Zoo and Conservation Biology Institute, Front Royal, VA, United States
[66]University of Tasmania, School of Natural Sciences, Hobart, Tasmania, Australia
[67]Bureau of Business Research at the IC2 Institute, The University of Texas at Austin, Austin, TX, United States
[68]Department of Microbiology, Immunology, and Pathology, Colorado State University, Fort Collins, CO, United States
[69]Curtin University, School of Design and the Built Environment, Perth, Western Australia, Australia
[70]University of Freiburg, Nature Conservation and Landscape Ecology, Freiburg, Germany
[71]Indiana University Bloomington, Bloomington, IN, United States
[72]Department of Biology, San Francisco State University, San Francisco, CA, United States
[73]University of Florida, Department of Wildlife Ecology and Conservation, Gainesville, FL, United States
[74]Department of Integrative Biology, Michigan State University, East Lansing, MI, United States
[75]Center for Global Change and Earth Observations, Michigan State University, East Lansing, MI, United States
[76]University of Idaho, Department of Entomology, Plant Pathology, and Nematology, Department of Biological Sciences, Institute for Health in the Human Ecosystem, Moscow, ID, United States
[77]Lincoln Park Zoo, Urban Wildlife Institute, Chicago, IL, United States
[78]National Research Council (CNR), Water Research Institute (IRSA), Verbania, Italy
[79]Laboratory of Vector Ecology and Applied Entomology, Joint Services Health Unit Cyprus, Akrotiri, Cyprus
[80]American Anthropological Association, Wanblee, SD, United States
[81]Edward Via College of Osteopathic Medicine, Monroe, LA, United States
[82]University of Tennessee, Center for Wildlife Health, UT One Health Initiative, Knoxville, TN, United States
[83]Lincoln Park Zoo, Chicago, IL, United States
[84]Maastricht University, Venlo, The Netherlands
[85]Iowa State University, Ames, IA, United States
[86]Gothenburg Global Biodiversity Centre, Gothenburg, Sweden
[87]University of Gothenburg, Department of Biological and Environmental Sciences, Gothenburg, Sweden
[88]Laboratorio de Invasiones Biológicas (LIB), Facultad de Ciencias Forestales, Universidad de Concepción, Concepción, Chile
[89]Illinois Natural History Survey and the Species File Group, University of Illinois, Champaign, IL, United States
[90]Département de microbiologie et d'infectiologie, Faculté de médecine et des sciences de la santé, Université de Sherbrooke, Sherbrooke, Canada
[91]Groupe de recherche en épidémiologie des zoonoses et santé publique, Université de Montréal, Saint-Hyacinthe, Canada
[92]Département de Sciences Biologiques, Université de Montréal, Montréal, Quebec, Canada
[93]Human Energy, Orinda, CA, United States
[94]Czech Academy of Sciences, Institute of Botany, Department of Invasion Ecology, Průhonice, Czech Republic
[95]British Columbia Ministry of Agriculture, Animal Health Centre, Abbotsford
[96]Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, British Columbia, Canada
[97]UK Centre for Ecology & Hydrology, Wallingford, United Kingdom
[98]Department of Geography and the Emerging Pathogens Institute, University of Florida, Gainesville, FL, United States
[99]Department of Mathematics, Department of Microbiology and Immunology, Biodiversity Research Centre, University of British Columbia, Vancouver, British Columbia, Canada
[100]Department of Human Dimensions of Natural Resources and the Center for Human-Carnivore Coexistence, Colorado State University, Fort Collins, CO, United States
[101]Bioeconomy Institute, Iowa State University, Ames, IA, United States
[102]Department of Natural Resource Ecology and Management, Iowa State University, Ames, IA, United States
[103]CSIRO, Black Mountain Laboratories, Canberra, Australia
[104]Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Ontario, Canada
[105]University of Idaho, Department of Earth and Spatial Sciences, Center for Resilient Communities, Moscow, ID, United States
[106]Florida Museum of Natural History and Biodiversity Institute, University of Florida, Gainesville, FL, United States
[107]LIVE Laboratory (University of Strasbourg, ENGEES, CNRS) and LTSER France Strasbourg, Strasbourg, France
[108]Department of Biology, Oklahoma State University, Stillwater, OK, United States
[109]Law School, College of Geography and Environmental Sciences, Zhejiang Normal University, Jinhua, Zhejiang, China

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

[110]Department of Infectious Diseases, Center for Precision One Health and Savannah River Ecology Laboratory, University of Georgia, Athens, GA, United States
[111]Bridgewater State University, Department of Biological Sciences, Bridgewater, MA, United States
[112]Department of Civil Engineering, Monash University, Clayton, Victoria, Australia
[113]Instituto Valenciano de Investigaciones Agrarias, Moncada, Valencia, Spain
[114]Department of Ecology and Evolutionary Biology and Museum of Zoology, University of Michigan, Ann Arbor, MI, United States
[115]Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, IA, United States
[116]Swansea University, Biosciences, Bridgend, United Kingdom
[117]University of Pretoria, Department of Veterinary Tropical Diseases, Pretoria, South Africa
[118]American Institute of Biological Sciences, Publications Department, Herndon, VA, United States
[119]Estación Biológica de Doñana (EBD-CSIC), Sevilla, Spain
[120]School of Public Health, Imperial College, London, United Kingdom
[121]Biosecurity Tasmania, Department of Natural Resources and Environment Tasmania, Hobart, Tasmania, Australia
[122]School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa
[123]South African National Biodiversity Institute, Kirstenbosch Research Centre, Cape Town, South Africa
[124]Department of Clinical Sciences, Colorado State University, Fort Collins, CO, United States
[125]Department of Sociology and the Dahdaleh Institute for Global Health Research, York University, Toronto, Ontario, Canada
[126]Chrysalis Consulting, Danang, Vietnam
[127]Institute for Plant Protection, China Academy of Agricultural Sciences (CAAS), Beijing, China
[128]School of Biological Sciences, University of Queensland, Saint Lucia, Queensland, Australia
[129]Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, Australia
[130]Biology and Microbiology, South Dakota State University, Brookings, SD, United States

*Corresponding author. E-mail: maotting@central.uh.edu

Keywords **One Health, disease, wildlife, human health, policy, education, nature-based solutions**

Introduction

Global communities and ecosystems face significant challenges that are complex and multidimensional. The complexities of these challenges encompass all living organisms, with significant negative effects from human-related activities, including from poor policy decisions and policies addressing "wicked problems" with their attendant messy solutions. The One Health concept brings together human, wildlife, and ecosystem interrelationships, with consideration of the factors and spatial and temporal scales that affect each. As with all dynamic concepts and models, the view of One Health has changed in the past few decades. Originally focused on disease spillover events from wildlife to humans, the One Health concept has broadened to consider a vast array of influencing factors that impinge on human communities, wildlife, and ecosystems. Policymakers have also become engaged in the One Health discussion, both acknowledging the interrelationship of humans and the environment as well as adding to the complexities of the concept. As a broad conceptual framework, One Health can provide the structure for developing and implementing solutions in a constructive stepwise manner.

This special issue engages a range of perspectives on the One Health concept, from its original focus on one-way transmission of pathogens (wildlife to humans), to our current understanding of the multiple-directional flows of diseases, and expanding to more complex, multidimensional interpretations. The articles show how One Health has begun to include a range of environmental stressors, such as pollutants, resources, habitat, and additional anthropogenic factors impacting humans, wildlife, and their environment. As more is understood about the complex interactions and relationships that denote One Health, the One Health framework will better aid in addressing and resolving issues through guiding decision-making, policy, and management, as well as research. Additional concepts have arisen that offer complementary lenses on how changes on our planet relate to the health of plants, animals, humans, and ecosystems, including the following:

- **Ecosystem Health** focuses on the ecological resilience and the interactions of the communities of organisms inhabiting a region.
- **Ecohealth** has a holistic view, similar to One Health, that considers the influences of human and animal health as part of the overall conceptual model (Harrison et al. 2019).
- **Planetary Health** is a holistic systems view of the world, recognizing the interconnectedness of the health and well-being of all life on Earth, and the need to regenerate natural systems, rather than simply minimizing harm (Martens 2023).

Although these concepts differ in scope and emphasis, they all share the same underlying goal: understanding and sustaining the delicate balance between human, animal, plant, and ecosystem health. Together, they highlight the deep interconnectedness of all life on Earth and the systems that support it. Each perspective underscores the profound influence humans have on these relationships—and our responsibility to protect and restore the health of the only planet on which we live.

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

One Health has become a topic for national and international programs that address a variety of issues affecting human communities, ecological resilience, environmental crises, as well as disease concerns. This *BioScience* One Health Special Collection was motivated to reflect the growing collection of published works and maturation of this concept. The topics covered are extremely broad, ranging across subjects, such as disease transmission, wildlife and human health, anthropogenic effects on One Health of human–wildlife–ecosystems, introducing our students to the concepts and importance of One Health, One Environmental Health, societal drivers and One Health, including equitable access to One Health solutions, and many other aspects of One Health. As such, this special issue is intended to encompass multiple aspects and perspectives on the very broad topic of One Heath.

Our goals for the Special Collection also include engaging the biomedical world in understanding the value of viewing human health through a lens of environmental health—and perhaps even more in the adverse consequences of not doing so. We challenge our traditional readership to consider the direct connection between our work and the health of our families, neighbors, and communities throughout our research and teaching activities. We hope that this One Health Special Collection will encourage other such submissions to *BioScience*.

We requested that authors for each accepted manuscript provide a short essay that highlights the big challenges/questions in One Health with an accompanying rationale. We grouped challenges/questions under the categories: Disease, Agriculture, Nature-Based Solutions, Indigenous and Community Issues, Education, One Health Conceptual Framework, and Policy—each relating to articles in the Special Collection issue. We include an introductory summary for each of the categories, written by members of the Editorial Board. This commentary and the following discussion of future challenges and questions did not undergo peer review beyond input from the *BioScience* Editorial Board.

Disease

An initial driver for the concept of One Health originated from the concern of transfer of pathogens from wildlife to humans. As more information was amassed and with increased understanding of disease processes involving human–wildlife interactions, it became clear that pathogens can pass in both directions as well as involve domestic species and other animals in close proximity to human communities (pets, urban wildlife, etc.). This section encompasses a further examination of the One Health Concept related to disease processes, risk for pathogen transmission, application of One Health concepts to mitigating risks, and transfer of pathogens.

Where is the elusive primary ebolavirus reservoir and how do we find it?

Challenge: What's a reservoir? How a One Health approach is critical to identifying zoonotic reservoir species and the multifaceted mechanisms of viral spillover (Sundaram et al. 2025).

Identifying wildlife reservoirs of zoonotic pathogens and predicting when and where they might trigger disease spillover is a grand challenge in global health. Meeting this challenge demands the integration of scientific insight across scales: including the molecular and cellular mechanisms of host–pathogen interactions, the physiological and nutritional ecology of wildlife populations, and the shifting availability of key resources across landscapes and regions. Tackling this complexity embraces the "One Health" ethos of communication across disciplines of comparative immunology, veterinary pathology, and disease ecology. Insights from different fields can provide valuable information on when and where to look for reservoirs, narrowing the scope of what might otherwise be a laborious or even logistically intractable task. For example, using an interdisciplinary approach, Sundaram and colleagues (2025) synergize insights into the cellular and molecular pathogenesis of infectious disease, host immunology, viral dynamics, fruit phenology, and bat reproductive ecology to predict where and when viral pulses occur. In addition, true predictive power at the wildlife spillover–human interface requires going further: extending this framework to include the structural drivers of spillover, drawing in social scientists who illuminate the political, cultural, and economic forces shaping human–wildlife–environment interactions. Sundaram and colleagues (2025) recommend making it a high priority to develop programs that foster collaboration among specialists in disciplines that typically see little cross communication, such as economics, epidemiology, cell biology, computational biology, and ecology.

Harnessing natural history collections for collaborative pandemic preparedness

Challenge: How can natural history collections and One Health scientists work synergistically on pandemic preparedness (Paul et al. 2025)?

The recent SARS-CoV-2 pandemic provided a wake-up call for the world, including museum scientists, which has led to considerable discussion among members of the natural history collections community on ways to leverage biorepositories for pandemic preparedness. Natural history collections provide a spatiotemporal record of Earth's biodiversity and are critical infrastructure for biological research. However, few actionable items have resulted, primarily due to stakeholder groups existing in separate spheres of biology (e.g., organismal biology, veterinary medicine, public health, virology, etc.), limiting the integration of natural history collections into One Health approaches.

Paul and colleagues (2025) suggest a more synergistic approach to pandemic preparedness. Although synergy in science often develops naturally, a more deliberate approach to networking public health scientists and natural history collections with One Health initiatives is needed. Communities of practice, such as the Museums and Emerging Pathogens in the Americas (MEPA), are working to break down these barriers and to create a network of scientists dedicated to documenting and understanding of zoonotic pathogens.

Recent federal funding cuts to biomedical research in the United States increase the risk of infectious diseases becoming more problematic in the coming years. In addition, changes in funding priorities at the National Science Foundation and the Institute of Museums and Library Science severely limit the ability of natural history collections and other groups to respond to the needs of pandemic prevention and preparedness. Now is not the time to divest from our critical scientific infrastructure. Instead, especially given recent memory of the SARS-CoV-2 pandemic, governments should be expanding their investment in biorepositories and One Health stakeholder networks of both humans and data to prevent future pandemics from occurring.

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Impacts of plant invasions on tick-borne disease risk

Challenge: How can we efficiently predict the effects of invasive plant species on tick-borne disease transmission (Flory et al. 2025)?

Expanding distributions of non-native invasive plants threaten biodiversity and ecosystem functions but could secondarily impact human health through changes in tick-borne disease transmission. Plant invaders can affect tick survival through alteration of localized conditions, and influence tick hosts by offering either better or worse shelter or foraging opportunities. Consequently, the density and activity of ticks in invaded areas may be enhanced or suppressed, shifting the risk of pathogen transmission to humans. The urgent challenge given the ongoing introductions of novel invasive species, is how to efficiently predict the effects of plant invaders on ticks and hosts.

Flory and colleagues (2025) propose an integrative One Health framework to help determine invasive plant impacts on tick-borne pathogen transmission risk, with the general hypothesis that specific functional traits of plant invaders may consistently affect microclimate and host habitat, which, in turn, alter tick survival and encounters with wildlife hosts. They propose that these interconnected drivers may be mediated by contextual factors including changing climate, landscape cover, and disturbance history. To enhance assessments of tick-borne pathogen transmission risk driven by new invaders, Flory and colleagues (2025) recommend that future research focus on links between plant functional traits, microclimate, host habitat use, tick abundance, and pathogen prevalence. Then, given sufficient geospatial data for human cases, tick surveillance records, vegetation surveys, and remotely sensed landcover change, including for known plant invasions, landscape scale disease risk assessments could be feasible. Ultimately, plant invader traits could offer a generalizable approach to evaluate and prioritize management of novel invaders, which could then be targeted for rapid removal to reduce disease risk for humans.

Broadening disease surveillance to include wild dolphins and killer whales: novel components of One Health

Challenge: Cetacean Pathogen Surveillance (Ashe et al. 2025).

Pathogen surveillance in free-ranging Pacific white-sided dolphins presents significant challenges beyond the logistics of collecting exhaled breath from a fast-swimming, acrobatic, and gregarious species. Securing adequate financial resources to advance our knowledge and assess the risk of emerging diseases remains problematic in many common wildlife species. As a crisis discipline, conservation funding priorities often focus on small, endangered populations at imminent risk of extinction. This is problematic from a One Health perspective, because it can be challenging to find funding to study abundant species, which can be more significant contributors to disease transmission throughout ecosystems than rare species (Gaston 2010, Borremans et al. 2019, Ashe et al. 2021). Pathogen surveillance in wild oceanic dolphins remains an emerging field characterized predominantly by opportunistic, reactive, or purely descriptive studies. Such approaches severely limit our ability to establish causal relationships regarding disease drivers, particularly in rare species where insufficient sample sizes compromise statistical power (Nelson et al. 2024). A One Health framework can help justify and increase funding for studying disease in common species. For example, nobody anticipated that massive mortality in insectivorous bats from a fungal disease would result in increased human infant mortality due to increased pesticide use, but it did (Frank, 2024). Recognizing the human, ecosystem, and wildlife co-benefits of including both common and rare species in pathogen surveillance increases value for funders and helps legislators find larger coalitions to support funding in tighter economic climates. With adequate funding, the field of cetacean pathogen surveillance is well positioned to move toward hypothesis-driven research frameworks. This transition could manifest through two complementary approaches: between-population comparative studies that compare microbial diversity and antimicrobial resistance through external benchmarks (Sutherland et al. 2011), and strategic sampling along gradients of anthropogenic habitat degradation or urban density (Williams et al. 2021). Additionally, natural experiments offer valuable opportunities for robust scientific inference. The recent decision to remove open-net Atlantic salmon aquaculture facilities from the authors' Broughton Archipelago study site presents an opportunity for sampling in a before-after-control-impact experimental design (Bass et al. 2024).

The land-use land-cover change–emerging infectious disease nexus reconsidered

Challenge: Structural One Health and the dynamic interconnections of emerging diseases, conflict, and other global crises (Koren and Chaves 2025).

Conflict and disease often occur simultaneously. Yet, the explanations of each phenomenon often decontextualize common structural causes, ignoring their interconnectivity. As such, the search for "One Health" principles is often done over a narrowly defined space unable to generate useful insight leading to improved health and well-being.

Structural One Health (Wallace et al. 2015) offers room to incorporate the relational nature of socioeconomic systems, including the political economy, armed conflict, and development; and of natural phenomena, including disease emergence and environmental change. This coupling can yield new insights into the common causes and extended risks posed by current converging crises and how to preemptively address them.

Koren and Chaves (2025) illustrate the power of this approach. Drawing on newly available, high-resolution data on infectious disease outbreaks—combined with information on conflict, forest cover variability, and a range of socio-economic and climate controls—the authors demonstrate how a Structural One Health framework can reveal the complex interconnections among environmental, health, and conflict dynamics. Their findings challenge the conventional, oversimplified view that deforestation directly drives disease outbreaks, instead highlighting the critical role of conflict and socio-economic conditions in shaping these relationships.

For policymakers, Structural One Health underscores the value of seeking common structural causes—and shared solutions—to today's overlapping global crises. For researchers, it opens a path toward actionable insights by encouraging a broader framing of research questions, as illustrated by several other contributions in this volume.

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Evolutionary epidemiology: understanding human non-communicable diseases through a niche construction approach

Challenge: How to integrate an evolutionary perspective into epidemiological studies that explore the interchanges in human and planetary health (Belardinelli et al. 2025)?

Planetary and human health are closely interconnected. The ongoing global environmental crisis is already affecting human health and well-being, shaping for our species an uncertain future marked by increasingly unsustainable environmental conditions, resource scarcity, and rising social inequalities. To better understand and address these interconnected social, environmental, and health challenges, future health research should adopt an evolutionary perspective. This approach can shed light on the underlying causes and the potential long-term consequences of human well-being's dependence on the simultaneous occurrence of multiple, interconnected, and interacting crises that are occurring on our planet.

Belardinelli and colleagues (2025) propose using Niche Construction Theory (NCT) to investigate how humans, through the alteration of the natural world, are modifying their own ecological and developmental niches. These changes can potentially generate novel selective pressures that, although beneficial on some levels, may prove maladaptive on others.

To explain this apparent contradiction between immediate benefits and maladaptation risks, the authors propose analyzing the different spatiotemporal dimensions—microscopic, individual, populational, and short-/long-term effects—where human-induced environmental changes, selective pressures, and health outcomes interact.

We are currently witnessing the embodiment of the maladaptive industrialized niche. Incorporating an evolutionary perspective into future health studies, and specifically within epidemiological research, offers a more comprehensive framework for understanding humans' active role in the environmental crisis and the ongoing fourth epidemiological transition. After the age of pestilence and famine, the age of receding pandemics and the current age of degenerative and human-made diseases (according to Omran's historical reconstruction), we might now experience a fourth transition characterized by greater instability in the distribution of diseases and causes of death, including new pandemics and diseases related to loss of biodiversity and climate change.

This lens can also clarify how the continued presence of planetary threats may alter ecological inheritance and, possibly, selective pressures for future generations, potentially impacting human fitness and locking us into an evolutionary trap.

Navigating the complexities of "One Health"

Challenge: How can we harness the tools provided by the burgeoning AI and big data revolutions to anticipate and predict the course of pandemics in a world challenged by global warming and ecosystems drastically altered by industrialization and urbanization (Saad-Roy and Getz 2025)?

Generative pre-trained transformers, typically in the guise of large language models, are revolutionizing our ability to synthesize existing information sourced by globally configured earth monitoring systems. In tandem, the recent COVID-19 pandemic has underlined the need for intensive data collection systems on state of pathogens and the health of animals and humans in both wild and domesticated ecosystems. These have underscored the importance of developing better big data analytics, highly networked AI communication support systems, and sophisticated computational aids to implement policies to manage and contain pandemic-level disease outbreaks. Given the most recent advances, massive potential exists for numerical computation and big data to change the landscape of One Health, as well as overall pandemic preparedness.

Many important issues, however, remain unresolved. Addressing these will be crucial to fully integrating advances in computational methods into One Health. For example, in a Viewpoint in this Special Issue, Saad-Roy and Getz (2025) outline the design for an integrated system of disease monitoring, data analytics, and epidemic simulation that includes the immunological history (strain exposure and vaccinations) and movement behavior of individuals, and a scenario analysis computational toolbox. They suggest that advanced computational approaches, in conjunction with the passive monitoring of animals (with a focus on behavior), could aid in detection of new pathogens in wild and domesticated animal populations. More generally, advances in computational epidemiology are needed to position One Health systems for the coming AI-dominated informational age. This will require the implementation of cutting-edge computational methods combined with automated intensive and extensive data collection.

One paleopathology and lessons from the past

Challenge: Restoring and maintaining public trust in how (biomedical) science can improve human and animal health (Buikstra et al. 2025).

Vaccines, for example, will not effectively counter diseases if they are not utilized. We must create responsible and understandable messages, while also underscoring the complexities that determine disease susceptibilities, resilience in the face of climate change, and the impacts of toxic environments. Although contemporary examples abound, interrogating past cases drawn from historical and archaeological sources illustrate outcomes, both resilient and devastating. These lessons from the past document the importance of human connections and our dependence on other species and the environment. We term this chronological extension of One Health, One Paleopathology, and advocate for the direct applications of past knowledge to contemporary biomedical problems it provides. We also illustrate germane examples from the past that can be used to open discussions of health-related topics in relatively neutral settings.

Buikstra and colleagues (2025) illustrate this One Paleopathology interdisciplinary perspective through direct applications of lessons from the past to issues in contemporary biomedical science. These include: (1) an archaeological case of equid pathology that informs animal sports medicine; (2) studies of archival evidence in documented collections of human remains that identify risk factors for the progression of chronic diseases, such as venereal syphilis; and (3) how archaeological evidence of the impacts of environmental toxins, including anthropogenic introductions, can provide baselines to evaluate the effects of contemporary contaminations.

It is also instructive to illustrate the way past peoples have faced challenges to health and dietary sufficiency, ranging from pandemic diseases such as plague, and environmental disturbance such as ENSO (El Niño, La Niña) event and climate change. These frequently underscore the robusticity of traditional knowledge, too often ignored today.

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Applying the resist–accept–direct framework to wildlife health management

Challenge: A need for creative, wildlife-specific disease management approaches (Moss et al. 2025).

Although they are natural parts of ecosystems, pathogens and parasites may also be invasive to new regions and present risks to humans, wildlife, or livestock. Agencies that manage wildlife populations may also be tasked with intervening in wildlife disease outbreaks—although their ability to control disease is often limited. The resist–accept–direct (RAD) framework (Moss et al. 2025) is one tool that helps agencies identify potential responses to wildlife disease outbreaks, particularly when halting disease spread is likely to be ineffective. The RAD framework describes three potential approaches: resist the introduction or spread of disease, accept disease outbreaks and their impacts, or direct disease impacts towards coexistence between wildlife and their pathogens. By laying out the options, the framework can give agencies a starting point for navigating decisions about how to intervene—but challenges remain. Although the One Health movement emphasizes the deep connections and commonalities between human, agricultural, and wildlife health, many of the frameworks, resources, and technologies for disease management from the public health and agricultural sectors simply do not translate to free-ranging wildlife. For example, existing diagnostic tools, vaccines, and pharmaceutical treatments are rarely applicable to wildlife, and research informing the control or impacts of wildlife disease usually lags far behind the pace of an outbreak. Thus, although the RAD framework can help managers decide when to intervene, their choice of how to intervene is still often limited by available science and an inadequate toolkit. The dominance of the human medical framework can also contribute to public misunderstanding and unrealistic expectations for wildlife disease control. The One Health movement can help address these challenges by acknowledging that, although wildlife disease is a multi-sector issue, it requires unique tools, research, and expectations that acknowledge the ecology, epidemiology, and management challenges of wildlife systems.

Resolving the conflict between infectious disease and beneficial urban nature

Challenge: Identifying when and where resource provisioning for wildlife amplifies or mitigates risk of pathogen transmission is critical for safeguarding urban health and wellbeing and would benefit greatly from a One Health approach (Robertson et al. 2026).

Understanding the implications of supplemental feeding for infectious disease dynamics is a key challenge for public health in cities. As the number of animal species encroaching into urban areas increases due to urbanization (Robertson et al. 2026), so does the need to clarify the impact of resource provisioning for wildlife by private residents (i.e., handfeeding, bird feeders) and by local councils. Supplemental feeding is a nuanced issue, capable of both sustaining and harming wildlife populations. Crucially, it can be a major driver of interspecies disease spread (Robertson et al. 2026), with feeding sites sometimes becoming transmission hotspots. Within cities, the topic of supplemental feeding grows in complexity, as it is often undertaken by private residents in public parks or on their property. In recent years, the need to understand the consequences of these activities for animal and human health has risen dramatically with the spread of H5N1 bird flu. In particular, the capacity of private supplemental feeding to facilitate the rapid spread of avian influenza in urban environments (for example, through handfeeding at urban lakes) requires further consideration. In other instances, planned resource provisioning by local councils may serve to mitigate disease risk—for instance, the strategic placement of fruit trees to redirect urban bat populations away from residential areas. Clarifying when and where resource provisioning increases, decreases, or negligibly affects pathogen transmission dynamics is necessary to guide public health advice and manage urban disease risk. The positive associations that many people have with feeding certain forms of wildlife, like birds, and the importance of nature in cities more broadly, further complicates these discussions. A One Health perspective is thus essential for answering this question, providing guidance on when and where resource provisioning is appropriate within the urban fabric, alongside instances of where it should be more actively discouraged.

Agriculture

Agriculture is the largest land-use globally (https://ourworldindata.org/grapher/breakdown-habitable-land) and one of the most essential relationships that humans have with the nonhuman world. Societies often move to increasingly intensive agricultural systems over time, with increasing simplification of processes, larger agricultural operations, and homogenization of practices from the genetics of domestic animals and plants through to landscape levels (Foley, 2005). This simplification is also often present in the goals of the agricultural systems—to maximize the production of provisioning ecosystem services with limited emphasis on other ecosystem services including human and nonhuman health. Yet, we can look to the past systems and to current advances to create agricultural systems that serve humans and nonhumans more holistically, and an impactful place to start is by increasing biodiversity (species and/or functional diversity) within agriculture-dominated landscapes. The contributing authors in this section focus on challenges related to identifying farming approaches that both contribute to food security and the maintenance of biodiversity. There are many instances where sustainable agricultural practices can enhance biological diversity—for example, traditional production of hay meadows in Europe and pastoralism (Briske et al. 2026). Changes toward increasing the biodiversity in agriculture-dominated landscapes are more likely to be successful if diverse stakeholders—including the producers—are invited to engage as partners in the work. Achieving greater biodiversity with coincident improved ecological resilience will enhance the One Health of the agriculture–human–ecosystem interface.

Orchard systems offer low-hanging fruit for low-carbon, biodiversity-friendly farming

Challenge: Can management of perennial cropping systems be amended as to reconstitute core ecosystem services profitably and fortify landscape-level spillover of functional biodiversity (Wyckhuys et al. 2025)?

Given their temporal stability and biological richness, orchards offer powerful levers to enhance landscape-level ecosystem service delivery. However, pesticide-intensive management poses a major hurdle. Replacing chemical inputs with biodiversity-based strategies such as biological control can help reverse biodiversity loss, resolve agrochemical pollution, and promote food security. But how do we effectively scale up biological control?

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Wyckhuys and colleagues (2025) outline how biological control can be taken to scale by reforming its underlying science, policies, regulations, and implementation modes. Biological control research should be anchored in a solid understanding of biodiversity and ecological processes, infused with next-generation tools and citizen science, and geared towards resilience rather than short-term yield gain. Pesticide-intensive systems could be the "low-hanging fruit" to focus on initially. Further, by treating orchards as complex, dynamic, and self-regulating socioecological systems, pest and sustainability issues can be tackled concurrently.

Long-term agroecological experiments and changes to academic reward systems are essential to overcome the limitations of short-term research and publishing pressures. Networked field trials, living labs, and farmer-scientist collaboration could generate adaptive, context-specific solution "bundles." Transdisciplinary research can assess synergies and trade-offs among biodiversity conservation, human health, and societal wellbeing. A closer integration with social sciences can pinpoint implementation bottlenecks and capture multidimensional benefits, ensuring that newly acquired insights support farm-level decision-making and action.

A funding boost can reconstitute core institutional capacity, expand infrastructure, and provide vital momentum to redesign orchard systems toward sustainability. Enabling policies and adapted regulations can tie pesticide phasedown objectives to creative incentives, monetary transition support or insurance systems, and tailored technical assistance. Such measures are to be embedded within a unified transnational framework promoting low- or zero-pesticide crop protection as a core element of low-carbon, climate-resilient and biodiversity-friendly farming landscapes.

By reconfiguring biological control science, policy, and practice, orchards can become landscape-level hubs of ecosystem service delivery that uphold the interconnected health of humans, animals, and the environment.

Can native vegetation in agroecosystems provide a net benefit for pollinators, despite pesticide use?

Challenge: Is it possible for humanity to simultaneously produce enough food for 10 billion people and halt biodiversity loss (Toth et al. 2025)?

Agriculture occupies approximately 40% of Earth's land cover and is a leading driver of terrestrial biodiversity loss. Beyond establishing large biological reserves, there is an urgent need and value to integrate semi-natural habitat *within agricultural landscapes* to reverse this loss. When done strategically, semi-natural habitat not only sustains biodiversity, but provides ecological functions important to agriculture, such as soil stabilization and pollination. Toth and colleagues (2025) describe a well-researched example of tallgrass prairie reconstructions within commercial-scale corn and soybean fields in the Midwestern United States. The practice, termed "prairie strips," uses patches of native, perennial grasses and forbs within cropland that increase biodiversity, while also providing benefits to soil, beekeeping, and native pollinator health.

Prairie strips provide valuable lessons for the practice of regenerative agriculture more globally. First, "all hands on-deck" are needed to reverse declines. Although government agencies and conservation organizations are important, farmer-led conservation is essential. Second, practices must address farmers' immediate concerns to motivate adoption. Farmers install prairie strips to stem soil erosion; the additional benefits of supporting pollinators and improving habitat for biodiversity are perceived as bonuses. Third, practices must be straightforward to implement, requiring relatively minimal changes to current farming practices. Prairie strips do not require farmers to change conventional practices such as tillage or the use of pesticides. Fourth, practices must not harm the economic bottom line of already struggling farmers, and will achieve widest adoption when supported by local and federal governmental programs. For example, prairie strips adoption is increasing because costs are offset through financial incentives from the US Conservation Reserve Program.

Is it *possible*? The Prairie Strips team experience working with farmers suggests a hopeful outcome! Farmers should be treated as key actors and equal partners in halting the loss of biodiversity and securing the critical ecosystem functions that nature provides.

Nature-based approaches and solutions

Nature-Based Approaches incorporate strategies that utilize existing natural processes and ecosystem services to optimize the health of humans, domestic and wild animals, and ecosystem resilience. The contributions in this section address a range of challenges that enhance critical aspects of ecosystem services, biodiversity, factors that are critical for the health of living organisms and considers One Health as an effective approach to conceptualize issues and to organize a structured framework for resolving issues.

Toward sustainable irrigation practices safeguarding groundwater biodiversity and ecosystem services

Challenge: At what spatial and ecological scales should local ecosystem management be designed to safeguard its long-term functioning and service provision (Fišer et al. 2025)?

Human well-being heavily relies on ecosystem services. As a result, conservation and management efforts often focus on preserving these services. However, such efforts typically treat ecosystems as isolated units, which rarely reflects reality. Ecosystem boundaries are often diffuse, and ecosystems themselves are functionally interconnected. Sustainable management of any local ecosystem must therefore be framed within a broader spatial context that accounts for inter-ecosystem dependencies. Fišer and colleagues highlight this complexity using the example of irrigation and groundwater. Human activities on the surface can cumulatively affect subsurface ecosystems, potentially impairing groundwater ecosystems and the services they provide. This interdependence raises a critical question: at what spatial and ecological scales should ecosystem management be designed to safeguard long-term functionality and service provision?

A promising approach may involve shifting from a human-centric, resource-driven management model to one that prioritizes ecosystem integrity and function. Achieving this transition demands interdisciplinary efforts in three key areas. First, we need a deeper understanding of community structure in many ecosystems, how communities respond to human disturbance, and how this disturbance affects ecosystem functioning. Second, we must evaluate the biological, spatial, and temporal interconnections among ecosystems. Integrating these insights can inform land-use planning and the establishment of ecologically meaningful buffer zones. The third—and most challenging—step is implementing such a model. This requires a paradigm shift: nature conservation should not be viewed as ancillary to the One Health agenda. Rather, true success in One Health can

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

only be achieved as an outcome of comprehensive global efforts to conserve nature and protect planetary health.

Biodiversity science and biosurveillance are fellow travelers

Challenge: One Health needs biodiversity sciences (but is the inverse true?) (Poisot et al. 2025).

Biodiversity has re-invented itself as a field that can make information flow from research to measurable policy outcomes; this new state of the field has emerged in part through the work of the Convention on Biological Diversity (CBD), and notably the adoption and first steps towards the implementation of the Kunming-Montréal Global Biodiversity Framework. In the last year, the CBD has adopted a sweeping action plan on biodiversity and health (in COP/DEC 16/L.10), which explicitly seeks to further the vision of One Health. It is worth asking two fundamental questions, that are liable to reshape the place of biodiversity within the One Health approach in the future. First, should the Convention on Biological Diversity join the One Health quadripartite? This would undoubtedly lead to easier knowledge and expertise transfer between the two domains, and speed up the mainstreaming of environmental expertise, which currently primarily resides outside of One Health circles. Second, what is the value added of One Health for biodiversity? The recent years have shown that the biodiversity monitoring community is firmly aware of the challenges of connections to health, human or otherwise. Maybe the vision of One Health where environmental expertise is tightly integrated already exists; it simply is carried out by the Convention on Biological Diversity. More constructively, the development of One Health, and the development of a vision of biodiversity as a health-adjacent field, must not be allowed to proceed in silos. The conceptual and organizational integration demands that all of these fields be given a common space to interact, exchange, and guide action.

Navigating the urban landscape: further understanding coupled human–wildlife systems to enhance the One Health perspective

Challenge: How can One Health frameworks integrate movement ecology to address the complexity of zoonotic disease transmission in human–wildlife coupled systems (Hussain et al. 2025)?

Urban ecosystems have become epicenters of zoonotic risk, shaped by the convergence of high-density human populations, fragmented wildlife habitats, and shifting movement dynamics of both people and animals. Yet, prevailing One Health frameworks often underrepresent the spatial and behavioral nuances that drive these risks. To truly address zoonotic spillover in cities, research must evolve to integrate movement ecology into One Health frameworks, particularly how space-use overlaps, human and animal behavior changes, and human mobility shape disease transmission pathways.

As detailed by Hussain and colleagues (2025), when animals like white-tailed deer, urban bats, and synanthropic primates navigate urban green spaces, they often overlap with human uses. These contact zones are dynamic, but not fully accounted for in current zoonotic disease modeling. Emerging technologies such as GPS telemetry, accelerometers, and mobile phone tracking offer the ability to understand human and animal movement patterns, revealing hotspots of interaction and pathogen flow. Integrating this information into One Health research allows for predictive surveillance systems and spatially targeted interventions.

The authors recommend that urban planning prioritize the design of ecological corridors, enforce wildlife-proof infrastructure, and integrate mobility data into public health forecasting. Surveillance systems should not only test targeted species but also align with real-time movement and behavioral data to monitor risk in urban and green-space interfaces. Furthermore, by embedding movement ecology into One Health strategies, we can transition from crisis response to anticipatory health governance. This shift reframes cities not only as human settlements, but as cohabitated, dynamic ecosystems where health policy considers the full spectrum of mobile life.

True sustainability is sustanimalism

Challenge: How can sustainability policy and research frameworks evolve to include multispecies justice as a core principle of planetary health (Martens et al. 2024)?

As planetary health gains prominence, its frameworks remain predominantly anthropocentric, often sidelining the ethical and ecological relevance of nonhuman animals. Future research must interrogate and expand the boundaries of planetary health to include interspecies justice, not only as a moral imperative but also as a structural necessity for resilient ecosystems.

Martens and colleagues (2024) propose *sustanimalism*—a model that integrates the well-being of all human- and nonhuman animals into sustainability thinking—as a foundation for this shift. Yet, this concept is largely absent from current health-environment policy discussions. A key research question is: What would sustainability metrics look like if they accounted for animal welfare and moral standing, not just environmental impact and human outcomes? Further interdisciplinary studies are needed to develop indicators, legal frameworks, and ethical models that assess sustainability from a multispecies perspective.

On the policy front, governments and global institutions should begin re-evaluating sustainability and food security strategies that rely on intensive animal agriculture. Policies that incentivize plant-based innovation, reduce reliance on livestock, and protect animal habitats must be expanded—grounded not just in emissions reductions but also in the recognition of animals as co-inhabitants, not commodities.

In short, future research should address the epistemic gap between planetary health and animal ethics, whereas policy should begin treating the inclusion of animal well-being as fundamental to long-term health and environmental planning—not as an optional add-on.

Predators and scavengers as sentinels for planetary health

Challenge: How can planetary health frameworks be redesigned to integrate the ecological functions and societal values of predators and scavengers while addressing the human–wildlife conflicts that threaten their persistence (O'Bryan et al. 2025)?

Predators and scavengers occupy a unique dual role in planetary health: they provide substantial ecological, economic, and human health benefits, yet they are also among the species most likely to generate local conflict. Although communities often experience real or perceived costs from species such as bats, vultures, dingoes, and large carnivores, emerging evidence shows that these species can generate benefits at regional and national scales—from disease regula-

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

tion and carcass removal to supporting food security and tourism economies (O'Bryan et al. 2025). Overcoming this tension remains a central challenge. At the same time, many predator and scavenger populations are declining rapidly due to habitat loss, persecution, and sociopolitical instability. Because numerous species live outside protected areas and within regions experiencing significant socioeconomic turmoil, their roles as biological sentinels, and their contributions to biodiversity and human well-being, risk being lost before they can be integrated into global conservation and health policy. Time is running short to align their protection with international biodiversity commitments. Finally, large knowledge gaps remain. Much of what we know about predator and scavenger ecosystem services comes from a narrow subset of species, whereas reptiles, amphibians, small mammals, and most marine predators are largely absent from the ecosystem-services literature. Addressing this gap requires investment in interdisciplinary research grounded in One Health and Planetary Health principles to quantify and map the contributions of these overlooked taxa. Only then can their ecological functions be meaningfully incorporated into decision-making at multiple scales.

One Health on islands: tractable ecosystems to explore the nexus between human, animal, terrestrial, and marine health

Challenge: Overcoming the hurdle of cross-context comparability of One Health research and interventions (Fountain-Jones et al. 2025).

A core challenge limiting One Health research is comparing complex linkages and intervention strategies across settings to draw generalizable conclusions. This issue is not unique to One Health; ecology, for example, has long grappled with capturing the complexity of interactions between organisms and their environments. One major breakthrough in ecology and evolution was the recognition of islands as natural laboratories, which paved the way for the development of island biogeography theory (Macarthur and Wilson 1967). Because each island serves as a discrete ecological unit, researchers can more easily replicate studies across multiple islands and measure how variations in factors—such as species composition, population density, and environmental pressures—shape ecological outcomes (e.g., Fukami et al. 2006, Warren et al. 2015). This replicability has significantly advanced our understanding of concepts like colonization, extinction, and community assembly (e.g., Losos and Ricklefs 2009), underscoring the power of comparative research in discrete, bounded settings.

Fountain-Jones and colleagues (2025) draw on evolutionary ecology to outline how islands could function as One Health natural laboratories. By reframing islands as tractable, comparable models for studying One Health in the context of climate and environmental change, we can develop more robust, predictive tools that are generalizable yet grounded in ecological realism. These studies are particularly well-suited to examining cross-cutting issues such as disease emergence, zoonotic disease transmission, reservoir dynamics, and vector control—key themes in One Health research. By highlighting the potential of island-based methodologies, Fountain-Jones and colleagues (2025) offer a critical bridge between methodological rigor and real-world relevance in global One Health research.

In the process of transformation: wildlife conservation in China in the post-epidemic era

Challenge:How can resilient mechanisms be developed to balance wildlife conservation and sustainable use, systematically prevent the spread of zoonotic diseases, and promote One Health (Zheng et al. 2025)?

Although the One Health framework emphasizes the interconnectedness of human, animal, and environmental health, policy implementation in many regions remains primarily oriented towards human health and economic security, with the ethical status and ecological functions of wildlife often marginalized. This limitation weakens the capacity to prevent zoonotic diseases at their source and hinders the development of resilient ecosystems. Future research must draw on global experience and actively challenge anthropocentric thinking in order to advance multispecies justice. It is also necessary to adopt more diverse research approaches, interdisciplinary studies combining legal geography and biology, for instance, may offer new insights.

Recent wildlife conservation efforts in China following COVID-19 reveal that, although legislative enhancements and technological innovation have substantially curbed illegal trade and habitat degradation, the tension between conservation and utilization persists as a fundamental challenge. This unresolved tension directly undermines the attainment of One Health objectives. An urgent priority is to identify an appropriate balance between conservation and utilization through scientifically robust ecological risk assessments and technology-enabled precision regulation.

The root causes of cross-species viral transmission lie in the destruction of wildlife habitats and illegal trade. Yet in many regions, One Health policies remain largely focused on pandemic emergency responses rather than systematically addressing the underlying tensions between humans and wildlife. Governments and relevant institutions must broaden their global perspectives and pursue locally appropriate legal reforms and coordinated enforcement mechanisms (Zheng et al. 2025). In doing so, they can construct resilient mechanisms for wildlife conservation and sustainable development, thereby enabling genuine health coexistence among humans, animals, and the environment.

Transdisciplinary research priorities for a One-Health approach to human–wildlife coexistence

Challenge: Integrate the approaches of One Health and human–wildlife coexistence to minimize conflict and support greater wellbeing (Salerno et al. 2025).

Linking human, animal, and ecosystem wellbeing under One Health has marshaled notable recent progress in health and sustainability sciences. Yet, One-Health approaches have disproportionately focused on human and domestic animal health, whereas ecosystem health including wildlife remains insufficiently engaged. This limited focus suggests untapped potential for addressing human–wildlife conflict challenges through supporting coexistence in systems where humans, domestic animals, and wildlife share space.

To minimize conflict, Salerno and colleagues (2025) propose an integration of One-Health approaches with the relatively nascent science of human–wildlife coexistence. This integration views coexistence—the occurrence of sustainable wildlife populations and human endeavors with minimal human–wildlife and human–human

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

conflict—at the intersection of human, domestic animal, and wildlife health, all supported by ecosystem health.

This framing elevates key research priorities to guide a future agenda. Wildlife predation of livestock and crops is a primary source of human–wildlife conflict worldwide, posing direct threats to multiple domains of human and animal health. Disease transmission is another form of conflict, and Salerno and colleagues point to not only the potential for pathogen spillover from wildlife to domestic animals and humans, but also the potential for spillback to vulnerable wildlife populations. Climate and land-use changes alter the ways in which wildlife come into contact with humans and domestic animals, and novel interactions have greater potential to result in conflict. In addition to direct conflict with people and wildlife, social conflict among people about wildlife is a prevalent yet understudied form of conflict, impacting human well-being and exacerbating direct conflict. Finally, although coexistence can lead to conflict, Salerno and colleagues also emphasize that further research should explore the potential benefits of wildlife for both human and domestic animal health.

To address these future challenges, Salerno and colleagues (2025) point to the importance of transdisciplinary research approaches, inclusive of diverse academic disciplines partnering with stakeholders and engaging with varied knowledge systems. Such approaches have the greatest potential to support coexistence outcomes and synergies across the domains of One Health.

Navigating One Health impacts of rugged terrain: challenges and opportunities

Challenge: How can One Health be effectively promoted in the context of rugged terrain (Cao et al. 2025)?

Terrain ruggedness creates a unique set of complexities for One Health because it generates multiple pathways that simultaneously produce benefits and risks. As outlined by Cao and colleagues (2025), this duality makes it difficult to design strategies that consistently advance One Health outcomes in rugged landscapes. Direct impacts arise when physical features modify movement, limit accessibility, and reshape local environments. For example, movement modification can restrict community mobility and wildlife dispersal, reducing disturbance and zoonotic transmission but also hindering healthcare delivery and genetic exchange. Access and disturbance regulation can protect sensitive habitats although delaying emergency response and isolating residents. Microscale climate regulation may buffer temperature extremes and support drought resilience, yet also create favorable conditions for disease vectors. Hazard modulation and risk buffering can lower flood exposure in low-lying areas but increase landslide susceptibility on steep slopes.

Indirect impacts occur when rugged terrain affects One Health through changes in ecosystem services and natural disaster risk. Terrain features that enhance biodiversity, soil stability, and water retention can strengthen ecological resilience but complicate resource management and agricultural use. These same characteristics can elevate exposure to erosion, landslides, and prolonged isolation during extreme events. Each mechanism embodies both opportunities and challenges that rarely align neatly with conservation or health objectives alone.

This complexity underscores why a key future challenge is determining how One Health frameworks can integrate these diverse effects into cohesive strategies. Addressing this challenge requires models that reveal the interplay of protective and harmful influences, and policies that harmonize conservation, resilient infrastructure, and equitable service access. Without such integrated approaches, rugged terrain will remain a persistent driver of vulnerability.

Microbiome: a nexus of One Health strategies to address emerging risks

How can climate change and pollution-driven shifts in microbiome dynamics be incorporated into predictive One Health models (Drobne et al. 2026)?

Climate change, pollution, and microbial contamination are increasingly recognized as drivers of microbiome instability across human, animal, and environmental domains. Our paper highlights that these stressors alter microbiome resilience, stability, and functional redundancy, thereby influencing health outcomes at multiple scales (Drobne et al. 2026). Yet, current One Health models rarely integrate microbiome data into predictive frameworks for climate and pollution impacts.

The challenge is to develop robust, cross-sectoral models that capture how environmental stressors reshape microbiome dynamics and, in turn, affect food safety, water quality, and disease emergence. For example, rising temperatures and altered precipitation patterns influence soil and water microbiomes, which cascade into agricultural productivity and zoonotic risk. Similarly, pollution-driven dysbiosis in gut microbiomes can exacerbate chronic disease burdens.

Incorporating microbiome indicators into predictive models would allow policymakers to anticipate vulnerabilities before they manifest as crises. This requires harmonized monitoring systems, standardized metrics, and integration of microbiome databases with climate and pollution datasets. Such models could inform adaptive interventions ranging from precision microbiome modulation to ecosystem restoration.

Addressing this challenge will position microbiome science as a cornerstone of anticipatory governance, enabling One Health policies that are not only reactive but proactive in safeguarding human, animal, and ecosystem health.

Seagrass meadows as a foundational concept for "One Health"

Challenge: facilitating the recognition of the holistic role of seagrass in human and ecosystem health

"Seagrass meadows as a foundational concept for 'one health'" (Unsworth et al. 2026) describe how embedding seagrass into a One Health framework requires addressing key scientific and policy challenges. They highlight that the research priorities include quantifying the full suite of co-benefits of carbon sequestration, fisheries production, and water-quality regulation, and determining whether these services co-vary across environmental contexts. They also explain we need to understand more about the thresholds and tipping points of loss as this is essential for predicting when human and ecosystem health benefits can be regained. Standardized monitoring, advances in remote sensing, and robust metrics for evaluating Nature-Based Solutions are also urgently needed. Equally important is socioeconomic research to understand community dependence and ensure conservation aligns with food security and climate justice.

Policy gaps remain substantial. Seagrasses are rarely recognized as critical natural "green infrastructure" in climate, food security, poverty alleviation, and public health strategies. Effective governance requires coordinated catchment-to-coast water-quality im-

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

provements, integration of seagrass protection into coastal planning and marine protected areas, and financial and legal mechanisms that prevent destructive activities. Ultimately, long-term success depends on sustainable financing, strong legal protection, and meaningful community participation to secure the One Health benefits that seagrass meadows provide.

Multicity research networks are needed to address global One Health challenges

Challenge: How can multicity research networks help address global One Health issues (Murray et al. 2025)?

Urban areas are the fastest growing habitat type on earth, creating opportunities for interactions between people and commensal zoonotic reservoirs, higher temperatures, pollutants, and less beneficial exposure to nature. More research is therefore needed to understand One Health challenges and opportunities in urban areas. However, it is difficult to generalize research results from a particular study area because cities differ in size, biome, climate, landscape, and sociodemographic contexts. To address this challenge, collaborative networks of researchers that collect comparable data using standardized methods, such as the Urban Wildlife Information Network, are needed to understand how One Health processes are generalizable within and among cities (Murray et al. 2025). In addition to spatial variation, researchers must consider the highly dynamic nature of urban landscapes, for example changes in development, climate, and human activity over time. These dynamics can inform predictive studies to highlight high-risk contexts for One Health challenges such as urban sprawl, flooding, and heat stress. To accurately inform such multi-city studies and associated predictions, long-term data is needed from sites representing gradients within the urban landscape. Such gradients can be designed to consider the socio-demographic landscape of the city to ensure that sampling is representative—for example, avoiding overrepresentation of privileged neighborhoods. This has twofold benefits of accurately reflecting a city's ecology and advancing the principles of environmental justice. Promoting interdisciplinary collaborations (ecologists, public health, urban planners, developers, architects) can help translate long-term data into actionable policies that address context-dependent One Health challenges. For example, efforts to increase nature in cities may exacerbate risks for zoonotic disease transmission if not done thoughtfully. Research networks such as the Urban Wildlife Information Network (Murray et al. 2025) can facilitate long-term, multi-city studies in spatiotemporally dynamic urban landscapes to improve the health of people, animals, and ecosystems in cities around the world.

Pyrohealth synchrony: integrating wildland fire into One Health to benefit plants, animals, ecosystems, and people

Challenge: How can society recognize the health benefits of wildland fire while addressing existing negative outcomes (Gilvarg et al. 2025)?

One Health efforts often fail to adequately consider the influence of environmental factors on the health of plants, animals, and humans. Gilvarg and colleagues (2025) detail the widespread omission of wildland fire from previous One Health efforts—something they identify as problematic because of the significant health benefits that fire management can facilitate. The authors advance a fire-integrated One Health framework that could address fire management challenges by uniting diverse stakeholders under a cohesive health-forward paradigm. This would reconcile the often-competing objectives of wildfire suppression and the use of fire as a tool to promote the health of plants, animals, humans, and their environments. Gilvarg and colleagues (2025) propose the concept of "pyrohealth synchrony"—or actively aligning contemporary fire management with historic fire regimes under current and future planetary changes—as the most likely way to generate novel, fire-informed health solutions and benefits. However, to make this new perspective workable, many challenges must be addressed.

Although fire has shaped our planet and its inhabitants for millennia, achieving "pyrohealth synchrony" will necessitate gaining and then leveraging detailed knowledge of historical fire regimes (i.e., frequency, intensity/severity, seasonality, and spatial heterogeneity) across diverse and constantly evolving ecosystems. Furthermore, research will need to elucidate the health effects of these regimes and how contemporary management (e.g., mechanical fuel treatments and prescribed fire) can mitigate their potential negative impacts, including smoke exposure and vector-borne disease spread. Translating these research efforts to tackle pressing global health issues will require planning and collaborations between fire and One Health practitioners facilitated through the strengthening of interdisciplinary partnerships (e.g., One Health Networks). Finally, human dimensions research must determine if fire-integrated One Health is a better way to communicate the complex interactions between wildland fire and health to stakeholders.

Preserving predation

Challenge: How can we put guardrails on One Health ideas to ensure that they are compatible with ecosystem integrity?

As the One Health concept has been increasingly adopted in conservation, there has been growing interest in wildlife disease. However, there is a current lack of clarity around what exactly constitutes disease and to what extent managers are obliged to intervene to prevent such processes.

Hampton et al. 2025 explore predation and its under-recognized tradeoffs with the concept of health that must be navigated when it comes to applying One Health ideas to wild animals. Over recent decades, veterinarians and wildlife managers in many contexts have attempted to treat animals injured in predation events as though predation is a disease. However, allowing nature to take its course for these animals is enabling an essential ecological process. In this context, runaway One Health ideas need to be checked in order to be consistent with the aims of conservation.

As for policy, wildlife managers should carefully consider the ethical rationale for any proposals to treat wild animals injured by predators. Restraint here will be necessary to prioritize resources for where they are most needed, and to protect the life-sustaining processes and balances of nature.

In short, predation is not a disease, and should not be treated as one, even if some people find its consequences distressing to witness.

Small islands as system and scale to examine the One Health concept

Challenge: Can One Health insights from small island socioecosystems be transposed to the global scale?

The limited land area, relatively clear ecological and social boundaries, and compressed socioecological dynamics of small islands posi-

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

tion them as unique laboratories for examining the forces that underpin the nature–human wellbeing nexus. Koenig et al. 2026 highlight the key interactions which characterize islands across the Caribbean, Pacific, and Indian Ocean, where empirical evidence shows that environmental degradation—and its social and health consequences—is ultimately driven by weak governance. Advancing One Health as the nature–human wellbeing nexus therefore consists of solving multiple social and environmental collective action problems (CAPs), which give rise to several challenges.

The first challenge is putting in place a harmonized governance framework that is able to address CAPs simultaneously. This leads to the second challenge of having adequate human and institutional capabilities to enhance the science–policy interface supported by transdisciplinary research to better understand the complex socioecological system explaining the nature–human wellbeing nexus. Another challenge is to contend with the cultural and political dimensions of the governance system that are macro elements influencing conversations related to nature and human well-being, and, hence, the direction of research and policy dialogue. The transdisciplinary approach will need to contextualize scientific research related to One Health within the broader ambit of political economies that will cover colonial and post-colonial exploitative and rent-seeking legacies. In islands, Koenig et al. 2026 have demonstrated that the underlying political ecology is rooted in financial maximization through consumption-driven economic growth—that is, an entropy increasing economic system, also documented at the global scale. Assessing the One Health concept in the context of islands therefore raises this central question: Can One Health be achieved in the current entropy-increasing, consumption-driven economic growth paradigm? The same question is arguably applicable at the global scale, framed by the planetary boundaries.

Indigenous and community issues

The concept of "health" is broad and provides a strong framework to consider well-being beyond human physical longevity and disease avoidance to include other domains of human and nonhuman health. Yet, the understandings and operationalizations of the One Health framework may too often focus on human physical well-being—and this is understandable given the origins of the framework from dominant, Western culture. The authors in this section highlight the need for the One Health framework to expand to more holistic understandings of health that incorporate worldviews and knowledge systems beyond those that form the foundation of Western science and culture. Examples of this include valuing collaboration in addition to individualism, redundancy in addition to efficiency, systems thinking in addition to reductionism, interdependence in addition to independence, and general resilience and transformability in addition to engineered resilience. Because awareness of one's own worldview and knowledge system is often implicit, we need to make these understandings and values explicit so that we can balance both the need for this work to be place-based and grounded in local knowledges with the ability to have common understandings that are translatable across languages and cultures. Deepening the One Health framework to have a shared foundational understanding that includes physical, spiritual, cultural, and environmental dimensions while also valuing local, Indigenous, and traditional knowledge and systems has potential to support planetary-level health.

Leveraging positive interactions in nature to enhance the shared goals and success of One Health

Challenge 1: How do we create and sustain successful One Health collaborations?

Challenge 2: How do we provide greater guidance for the implementation of One Health initiatives (DeMartini et al. 2025)?

With rapid growth of the One Health approach to address the increasing challenges to human, nature, and environmental well-being, practitioners have identified the need for greater guidance in the design and implementation of One Health initiatives (e.g., Pepin et al. 2024). Cooperative and positive interactions occur at all levels of biological organization. The success and significance of these relationships are evidenced by their persistence in the face of natural selection and environmental perturbations. This plethora of cooperative and positive relationships in nature can inform the design and implementation of One Health initiatives. More specifically, the development and persistence of these relationships in nature entail processes—mobilization, incentivization, accountability—that can inform approaches for efficiently building collaborations across One Health initiatives (DeMartini et al. 2025). For instance, the strategic selection of partners and their perceived contributions, incentivizing each partner based on their desired "rewards" for participation, and monitoring the progress of partners to provide feedback and avoid self-interested behavior, all contribute to successful collaborations. This applies across local, regional, national, and international scales of collaboration. Protecting and leveraging cooperative and positive interactions can facilitate achieving One Health objectives. Examples include enhancing taxonomic and functional diversity to control disease outbreaks, and leveraging natural barriers (e.g., coral reefs, mangroves, wetlands) to protect coastal ecosystems and human communities. Future challenges include ensuring the capacity for future discoveries of positive interactions (e.g., Coale et al. 2024) and the means of leveraging relationships to achieve One Health objectives. Other challenges include impediments to institutional partnerships such as diminished capacity to engage in potential collaborations, and cultural barriers to collaboration.

The geroscience perspective on One Health

Challenge: How can translational gerontology be integrated into the One Health framework, so that non-pharmacological and pharmacological interventions that promote healthy longevity are conceptualized, and pursued, in ways that take seriously the interdependence of healthy human aging and animal and environmental health (Farrelly 2025)?

Chronic disease (e.g., heart disease, cancer, and Alzheimer's), frailty and disability become more prevalent in an aging world, leading to a growing healthspan–lifespan disparity. Translational gerontology studies non-pharmacological and pharmacological interventions that modulate the mechanisms of aging, revealing novel strategies to increase healthspan by slowing the rate of biological aging.

Farrelly (2025) advances the Geroscience Perspective on One Health, a framework that illuminates how One Health can reshape our perception of, and ability to redress, the health risks of both infectious and chronic disease in ways that take seriously the interconnections between human, animal and environmental health. The framework emphasizes the different environmental, lifestyle, and pharma-

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

cological ("gerotherapeutics") interventions that can promote healthy longevity, and animal and planetary health.

Air pollution reduction, enhancing the "green infrastructure," improving the quality of dietary options and the opportunities for exercise and connecting with people and nature are examples of nonpharmacological interventions that improve the healthy longevity of human populations while also benefitting animal and planetary health.

Drugs that slow aging could also be utilized to improve not only the health of aging populations, but also the health of companion pets and the productive lifespan of agricultural animals (e.g., dairy cattle). By reducing the disparity between healthspan and lifespan, gerotherapeutics could reduce the greenhouse gas emissions from the global healthcare systems of an aging world, as well as emissions from meeting the energy requirements of companion pets and agricultural animals.

Evolutionary principles shape the health of humanity as a planetary-scale organism

Challenge: What are the foundational scientific principles of One Health that can ground it as more than a metaphor? How can One Health rigorously define "health" across scales—from individuals to ecosystems to the planet as a whole (Jacob and Pourdavood 2025)?

A critical challenge for One Health is to move beyond its metaphorical invocation of interdependence and instead establish a scientific framework that integrates organismal, ecological, and evolutionary logic. In complex systems analysis, terms adopted from engineering-based approaches such as "feedback" and "regulation" are used to describe attributes and functions but exclude developmental and evolutionary mechanisms that underpin the health of the system. What we require is to ground health in a framework that includes the centrality of learning, creativity, and resilience in living systems, that is, based on the fundamental principles of biological organisms.

Jacob and Pourdavood (2025) suggest that evolutionary-developmental (evo-devo) biology offers a promising scaffold. Their application of evo-devo principles emphasizes the creative tension between preservation and innovation within species and lineages, the importance of energetics (not merely disembodied information processing), and the importance of biological selves for putting information processing in context. This helps define health not merely as equilibrium or even sustainability, but as *evolvability*—a capacity for increasing the probability of successful evolution. As such, they have suggested that such principles could underlie a major evolutionary transition from ecosystem to organism.

One Health must grapple with planetary-scale dynamics. Jacob and Pourdavood propose viewing the biosphere and human derived technosphere and infosphere as part of an integrated system with organism-like tendencies. Their work revisits the early 20th-century notion of the *noosphere* as a way to conceptualize this globally emergent, evolutionary system. As the paper argues, this demands a reconceptualization of health as a distributed, collective property—beyond mere survival—and toward increasing the probability of a successful evolutionary outcome.

An Innu poem as a reflection on innovation in One Health initiative at the Université de Montréal

Challenge: How can One Health initiative move beyond technical and biological interdependence to meaningfully engage with the emotional, cultural, and symbolic dimensions of human-environment relationships (Beauchet 2025)?

To address the ecological crisis, One Health must evolve beyond its current multidisciplinary scope. The biological interdependence of humans, animals, and the environment is well recognized. Yet this is not enough. The global crisis is not only ecological but also a crisis of meaning.

One Health must therefore integrate Indigenous knowledge systems and mesology as essential components of its foundation (Beauchet 2025). These knowledge systems offer relational and place-based understandings of health that resonate deeply with the lived experiences of communities. They challenge Western dualisms and emphasize the entanglement of the human and nonhuman worlds. Beyond this, the authors propose incorporating phenomenology and aesthetics into One Health. Phenomenology, the study of conscious experience, allows us to explore how people perceive and make meaning of their environments through embodiment, emotion, and lived experience. It sheds light how reconnection to nature can restore well-being. Similarly, engaging with nature through art and cultural ritual, including poetic, musical, or visual expressions, awakens emotions, fosters empathy, and a renewed sense of belonging. These forms of aesthetic engagement activate ethical and behavioral shifts that scientific data alone rarely achieves. Incorporating these approaches will not only make One Health more emotionally resonant and inclusive, but also strengthen its ethical, cultural, and transformative potential.

Community-based co-production of knowledge about wildlife trade and anthrax as a high consequence pathogen

Challenge: What assumptions may be challenged when employing co-production methods into applied One Health research (Gore et al. 2025)?

Although One Health recognizes the equal importance and interconnectedness of people, the environment, and animals (Lebov et al. 2017), it can be difficult in practice to maintain equivalence across these spheres and types of relationships between them (e.g., causality, directionality, intensity, meaning), because scientists may assume away conflicting priorities that can appear during research. Scientists can more centrally consider that although equivalent importance of the spheres is assumed, lived experiences and on-the-ground realities are unlikely to be mirrored and need not be penalized. Researchers should not take for granted that disruptions to harmonization across spheres can occur at multiple points along the scientific process. Scientists focusing research questions on ecosystem and animal species health may find it challenging to align study system boundaries with the lived experiences of community members. Communities may find resources dedicated to wildlife health to be disproportionately high against those allocated to human health and well-being, even if risks to human health are posed by the same wildlife. Scientists quantifying human–animal interactions may view human behavior underlying disease transmission as harmful because it involves illegal use, yet community members can view the same interactions as legitimate practices (Hübschle, 2017) linked to cultural and customary use

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

(https://doi.org/10.5281/ZENODO.10280636; Williams et al. 2025). Scientists wishing to apply results and contribute to science-to-action pathways (Hitziger et al. 2018) can be challenged to accept various decision-making authorities and actors can be deeply involved in activities that threaten animals and the environment (e.g., poaching, poisoning). Scientists using systems approaches can be challenged to align with silo-specific donor motivations or priorities based on geopolitical boundaries rather than where multiple environmental, social, or physical harms converge and interact, or to prioritize some zoonotic diseases over others deemed more relevant by local stakeholders. Research can more directly explore underlying assumptions about equivalent importance across spheres, particularly when engaging in applied research involving communities whose lived experience often do not mirror the ideal.

Holistic differentiation and generalized specialization

Challenge: How can Indigenous worldviews, particularly those of the Lakota, that offer a holistic, relational, and cyclical understanding of life that aligns with and even anticipates modern interdisciplinary frameworks—like the One Health approach—be valued and integrated into contemporary approaches to complex global problems, including public health (Meyers 2025)?

Meyers (2025) discusses Indigenous knowledge as holistic and relational, contrasting with Western compartmentalized, linear, and individualistic models. He shows Lakota language and worldview reflect this interconnectedness, such as the concept of *mitakuye oyasin* ("we are all related") and the use of *oyate* to describe other species. Anthropology offers tools to explore these cultural contrasts. Modern science is beginning to circle back to holistic models, but Indigenous frameworks have long embodied this thinking. Real-world problems like type-2 diabetes in Indian Country demonstrate the limitations of narrow, biomedical solutions, and the need for culturally informed, holistic approaches (e.g., food sovereignty, traditional diets).

Native scholars in academia often become "generalized specialists," a role that, although challenging, mirrors the holistic integration of knowledge that Indigenous approaches value.

In short, Meyers (2025) advocates for recognizing and integrating Indigenous holistic ways of knowing—rooted in language, culture, and worldview—into contemporary problem-solving frameworks. However, how to successfully integrate Indigenous knowledge with more narrow focused research questions is easier said than done. What does true integration look like?

Globalizing One Health requires consistent and culturally appropriate translation of the term across languages

Challenge: How can global health governance ensure consistent and culturally appropriate translations of "One Health" so the approach is understood as a unified framework across diverse languages and societies (Wu et al. 2025)?

The One Health approach, linking the health of humans, animals, and ecosystems, has become foundational in global health governance. Yet, as the concept circulates globally, its translation across languages has received little attention. Wu and colleagues (2025) show that the term One Health has been translated into at least 20 different versions in Chinese, and similar inconsistencies appear in French and Spanish. These variations are not merely linguistic. They shape how institutions and publics interpret the meaning of One Health, whether as zoonotic disease control, environmental stewardship, or integrated health governance. Without consistent translation, One Health risks losing coherence as it travels across cultural and policy contexts.

Translation is not a neutral process. It is a cultural and political act that determines how global concepts are localized and understood. Inconsistent translations can distort meaning, weaken coordination, and erode public engagement. For instance, differing Chinese translations have led to parallel, sometimes conflicting initiatives among agencies and universities. A term intended to unify sectors has, paradoxically, generated fragmentation. The challenge is therefore not simply how to translate One Health, but how to ensure that its integrative intent, its "oneness," is preserved across languages and societies.

Language is infrastructure for global health cooperation. When key frameworks are expressed inconsistently, communication falters among governments, researchers, and communities. Translation inconsistencies can lead to divergent interpretations of priorities, disjointed policies, and reduced effectiveness in cross-sectoral collaboration. They also hinder public understanding: if the term fails to resonate culturally, people may not recognize themselves within the One Health vision or see how it relates to their everyday health practices.

To realize One Health as a truly global framework, the field must treat translation consistency and cultural resonance as central governance issues. A shared name that carries different meanings cannot foster shared action. Ensuring consistent and culturally appropriate translation of One Health is essential to its success as a global framework for global health.

Education

The One Health concept is much more likely to gain traction with increased public engagement through incorporation into Citizen Science and through its formal introduction at educational institutions. Education initiatives should be considered at both undergraduate and professional medical training. Promoting One Health through public awareness and formal training will not only increase the public demand for sustainable practices but will also help steer bright and enquiring minds towards addressing the pressing research and policy questions of One Health. The authors in this section provide a framework to address future challenges to educating the public to One Health.

Beyond mental well-being: a One Health perspective on biophobias

Challenge: How can we quantify the socio-economic and ecological impacts of biophobias to develop policies aimed at mitigating the growing burden of human–nature disconnect (Mammola et al. 2025)?

The impact of biophobia—phobic reactions toward elements of nature—compromises the health of humans, wildlife, and the broader environment. Yet, biophobia has received surprisingly little attention outside the field of psychiatry. As with any emerging topic that spans disciplinary boundaries, progress in understanding biophobias has been hampered by fragmented knowledge across fields and the absence of a coherent framework to connect disparate studies.

Mammola and colleagues (2025) propose grounding biophobia research within a One Health approach as a way forward to better understand its multi-dimensional impacts. Two consequential research questions emerge: How can we better quantify the socio-economic

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

and ecological dimensions of biophobia? What policies and actions are most effective in reducing its impact? Indeed, we currently do not fully understand whether certain pillars of the One Health framework are more economically, environmentally, or culturally impacted by biophobia than others. More transdisciplinary studies are needed to fill this gap.

This lack of synthesis also hinders the development of effective policies and interventions to address the growing prevalence of biophobia. One Health thinking could guide efforts to integrate medical, socio-economic, and ecological perspectives in addressing biophobia. Currently, the few existing policies aimed at mitigating its effects are often reactive (e.g., focused on pest control) rather than proactive (e.g., addressing the root causes of fear). What is needed is a set of preventive, educational, and regulatory policies and interventions that reduce both the prevalence of biophobia and the associated costs across all pillars of the One Health framework.

Inclusive science communication as a tool to address One Health challenges

Challenge: One Health issues by definition require interdisciplinary collaborations between scientists, policymakers, community members, humanists, and more—but such collaboration is stymied by ineffective communication between groups. How can we empower more effective communication (Kelp 2025)?

Scientists must employ inclusive approaches to science communication, considering the worldview of the groups with whom they collaborate in order to learn and solve complex One Health challenges (1). Rather than simply intending to inform or persuade non-scientists, scientists must reflect upon their science communication goals, identities, need for external expertise, and tangible community supports and policies to adopt solutions to One Health issues. Researchers and educators are continuing to develop best practices for how to train scientists in these complex skills. Beyond scientists, policymakers, and community members can engage in self-reflection on how they communicate about science, utilizing these same inclusive approaches to science communication. Such consideration of diverse worldviews, careful consideration of communication goals and approaches, and collaboration across sectors can help facilitate solution-making for One Health challenges.

Synergizing One Health with osteopathic medicine: towards a unified health approach ("One HealthOM")

Challenge: How can osteopathic medical education and practice be systematically integrated into One Health frameworks to enhance syndromic surveillance, prevention, and interdisciplinary response to emerging health threats (Brolinson et al. 2025)?

Despite growing recognition of the One Health paradigm, which links human, animal, and environmental health, integration with osteopathic medicine remains underdeveloped in research, education, and policy. Yet osteopathic physicians (DOs) are uniquely positioned to contribute to One Health through their training in holistic care, preventive medicine, and systems-based thinking. As outlined in Brolinson et al. 2025, initiatives at institutions like Edward Via College of Osteopathic Medicine (VCOM) and Midwestern University demonstrate that DOs can significantly enhance One Health through community-based surveillance, environmental toxicology research, and regional infectious disease tracking.

However, current One Health frameworks rarely include osteopathic stakeholders as core contributors. This omission represents a missed opportunity, especially as DOs now constitute 25% of the U.S. medical student population. A pressing research and policy goal should be to establish structured pathways for integrating osteopathic curricula, residency training, and public health engagement with One Health initiatives. This includes leveraging osteopathic colleges' clinical networks for real-time syndromic surveillance, as VCOM has done through its Via Learning Management System, which flagged early signs of COVID-19.

Future efforts should assess how osteopathic principles can enhance One Health's capacity for early detection, resilience, and community trust, particularly in underserved and rural areas where DOs frequently practice. This will require new models of collaborative education, shared funding mechanisms, and metrics that capture the added value of osteopathic participation in interdisciplinary health ecosystems.

Building capacity in One Health: Lessons in developing and maintaining interdisciplinary programs in higher education

Challenge: How might we expand capacity for implementing One Heath principles to address societal health challenges (Husband et al. 2025)?

Although the concept of One Health is increasingly adopted by academics, government agencies, and private industry, its impact on societal health will be limited by our capacity to transform existing organizational structures and implement One Health principles in a practical and meaningful way. The need for One Health tools and skills is recognized by international organizations; however, development of programs in higher education lag behind, often impeded by the discipline-based structure of its institutions. In essence, launching educational programs in One Health is a microcosm of the very challenges facing One Health implementation in society.

Husband and colleagues (2025) evaluate the strategies used in creating and launching one of N. America's first four-year undergraduate degrees in One Health. Reflecting its interdisciplinary foundations, the program is a collaboration among eight departments in four colleges (faculties); it is a unique degree program (Bachelor of One Health), operating at arm's length from its social and scientific disciplinary pillars. The program is organized around health challenges and is structured to explore animal, human, and environmental health as well as their relations, develop skills of interdisciplinarity (e.g., systems thinking, disciplinary humility, team problem solving), interact with One Health practitioners through case studies, culminating in a capstone experience in which students work with community partners on a regional health problem. Equally important, the study reflects on the process of program development and how, through campus-wide vision, recognition of collaborators, and inclusive governance processes and departmental incentives, higher education can facilitate educational innovation through cross disciplinary collaborations.

Actioning One Health is not automatic; rather, it requires not only an understanding of its principles but the procedures for applying it to specific problems and adapting within pre-existing organizational structures and processes. Preparing the next generation of One Health thinkers will require leadership to support challenge-based programming and continued research on identifying key competencies of interdisciplinarity, testing methods of teaching these competencies, and

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

evaluating their impacts on higher learning, now and after graduation.

Microbiome: a nexus of One Health strategies to address emerging risks

What strategies can effectively embed microbiome-health literacy and citizen science into One Health governance to ensure equitable and sustainable implementation?

Drobne and colleagues (2026) emphasizes that long-term success in advancing One Health depends on microbiome-health literacy, innovative educational strategies, and citizen science engagement. Although microbiome indicators offer powerful tools for surveillance and intervention, their utility is limited if stakeholders—from policymakers to the public—lack the knowledge to interpret and act upon them.

The challenge is to democratize microbiome science by embedding literacy and citizen participation into One Health governance. Citizen science initiatives can expand monitoring capacity, generate localized data, and foster public trust. Educational programs that integrate microbiome concepts into curricula and community outreach can empower individuals to understand how their behaviors—diet, antibiotic use, waste management—affect microbiome resilience and ecosystem health.

Embedding social science perspectives is equally critical. Policies must account for cultural contexts, equity concerns, and behavioral drivers that shape microbiome outcomes. Without this integration, microbiome-informed interventions risk being technocratic and inaccessible.

One Health conceptual framework

The One Health Conceptual Framework brings together the overall perspective of the interdependence and interactive relationship of humans, domestic and wild animals, and resilient ecosystems. There are varied frameworks for the One Health Concept that have been utilized to address specific issues. In addition, there are models and approaches to assist in developing a One Health Framework for use in resolving a particular scenario. As such, the One Health Conceptual Framework has served as an approach to development and implement projects within an overall program to address issues that range from regional to global scales. The Challenge questions raised by the authors below stimulate novel perspectives and approaches to relating ecosystem health to One Health.

Rethinking our collective well-being by sliding from One to Common Health

Challenge: How can the Common Health approach be locally implemented to foster well-being of ecosystems, society, and individuals alike (Bois and Staentzel 2025)?

Facing a global polycrisis, a number of challenges arise to systemically evolve that is, take care of the causes to eventually stop facing adverse consequences, rather than running after worsening consequences.

Despite the urgency of the situation, Bois and Staentzel (2025) argue that there is also an urgent need to reflect on where we want to go—and to prioritize shared meanings over polarized words. Rather than accepting artificially constructed oppositions (e.g., biodiversity vs. energy, end of the month vs. end of the world), they advocate for a nuanced, non-binary approach. Once collective goals are clarified, the next step is to define how we want to get there: alone or together, locally or globally, quickly or steadily, and in a way that does not worsen the current state. In this light, promoting the health of the planet as a whole becomes a guiding principle. Finally, how do we make this vision real? What is the appropriate scale of transformation? These questions ground the reflection we propose in their work "Rethinking our collective well-being by sliding from "one" to "common" health" (Bois and Staentzel 2025). One central point they emphasize is illustrated by a figure in their contribution, where environmental health is represented as the foundational base of a triangular relationship supporting both human and social health. This visualization underscores that no form of sustainable well-being can persist without a healthy environment. It is equally important to spatialize and contextualize this triangular framework, especially through a better understanding of territorial planning and land-use efforts. Only by recognizing the spatial interdependencies can we find a more stable and just balance between ecological integrity and societal needs.

Within it, they present a preliminary protocol to address these challenges by intertwining science and policy through research-action initiatives embedded in Long-Term Social-Ecological Research (LTSER) contexts.

A sonic One Health framework: characterizing health of the environment, animals, and humans using a soundscape perspective

Challenge: As the soundscape is the collection of all sounds of a place—including the sounds of nature and the sounds of society—is the soundscape a healthy representation of a place and how do these impact the well-being of people, wildlife, and landscapes (Pijanowski et al. 2025)?

Sound is a universal property of a place. Indeed, pure silence does not exist on Earth except in artificial installations. The sounds associated with a place—those arising from the animal community, the geophysical environment through the movement of water and energy, and those from society—are known to have either positive (e.g., the pulsating sounds of crickets are calming) or negative (e.g., loud traffic noise can lead to hypertension) impacts. In their article outlining what we know about the composition of soundscapes across the pillars of One Health, Pijanowski and colleagues (2025) describe a Sonic One Health Framework composed of a Sonic One Health System, a Sonic One Health Network, and a Sonic One Health Remediation Pathway. The authors describe how healthcare professionals, for example, those in the auditory sciences and neurobiology, have studied how noise levels and particular sound sources affect the whole-body state well-being of humans and wildlife. Transportation specialists, urban planners, and conservation scientists also manage sound within their professional spaces. Pijanowski and colleagues (2025) argue that these disparate experts are needed to help address the increasing volume and spatial coverage of "noise," or broadly the sounds of society, while also being attentive to increasing the exposure of people to the sounds of the natural world which have positive impacts on well-being. Three case studies that illustrate different applications of how sound can be used as a unifying theme within a Sonic One Health Framework, are briefly described.

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Bridging One Health and sustainability: the anatomy of a socioethical issue

Challenge 1: What strategies can be developed to overcome the instrumentalization of ecological concepts within One Health, and conversely, stimulate greater engagement of sustainability scholars?

Challenge 2: How can One Health better integrate humanities methodologies to address ethical dilemmas inherent to interdisciplinary exchanges between goal-oriented fields of health and sustainability?

Challenge 3: Building a rational-methodological framework to facilitate pragmatic and interdisciplinary discussions that reconcile conflicting health and biodiversity values (Boudreau LeBlanc, 2025)?

The current operationalization of One Health faces significant interdisciplinary challenges, notably in bridging the gap between health and biodiversity communities. Scholars have observed multiple systemic issues: an ongoing instrumentalization of ecological knowledge by health frameworks, limited engagement by biodiversity experts, and pronounced power asymmetries favoring health over biodiversity concerns. Moreover, conversations around environmental issues frequently devolve into instrumental or emotional debates, highlighting fundamental difficulties in interdisciplinary dialogue and diminishing the intrinsic value traditionally emphasized by ecological disciplines.

Addressing these challenges requires integrating humanities-based methodologies into One Health practices, particularly focusing on ethics, rational negotiation, and structured interdisciplinary dialogue. Rational methodologies drawn from philosophy and ethics offer significant potential to facilitate objective, pragmatic discussions about measurement (metrology) and truth (epistemology), thus overcoming ideological conflicts and creating balanced, inclusive spaces for dialogue.

This future direction advocates establishing a common methodological ground to articulate clearly the interdependencies between health and biodiversity. Explicitly incorporating these rational, humanities-oriented frameworks into One Health could profoundly enhance mutual understanding and collaboration, fostering innovative solutions and more equitable interdisciplinary exchanges.

The importance of integrating evolutionary-developmental perspectives into One Health approaches

Challenge: How can we integrate evolutionary history and developmental timing into One Health frameworks to address modern health problems (Kritzell et al. 2026)?

For modern health challenges affecting both wildlife and humans, the temporal dimensions of exposure, specifically *when* and *for how long* individuals encounter disease-relevant factors, can be just as important as identifying *what* causes disease. Temporal influences operate along two scales: the longer scale of evolutionary history and the shorter scale of how events unfold across developmental timelines. Evolutionary history sets the bounds of possible responses to novel and changing environments, whereas developmental timing determines both the nature and onset of health outcomes.

Kritzell and colleagues (2026) argue that evolutionary developmental biology (evo-devo) provides a pathway to integrate these dimensions into One Health, anchoring the approach in evolutionary and developmental mechanisms. By incorporating these mechanisms, authors argue that One Health may move beyond a reactive focus on identifying disease drivers to a more predictive framework for where and how disease will emerge. To achieve this, Kritzell and colleagues (2026) propose leveraging the Exposome and the Developmental Origins of Health and Disease concepts, while outlining major challenges to integration and how similar barriers have been addressed in other fields. Explicitly incorporating evo-devo and One Health, while utilizing these concepts, will require interdisciplinary participation and collaboration, but will greatly enhance our ability to predict, respond to, and overcome global health challenges.

Policy

Human well-being and prosperity will be furthered by taking One-Health perspectives, but only if policymakers act on the insight provided by the One-Health conceptual framework. Policy changes reflecting input from environmental scientists can rapidly address serious challenges to human welfare, for example, ozone layer depletion and acid rain poisoning of freshwater bodies (e.g., Fenster et al. 2021). This contribution to this Special Collection focusing entirely on policy and specifically on the US Lacey Act, demonstrates that many nations have the existing legislative machinery to immediately address the issues raised in this special issue. However, although the Lacey Act of 1900 may offer a novel approach to stemming the influx of new zoonotic pathogens, it relies on agency authority and discretion. A 2024 Supreme Court decision overturning the four-decade-old *Chevron* doctrine may attenuate federal agency authority and rulemaking. Arising from the 1984 case *Chevron vs. the Natural Resources Defense Council*, the *Chevron* doctrine directed a court to uphold an agency's "reasonable" interpretation of federal statute, if Congress had not explicitly addressed the statute in question in a legal dispute. The *Chevron* decision was highly influential in shaping federal rulemaking under various environmental laws. Now the Supreme Court has empowered lower federal courts to interpret ambiguities in statutes without special deference to the relevant agency's own understanding. To what extent this watershed change is a threat to advancing One Health objectives or an opportunity in disguise remains to be seen. There are two overarching lessons: policy action is dependent on the political will of the electorate and constant vigilance through increasing public awareness of the consequences of policy changes is necessary to maintain positive momentum towards achieving One Health goals.

The US Lacey Act is a One Health Policy Framework 125 years in the making

Challenge: How can historic policy frameworks address contemporary One Health aims (Anderson et al. 2025)?

Human, animal, and environmental health have traditionally been approached independently in the United States, both in practice and policy. Accordingly, regulatory authority to address these three health aims has been divided among federal agencies. The One Health approach considers the three health components in unison and thus calls for a unified policy approach. This presents the question, must we start from scratch in creating One Health policy frameworks, or can we modify our use of existing systems?

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Anderson and colleagues (2025) provide an example of how the implementation of historic legislation can be adapted to achieve One Health goals. The Lacey Act of 1900 was the first law enacted specifically to protect wildlife and regulate wildlife imports in the U.S. In its contemporary form, the Lacey Act authorizes the US Fish and Wildlife Service (USFWS) to designate wildlife species as "injurious," thereby prohibiting their import into the United States without a permit. Although species can be designated as injurious for many reasons, including human health, most have been listed due to potential ecological impacts. As a natural resources agency, it is perhaps unsurprising USFWS has focused its authority on ecological aims. The American Rescue Plan Act, passed in 2021 in response to the COVID-19 pandemic, directed USFWS to utilize its injurious listing authority for imported wildlife species that host zoonotic pathogens. By directing a natural resources agency to utilize its authority to protect public health, the United States Congress implemented a One Health–oriented interpretation of historic legislation.

Emerging health threats require efficient response systems. Novel interpretation and application of existing regulations is a valuable mechanism to address today's rapidly changing global health environment.

One biosecurity is essential to implement One Health

Challenge: How can biosecurity measures be systematically integrated into One Health to address biological threats to biodiversity, food and water security, and global health in a coordinated, sustainable way (Hulme et al. 2025)?

Invasive alien species are arguably one of the most complex and undervalued emerging biological threats to global health. It is increasingly recognized that human activities have spread pathogens, parasites, and their vectors across the world fueling multiple epidemics and pandemics. However, the considerable impact invasive alien pests, pathogens, and weeds have on ecosystem services supporting food and water security and good quality of life remain poorly quantified. As a result, biosecurity interventions essential to prevent, contain, or eradicate these biological threats remain chronically underresourced and poorly implemented in most parts of the world.

The transboundary nature of biological invasions is facilitated by the international movement of people and goods. Transport networks enable invasive species to rapidly progress from a local problem to a global crisis. Thus, failure to manage a biological threat in one nation can lead to a cascade of economic and environmental consequences across the globe. Hulme and colleagues argue that the current limited regional and global governance of biological invasions undermines any approach to deliver One Health. They recommend embedding biosecurity more strongly within the One Health framework to be a catalyst for a more holistic approach to the management of biological invasions that ensures a common suite of tools, regulatory approaches, and policy frameworks are integrated across the human, animal, plant, and ecosystem health sectors. This holistic approach—recently termed "One Biosecurity"—requires a step change in how biological invasions are managed, according to Hulme and colleagues (2025). One Biosecurity includes overcoming and crossing disciplinary barriers to strengthen surveillance systems, extend risk assessments to encompass the breadth of potential impacts, ensure open data sharing, and coordinate effective public engagement. The authors proposed that it is in the interest of each individual government to support the biosecurity of its neighboring countries, of its regional partners, and, indeed, globally to effectively address the threat of invasive alien species. Integrated governance is critical to enable the international community to act collectively to prevent local biological threats from escalating into global emergencies. Such coordination will be critical to underpinning a One Health framework which ultimately can prevent and mitigate health threats that emerge at the interface between humans, animals, plants, and the environment.

Author contributions

Mary Ann Ottinger (Conceptualization, Supervision, Writing – original draft, Writing – review & editing), Geoffrey M. Henebry (Writing – review & editing), Meghann Jarchow (Writing – original draft, Writing – review & editing), Rodney Keenan (Writing – review & editing), Anna Monfils (Writing – review & editing), Katey Pelican (Writing – original draft, Writing – review & editing), Pim Martens (Writing – review & editing), Paige S. Warren (Writing – review & editing), Paul Abram (Writing – original draft, Writing – review & editing), Molly A. Albecker (Conceptualization, Writing – review & editing), Brian F. Allan (Conceptualization, Writing – original draft, Writing – review & editing), Todd W. Anderson (Conceptualization, Writing – original draft, Writing – review & editing), C. Jane Anderson (Conceptualization, Writing – original draft, Writing – review & editing), Erin Ashe (Writing – review & editing), Edmundo Barrios (Writing – original draft, Writing – review & editing), Olivier Beauchet (Writing – review & editing), Sarah Bekessy (Supervision, Writing – review & editing), Sofia Belardinelli (Conceptualization, Writing – original draft, Writing – review & editing), Paul Bois (Writing – original draft, Writing – review & editing), Antoine Boudreau LeBlanc (Writing – review & editing), Alexander Braczkowski (Writing – review & editing), Jane Ellen Buikstra (Writing – original draft, Writing – review & editing), Yanni Cao (Writing – original draft, Writing – review & editing), Mark Carr (Conceptualization, Writing – original draft, Writing – review & editing), Luis Fernando Chaves (Writing – review & editing), Jana Collatz (Writing – original draft, Writing – review & editing), Louise Cooley (Writing – review & editing), Kevin Crooks (Conceptualization, Writing – original draft, Writing – review & editing), Kevin Curtin (Writing – original draft, Writing – review & editing), Juan Martin Dabezies (Writing – review & editing), Michele Dechoum (Writing – review & editing), Prakash N. K. Deenapanray (Writing – review & editing), Edward Emile DeMartini (Conceptualization, Writing – original draft, Writing – review & editing), Adam Dolezal (Writing – original draft, Writing – review & editing), Martin Dovciak (Writing – review & editing), Damjana Drobne (Writing – original draft, Writing – review & editing), Maged Elkahky (Writing – original draft, Writing – review & editing), Mariline Fancelli (Writing – original draft, Writing – review & editing), Franz Essl (Writing – review & editing), Colin Farrelly (Conceptualization, Writing – original draft, Writing – review & editing), Cadhla Firth (Writing – original draft, Writing – review & editing), Cene Fišer (Writing – original draft, Writing – review & editing), S. Luke Flory (Conceptualization, Writing – original draft, Writing – review & editing), Nicholas M. Fountain-Jones (Conceptualization, Writing – original draft, Writing – review & editing), Luigi Garaffa (Conceptualization, Writing – original draft), Joseph K. Gaydos (Writing – review & editing), Wayne M. Getz (Writing – original draft, Writing – review & editing), Samuel Charles Gilvarg (Writing – original draft, Writing – review & editing), Meredith Gore (Writing – original draft, Writing – review & editing), Nicole Gottdenker (Writing – original draft, Writing – review & editing), Vanina Guernier-Cambert (Writing –

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

review & editing), Rodrigo Hamede (Writing – review & editing), Jordan Hampton (Writing – review & editing), Annette M. Hübschle (Writing – original draft, Writing – review & editing), Phillip E. Hulme (Conceptualization, Methodology, Writing – original draft, Writing – review & editing), Jacinta Humphrey (Supervision, Writing – review & editing), Brian Husband (Conceptualization, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing), Zehidul Hussain (Writing – review & editing), Kate Hutson (Conceptualization, Writing – original draft, Writing – review & editing), Michael Jacob (Conceptualization, Writing – original draft, Writing – review & editing), Marshall P. Jones (Writing – review & editing), Menna NMI Jones (Writing – review & editing), Matt Kammer-Kerwick (Writing – original draft, Writing – review & editing), Nicole Kelp (Conceptualization, Writing – original draft, Writing – review & editing), Holly Kirk (Supervision, Writing – review & editing), Alexandra-Maria Klein (Writing – original draft, Writing – review & editing), Xavier Gaston Hervé Koenig (Writing – original draft, Writing – review & editing), Jonathan Kolby (Writing – review & editing), Ore Koren (Writing – review & editing), Camryn Ashley Kritzell (Writing – original draft, Writing – review & editing), Ralph J. Larson (Conceptualization, Writing – original draft, Writing – review & editing), Marcus A. Lashley (Writing – original draft, Writing – review & editing), Brian Leydet (Writing – original draft, Writing – review & editing), Catherine Lindell (Writing – original draft, Writing – review & editing), Shirley Luckhart (Writing – original draft, Writing – review & editing), Seth B. Magle (Writing – review & editing), Stefano Mammola (Writing – original draft, Writing – review & editing), Angeliki F. Martinou (Writing – review & editing), Richard Meyers (Writing – review & editing), Pawel Michalak (Writing – review & editing), Debra Miller (Writing – original draft, Writing – review & editing), Maureen H. Murray (Writing – review & editing), Kimberly Nielsen (Writing – review & editing), Barbara F. Nowak (Writing – review & editing), Christopher O'Bryan (Writing – review & editing), Matthew O'Neal (Writing – review & editing), Malgorzata O'Reilly (Writing – review & editing), Julia Osterman (Writing – original draft, Writing – review & editing), Anibal Pauchard (Writing – review & editing), Deborah L. Paul (Writing – original draft, Writing – review & editing), Jérôme Pelletier (Writing – original draft, Writing – review & editing), Maria Pinto (Writing – original draft, Writing – review & editing), Timothée Poisot (Writing – original draft, Writing – review & editing), Parham Pourdavood (Conceptualization, Software, Visualization, Writing – review & editing), Petr Pyšek (Writing – review & editing), Stephen A. Raverty (Writing – review & editing), Kimberly Rivera (Writing – review & editing), Katherine May Robertson (Conceptualization, Writing – original draft, Writing – review & editing), Helen Roy (Writing – review & editing), Sadie J. Ryan (Conceptualization, Writing – original draft, Writing – review & editing), Chadi M. Saad-Roy (Writing – original draft, Writing – review & editing), Jonathan Salerno (Conceptualization, Writing – original draft, Writing – review & editing), Lisa Schulte Moore (Writing – review & editing), Andy Sheppard (Writing – review & editing), Chloe Sher (Writing – original draft, Writing – review & editing), Alistair MS Smith (Writing – original draft, Writing – review & editing), Pamela Soltis (Writing – original draft, Writing – review & editing), Cybill Staentzel (Writing – original draft, Writing – review & editing), Patrick R. Stephens (Writing – original draft, Writing – review & editing), Mingwei Su (Writing – original draft, Writing – review & editing), Yunbo Zheng (Writing – review & editing), Mekala Sundaram (Writing – original draft, Writing – review & editing), Thilina Surasinghe (Writing – review & editing), Fiona Tang (Writing – original draft, Writing – review & editing), Alejandro Tena (Writing – original draft, Writing – review & editing), Cody W. Thompson (Writing – original draft, Writing – review & editing), Amy Toth (Writing – original draft, Writing – review & editing), Richard Unsworth (Writing – review & editing), Andrew L. Vander Yacht (Writing – original draft, Writing – review & editing), Henriette van Heerden (Writing – original draft, Writing – review & editing), James Verdier (Writing – review & editing), Montserrat Vilà (Writing – review & editing), Paolo Vineis (Conceptualization, Writing – original draft), Emma Watkins (Writing – review & editing), Rob Williams (Writing – review & editing), Vivienne Williams (Writing – review & editing), John Wilson (Writing – review & editing), Barbara Wolfe (Writing – review & editing), Cary Wu (Writing – original draft, Writing – review & editing), Jianyong Wu (Writing – original draft, Writing – review & editing), Kris Wyckhuys (Conceptualization, Supervision, Writing – original draft, Writing – review & editing), Jane Younger (Writing – review & editing), and Charles B. Fenster (Conceptualization, Supervision, Writing – original draft, Writing – review & editing)

References cited

Anderson CJ, Jewell SD, Kolby JE, Jones MP, Firth C, Reaser JK. 2025. The US Lacey Act is a One Health policy framework 125 years in the making. *BioScience*. https://doi.org/10.1093/biosci/biaf077

Ashe E, Gaydos JK, Nielsen KA, Raverty SA, Yruretagoyena L, Williams R. 2025. Broadening disease surveillance to include wild dolphins and killer whales: Novel components of One Health. *BioScience*. https://doi.org/10.1093/biosci/biaf154

Ashe E, Williams R, Clark C, Erbe C, Gerber LR, Hall AJ, Hammond PS, Lacy RC, Vollmer NL. 2021. Minding the data-gap trap: Exploring dynamics of abundant dolphin populations under uncertainty. *Frontiers in Marine Science* 8. https://doi.org/10.3389/fmars.2021.606932

Bass AL, DiCicco E, Kaukinen KH, Li S, Johnson R, Powell J, Isaac V, Dedeluk NB, Bateman AW, Miller KM. 2024. Infectious agent release and Pacific salmon exposure at Atlantic salmon farms revealed by environmental DNA. *Scientific Reports* 14: 31488.

Beauchet O. 2025. An Innu poem as a reflection on innovation in One Health initiative at the Université de Montréal. *BioScience*. https://doi.org/10.1093/biosci/biaf001

Belardinelli S, Garaffa L, Pievani T, Vineis P. 2025. Evolutionary epidemiology: A look ahead at human noncommunicable diseases through a niche construction approach. *BioScience*. https://doi.org/10.1093/biosci/biaf095

Bois P, Staentzel C. 2025. Rethinking our collective well-being by sliding from one to Common Health. *BioScience*. https://doi.org/10.1093/biosci/biaf013

Borremans B, Faust C, Manlove KR, Sokolow SH, Lloyd-Smith JO. 2019. Cross-species pathogen spillover across ecosystem boundaries: Mechanisms and theory. *Philosophical Transactions of the Royal Society B: Biological Sciences* 374: 20180344. https://doi.org/10.1098/rstb.2018.0344

Boudreau LeBlanc A et al. 2025. Bridging One Health and sustainability: The anatomy of a socioethical issue. BioScience http://doi.org/10.1093/biosci/biaf008.

Briske DD, Cromsigt PGM, Davies J, Fernández-Giménez ME, Luizza MW, Manzano P, Singh R. 2026. Pastoralism can mitigate biodiversity loss on global rangelands. *BioScience* 76: 78–89. https://doi.org/10.1093/biosci/biaf158

Brolinson PG, Stoner AM, Rawlins F, II, Sutphin HD, Michalak P. 2025. Synergizing One Health with osteopathic medicine: Towards a unified health approach ('One HealthOM'). *BioScience*. https://doi.org/10.1093/biosci/biaf123

Buikstra JE, Uhl E, Schug GR. 2025. One Paleopathology and lessons from the past. *BioScience*. https://doi.org/10.1093/biosci/biaf115

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Cao Y, Martins R, Lee J, Wu J. 2025. Navigating One Health impacts of rugged terrain: Challenges and opportunities. *BioScience*. https://doi.org/10.1093/biosci/biaf126

Coale TH et al. 2024. Nitrogen-fixing organelle in a marine alga. *Science* 384: 217–222.

DeMartini EE, Anderson TW, Carr MH, Larson RJ. 2025. Leveraging positive interactions in nature to enhance the shared goals and success of One Health. *BioScience*. https://doi.org/10.1093/biosci/biaf067

Drobne D et al. 2026. Microbiome: A nexus of One Health strategies to address emerging risks. *BioScience. https://doi.org/10.1093/biosci/biag011*.

Farrelly C. 2025. The geroscience perspective on One Health. *BioScience*. https://doi.org/10.1093/biosci/biaf080

Fenster CB et al. 2021. A call to action: Marshaling science for society. *BioScience* 71: 7–8. https://doi.org/10.1093/biosci/biaa138

Fišer C et al. 2025. Toward sustainable irrigation practices safeguarding groundwater biodiversity and ecosystem services. *BioScience*. https://doi.org/10.1093/biosci/biaf016

Flory SL, Ryan SJ, Taneja Y, Muñoz M, Lippi CA, Allan BF. 2025. Impacts of plant invasions on tick-borne disease risk. *BioScience*. https://doi.org/10.1093/biosci/biaf153

Fountain-Jones NM et al. 2025. One Health on islands: Tractable ecosystems to explore the nexus between human, animal, terrestrial, and marine health. *BioScience*. https://doi.org/10.1093/biosci/biae101

Foley JA et al. 2005. Global Consequences of Land Use. *Science* 309: 570–574.

Frank EG. 2024. The economic impacts of ecosystem disruptions: Costs from substituting biological pest control. *Science* 385. https ://doi.org/10.1126/science.adg0344

Fukami T et al. 2006. Above- and below-ground impacts of introduced predators in seabird-dominated island ecosystems. *Ecology Letters* 9: 1299–1307. https://doi.org/10.1111/j.1461-0248.2006.00983.x

Gaston KJ. 2010. Valuing common species. *Science* 327: 154–155. https://doi.org/10.1126/science.1182818

Gilvarg SC, Leydet B, Dovciak M, Smith AMS, Miller DL, Luckhart S, Lashley MA, Vander Yacht AL. 2025. Pyrohealth synchrony: Integrating wildland fire into One Health to benefit plants, animals, ecosystems, and people. *BioScience*. https://doi.org/10.1093/biosci/biaf068.

Gore M, Hübschle A, Dabezies JM, Munoz Cassolis N, van Heerden H, Wolfe BA, Williams VL, Curtin KM, Kammer-Kerwick M, Hamming P. 2025. Community-based coproduction of knowledge about wildlife trade and anthrax as a high-consequence pathogen. *BioScience*. https://doi.org/10.1093/biosci/biaf137

Hampton JO, Newsome TM, Dickman A, Sandøe P. 2025. Preserving predation. *BioScience*. https://doi.org/10.1093/biosci/biaf121

Harrison S, Kivuti-Bitok L, Macmillan A, Priest P. 2019. EcoHealth and One Health: A theory-focused review in response to calls for convergence. *Environment International* 132. https://doi.org/10.1016/j envint.2019.105058

Hitziger M, Esposito R, Canali M, Aragrande B, Häsler B, Rüegg SR. 2018. Knowledge integration in One Health policy formulation, implementation and evaluation. *Bulletin of the World Health Organization* 96: 211–218.

Hübschle A. 2017. Contested Illegality. Pages 177–197 in Beckert J, Dewey M, eds. *The Architecture of Illegal Markets: Towards an Economic Sociology of Illegality in the Economy*. Oxford University Press. https://doi.org/10.1093/oso/9780198794974.003.0010

Hulme PE, Dechoum MS, Essl F, Martinou AF, Pauchard A, Pyšek P, Roy HE, Sheppard AW, Vilà M, Wilson JRU. 2025. One biosecurity is essential to implement One Health. *BioScience*. https://doi.org/10.1093/biosci/biaf110

Husband BC, Pollock H, Clow K, Finnis E, Goodridge L, Newman A, Parmley EJ, Rosen S, Steffens TS. 2025. Building capacity in One Health: A case study in developing and sustaining interdisciplinary programs in higher education. *BioScience*. https://doi.org/10.1093/biosci/biaf160

Hussain Z, Palomo G, Anderson T, Mullinax JM, Roess AA, Gallo T. 2025. Navigating the urban landscape: Integrating animal movement ecology with the One Health framework to better understand urban ecosystems. *BioScience*. https://doi.org/10.1093/biosci/biaf082

Jacob M, Pourdavood P. 2025. Evolutionary principles shape the health of humanity as a planetary-scale organism. *BioScience*. https://doi.org/10.1093/biosci/biaf055

Kelp N. 2025. Inclusive science communication as a tool to address One Health challenges. *BioScience*. https://doi.org/10.1093/biosci/biaf011

Koenig XGH, Vincent Florens FB, Iranah P, Tatayah V, Deenapanray PNK. 2026. Small islands as system and scale to examine the One Health concept. *BioScience*. https://doi.org/10.1093/biosci/biag019

Koren O, Chaves LF. 2025. The land-use land-cover change–emerging infectious disease nexus reconsidered. *BioScience*. https://doi.org/10.1093/biosci/biaf045

Kritzell C, Ottinger MA, Albecker M. 2026. The importance of integrating evolutionary-developmental perspectives into One Health approaches. *BioScience*. https://doi.org/10.1093/biosci/biag067

Lebov J, Grieger K, Womack D, Zaccaro D, Whitehead N, Kowalcyk B, MacDonald PDM. 2017. A framework for One Health research. *One Health* 3: 44–50.

Losos JB, Ricklefs RE. 2009. Adaptation and diversification on islands. *Nature* 457: 830–836. https://doi.org/10.1038/nature07893

MacArthur RH, Wilson EO. 1967. *The Theory of Island biogeography (MPB-1)*. Princeton University Press.

Mammola S, Nanni V, Martino S, Correia R, Eckert EM, Norberg MM, Soga M. 2025. Beyond mental well-being: A One Health perspective on biophobias. *BioScience*. https://doi.org/10.1093/biosci/biaf084

Martens P, Reesink M, Soeters K. 2024. True sustainability is sustanimalism. *BioScience* 75: 350–350. https://doi.org/10.1093/biosci/biae100

Martens P. 2023. Planetary health: The need for a paradigm hift. *BioScience* 74: 128–129. https://doi.org/10.1093/biosci/biad107

Meyers R. 2025. Holistic differentiation and generalized specialization. *BioScience*. https://doi.org/10.1093/biosci/biaf096

Moss WE, Schuurman GW, Almberg ES, Buttke DE, Galloway NL, Gibbs SEJ, Hubbs A, Richgels KLD, White CL, Cross PC. 2025. Applying the resist–accept–direct (RAD) framework to wildlife health management. *BioScience*. https://doi.org/10.1093/biosci/biaf061.

Murray MH et al. 2025. Multicity research networks are needed to address global One Health challenges. *BioScience*. https://doi.org/10.1093/biosci/biaf106

Nelson BW, Ward EJ, Linden DW, Ashe E, Williams R. 2024. Identifying drivers ofdemographic rates in an at-risk population of marine mammals using integrated population models. *Ecosphere* 15: e4773.

O'Bryan CJ, Braczkowski AR, Martens P. 2025. Predators and scavengers as sentinels for planetary health. *BioScience*. https://doi.org/10.1093/biosci/biaf054

Ottinger MA, Geiselman C. 2023. *One Health Meets the Exposome*. Academic Press. An Imprint of Elsevier Press.

Paul DL et al. 2025. Harnessing natural history collections for collaborative pandemic preparedness. *BioScience*. https://doi.org/10.1093/biosci/biaf035.

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Pepin K et al. 2024. Steps towards operationalizing One Health approaches. *One Health* 18: 100740.

Pijanowski BC et al. 2025. A sonic One Health framework: Characterizing health of the environment, animals, and humans using a soundscape perspective. *BioScience*. https://doi.org/10.1093/biosci/biaf109

Poisot T, Becker DJ, Catchen MD, Gibb R, Shimabukuro PHF, Carlson CJ. 2025. Biodiversity science and biosurveillance are fellow travelers. *BioScience*. https://doi.org/10.1093/biosci/biaf091

Robertson K, Kirk H, Humphrey J, Bekessy A. 2026. Resolving the conflict between infectious disease and beneficial urban nature. *BioScience*. https://doi.org/10.1093/biosci/biaf207

Saad-Roy CM, Getz WM.. 2025 Navigating the complexities of "One Health". *BioScience*. https://doi.org/10.1093/biosci/biaf051

Salerno et al. 2025. Transdisciplinary research priorities for a One-Health approach to human–wildlife coexistence. *BioScience*. https://doi.org/10.1093/biosci/biaf026

Sundaram M, Gottdenker NL, Stephens PR. 2025. Where is the elusive primary ebolavirus reservoir and how do we find It?. *BioScience*. https://doi.org/10.1093/biosci/biaf050

Toth AL et al. 2025. Can native vegetation in agroecosystems provide a net benefit for pollinators, despite pesticide use? *BioScience*. https://doi.org/10.1093/biosci/biaf194

Unsworth RKF, Comey I, Jones BLH. 2026. Seagrass meadows as a foundational concept for 'One Health". *BioScience*. https://doi.org/10.1093/biosci/biaf208

Wallace RG, Bergmann L, Kock R, Gilbert M, Hogerwerf L, Wallace R, Holmberg M. 2015. The dawn of Structural One Health: A new science tracking disease emergence along circuits of capital. *Social Science & Medicine* 129: 68–77.

Warren BH et al. 2015. Islands as model systems in ecology and evolution: Prospects fifty years after MacArthur-Wilson. *Ecology Letters* 18: 200–217. https://doi.org/10.1111/ele.12398

Williams R, Ashe E, Broadhurst G, Jasny M, Tuytel D, Venton M, Ragen T. 2021. Destroying and restoring critical habitats of endangered killer whales. *BioScience* 71: 1117–1120.

Williams VL, Drouilly M, Coals PGR, Whittington-Jones GM. 2025. Pan-African review of cultural uses of carnivores. *PLoS ONE* 20: e0315903.

Wu C, Ong J, Clifford Astbury C, Lee KM, Shi Z, Gong Z, Viens AM, Desai S, Tsasis P, Penney TL. 2025. Globalizing One Health requires consistent and culturally appropriate translation of the term across languages. *BioScience*. https://doi.org/10.1093/biosci/biaf161

Wyckhuys KA et al. 2025. Orchard systems offer low-hanging fruit for low-carbon, biodiversity-friendly farming. *BioScience*. https://doi.org/10.1093/biosci/biae140

Zheng Y, Zhu Y, Su M. 2025. In the process of transformation: Wildlife conservation in China in the post-epidemic era. *BioScience*. https://doi.org/10.1093/biosci/biaf058

Downloaded from academic.oup.com/bioscience/article/76/10/1128/8994574 by guest on 02 November 2026

Received: 3 June 2026. **Accepted:** 4 June 2026

© The Author(s) 2026. Published by Oxford University Press on behalf of the American Institute of Biological Sciences. All rights reserved. For commercial re-use, please contact reprints@oup.com for reprints and translation rights for reprints. All other permissions can be obtained through our RightsLink service via the Permissions link on the article page on our site-for further information please contact journals.permissions@oup.com